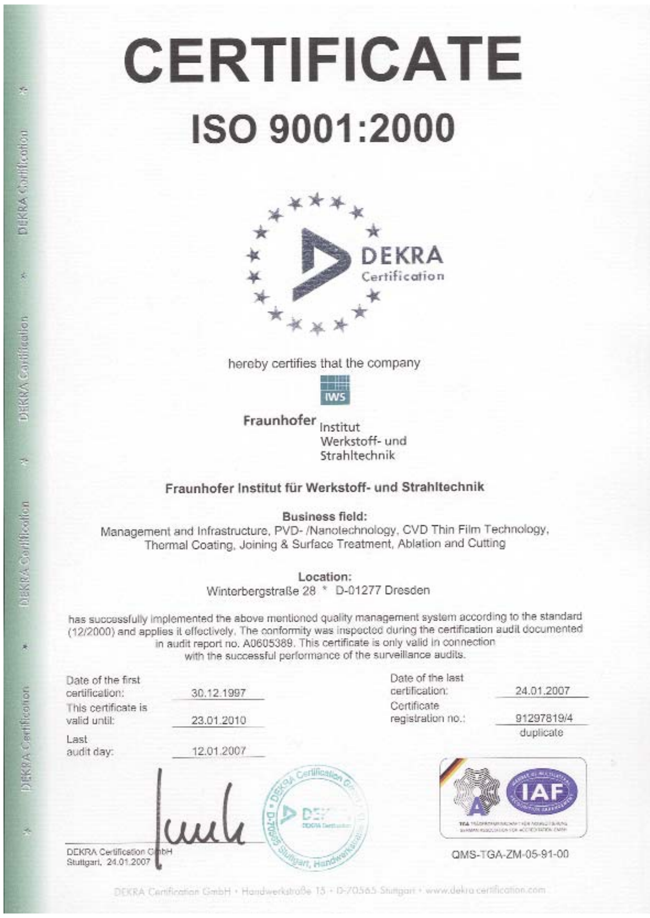
Fraunhofer Institute Material and Beam Technology

Annual Report 2008

Internet: www.iws.fraunhofer.de

Fraunhofer Institute Material and Beam Technology

Annual Report 2008



CERTIFICATE

ISO 9001:2000

DEKRA Certification

hereby certifies that the company

Fraunhofer Institut Werkstoff- und Strahltechnik

Fraunhofer Institut für Werkstoff- und Strahltechnik

Business field:
Management and Infrastructure, PVD- /Nanotechnology, CVD Thin Film Technology, Thermal Coating, Joining & Surface Treatment, Ablation and Cutting

Location:
Winterbergstraße 28 * D-01277 Dresden

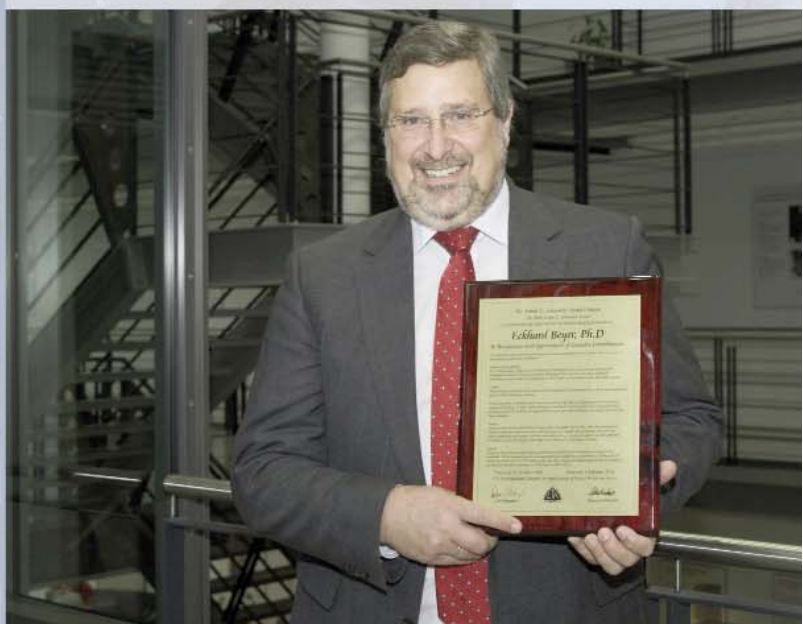
has successfully implemented the above mentioned quality management system according to the standard (12/2000) and applies it effectively. The conformity was inspected during the certification audit documented in audit report no. A0605389. This certificate is only valid in connection with the successful performance of the surveillance audits.

Date of the first certification:	30.12.1997	Date of the last certification:	24.01.2007
This certificate is valid until:	23.01.2010	Certificate registration no.:	91297819/4 duplicate
Last audit day:	12.01.2007		

DEKRA Certification GmbH
Stuttgart, 24.01.2007

QMS-TGA-ZM-05-91-00

DEKRA Certification GmbH • Handwerkstraße 15 • D-70565 Stuttgart • www.dekra-certification.com


Eckhard Beyer, Ph.D

Preface

Early 2008 demonstrated still booming industry conditions but ended with a downward economic trend. This negative development in the overall economy affects research and development spending with a certain delay. Therefore in spite of the conditions, the IWS was able to repeat the excellent result of the previous year. Research revenues from industrial customers came close to 8 million Euros. In 2008 we expanded our capacities and hired ten additional employees.

Our project center CCL in the USA finished 2008 equally well. In particular the laser beam welding of batteries for future car generations contributed to the success. Our project group at the DOC was active in the area of energy technologies; the scientists successfully developed new coatings and coating systems for fuel cells.

An IWS highlight was the development of an extremely wear resistant coating, which drastically reduces the coefficient of friction even when using lubricants. This IWS coating will have automotive powertrain applications to reduce CO_2 emission and fuel consumption of cars.

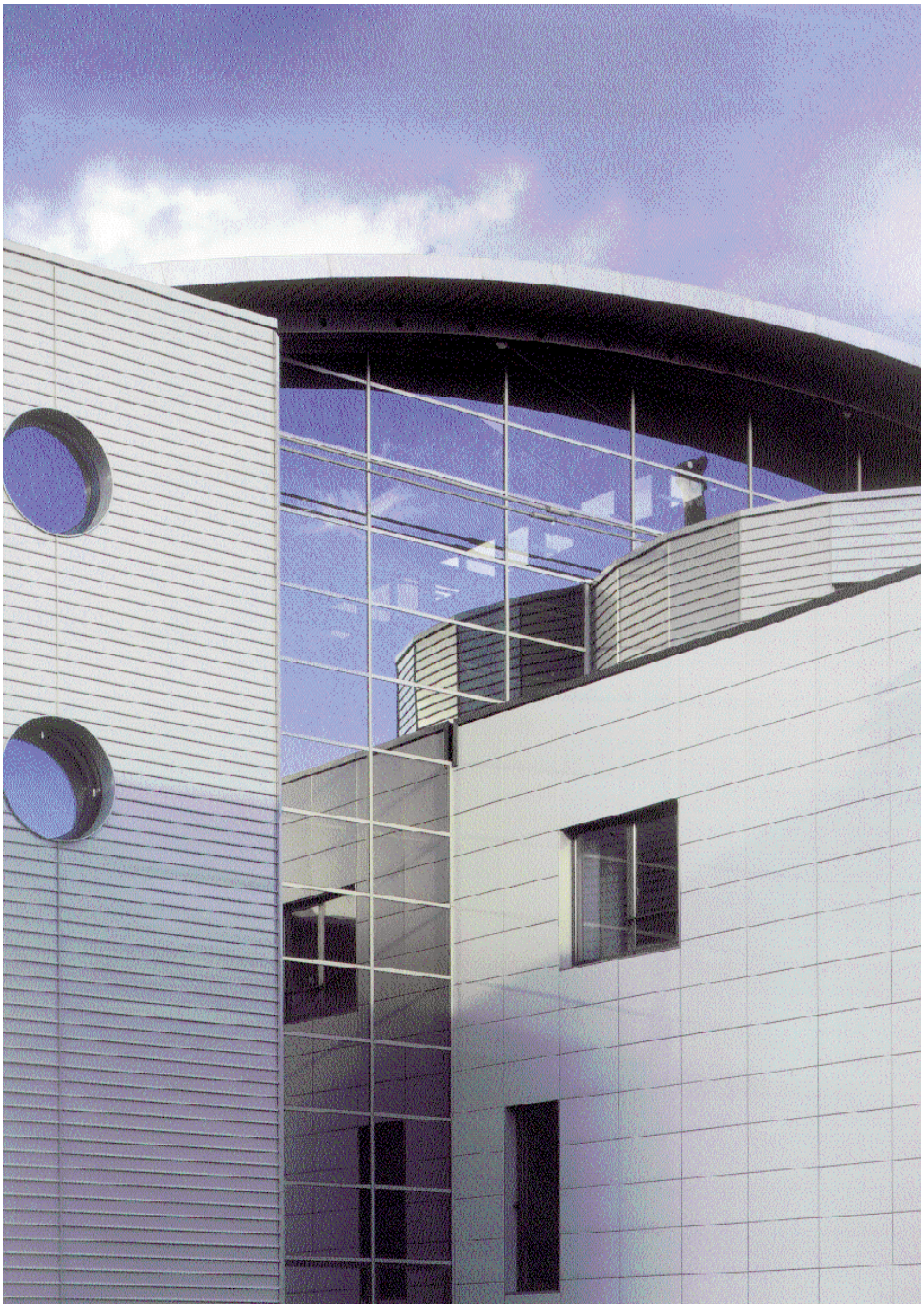
In 2008 several innovative laser technologies were developed as well as commercialized.

A special event represented the signing of a cooperation agreement with the Technical University in Wrocław at which federal chancellor Angela Merkel participated. The establishment of the project center aims at improving the research cooperation with Poland, at exploiting the synergies of complementary expertise, and especially at developing the Eastern European markets.

For 2009 we expect a decline in industrial revenues. However, based on already issued grant agreements, we anticipate an increase in publicly funded projects; so we face the difficult year with moderate optimism.

Eckhard Beyer

The secret of success is determination.
Benjamin Disraeli



Fraunhofer-Institut für
Werkstoff- und Strahltechnik IWS

Fraunhofer Institute for
Material and Beam Technology IWS

Winterbergstraße 28
01277 Dresden
Germany

phone: +49 (0) 351 2583 324
fax: +49 (0) 351 2583 300

e-mail: info@iws.fraunhofer.de
website: www.iws.fraunhofer.de

Contents

"Fraunhofer Project Center for Laser Integrated Manufacturing" founded in Wrocław

Dr. Angela Merkel wishes Prof. Beyer success for the establishment of the German-Polish research center

On September 24th 2008 and in the presence of Dr. Angela Merkel, the Technical University of Wrocław and the Fraunhofer IWS signed a framework agreement to found the joint "Fraunhofer Project Center for Laser Integrated Manufacturing". According to Dr. Merkel the center assumes a vanguard role in applied research collaboration between Germany and Poland. She recognizes the cooperation of "an excellent German photonics institute with one of the most renowned production technology institutes in Poland" as an important building block in neighborly relations.

Laser Institute of America distinguished Professor Eckhard Beyer

On October 22nd 2008 the Laser Institute of America (LIA) presented Professor Eckhard Beyer with the Arthur L. Schawlow award. The award is named after the Nobel Prize laureate and is the most prestigious recognition in the field of laser technology. The Schawlow award recognizes the accomplishments of individuals who provided extraordinary contributions to the field of laser applications in science, industry and education.

Prof. Beyer receives the Schawlow Award 2008 at the annual meeting of LIA during the ICALEO 2008

4th international workshop "Fiber Laser"

Latest developments are presented at the 4th fiber laser workshop in the International Congress Center Dresden

The fourth international workshop on fiber lasers was held at the Congress Center in Dresden on November 5th and 6th 2008. The Fraunhofer IWS Dresden organized the workshop. In recent years research and development in this area have made steady progress. Accordingly, the number of fiber laser applications is continuously increasing. About 340 participants learned about new possibilities of using fiber lasers in laser materials processing applications.

Recognition of an innovative process for the manufacturing of airbag protection covers

On June 2nd 2008 the company Schreiner Protech received the "Innovation Award 2008" of the Free State of Bavaria for a new flexible process to manufacture protective covers for airbags. Engineers at the Fraunhofer IWS performed the basic technology and system development of this process.

Further commercialization of robot based laser systems for hardening and buildup welding

A subcontract from ALOtec Dresden GmbH in spring 2008 led the IWS to implement a robot based laser-hardening system with a 6 kW diode laser at the company EMO in Celje (Slovenia). The system is currently used to harden tools for body making. As a subcontractor the IWS was responsible for the development of the technology as well as the delivery of special components.

In October 2008 IWS engineers integrated a 6 kW diode laser, including system and process technology, into a laser buildup welding robot machine with pivot and swivel axes at the Greek company Roussakis Ship Repairs. The system is used to repair various ship components. A high degree of flexibility is ensured by the availability of a set of different powder nozzle configurations of the Fraunhofer IWS COAXn family.

Installation of a robot based laser hardening system in Slovenia

Laser beam buildup welding of ship components at Roussakis Ship Repairs in Greece

Temperature control system to braze solar cells

Brazing system of the company teamtechnik Maschinen and Anlagen GmbH Freiberg with an integrated temperature control system from Fraunhofer IWS, upper pic.: optics with filter holder

The cooperation between the Fraunhofer IWS Dresden and the company teamtechnik Maschinen und Anlagen GmbH Freiberg began in 2007. Both partners developed a fast detection and control system for temperature control applications. A system that had originally been developed for laser hardening processes was adapted to brazing of solar cells. The system was refined for 2008 and implemented in additional installations of teamtechnik equipment.

Diamor® coatings on thermal spray coated ball valves

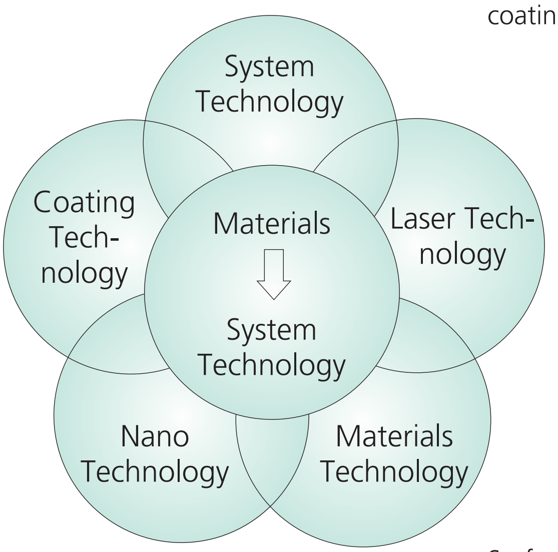
The coating of balls for ball valves was commercialized in low volume production

In 2008 the results of a joint research project with the company KVT Kurlbaum GmbH were commercialized in low volume production. A Diamor® top layer is applied as an overcoat to a thermally sprayed hard metal coating on ball valves. The coefficient of friction in the valve is reduced to one third and the lifetime of the ball valves drastically increases.

Our Mission: We solve our customer's problems and consider projects as successful if our customers are earning money with the developed solution

Short portrait

The research and development work at the Fraunhofer Institute for Material and Beam Technology (IWS) is based on our substantial expertise in materials- and nanotechnologies combined with the resources for comprehensive materials analysis and characterization. The specialty and competitive advantage of the Fraunhofer IWS lies in the combination of this fundamental expertise with its far reaching experiences and resources in the areas of coating and laser technologies.



Activity areas of the Fraunhofer IWS Dresden

Surface and coating technologies increasingly involve plasma processes. Therefore the institute developed a core competence area in plasma coating processes, which includes atmospheric pressure plasma sources and plasma CVD reactors.

In the area of laser technologies, the IWS focuses on laser materials processing and the development of laser specific system solutions.

To fulfill our mission to develop new technologies for industrial customers and to support them during the technology transfer, we developed a core competence in the area of system technologies.

Laser and surface technologies are production technologies. A central element of production technologies is materials. Materials are constantly developed and improved. Materials science plays an important role in macro processing. Similarly, nanotechnology is of fundamental importance to thin film coating technologies. In both areas the institute created new and extended upon existing core competences. Due to the close cooperation with equipment and system manufacturers, the IWS is in the position to offer "one stop solutions" to our customers. In general these solutions rely on novel concepts, which are based on an overall systems and process approach that also considers materials and workpiece behavior. The steady expansion of IWS equipment resources guarantees an effective and high-level project performance utilizing the latest technologies available.

Business fields

The IWS business fields are joining, cutting, and surface technologies. In particular are the following areas:

- joining,
- removal and cutting,
- surface technologies consisting of
  - surface layer technologies,
  - thermal coating technologies,
  - PVD vacuum coating technologies,
  - CVD atmospheric pressure coating technologies.

The business field "Surface Technologies" primarily addresses wear and corrosion protection, optical and decorative coatings, other functional coatings as well as the removal, structuring and repair of surfaces.

Our core competences:

Laser materials processing

- high speed cutting of thick metal sheets
- cutting and welding of plastics and other non-metals
- development of welding processes for hard-to-weld materials
- laser hybrid technologies such as
  - laser induction welding
  - laser induction remelting
  - plasma TIG or MIG assisted laser welding
- laser and plasma powder buildup welding
- laser surface layer hardening, alloying, and remelting as well as short-term heat treatment
- removal and cleaning
- process monitoring and control

Plasma coating processes

- plasma, flame, and HVOF spraying
- atmospheric pressure plasma assisted CVD (microwave and arc jet plasmas)
- plasma etching
- development and adaptation of plasma sources
- vacuum arc processes
- precision coating processes (magnetron and ion beam sputtering)
- laser arc processes as hybrid technology

Materials science, nanotechnology

- properties analysis of surface treated, coated and welded materials and parts
- failure and damage analysis
- optical spectroscopic characterization of surfaces and coatings down to the nanometer
- mechanical tribological characterization
- thermoshock testing of high temperature materials
- coating thickness and E-modulus measurements of nm to µm coatings

Systems technology

- utilization of the process know-how to develop, design and build components, equipment and systems that can be integrated in manufacturing lines including software components
- laser system solutions for cutting, welding, coating and surface refinement
- development of process monitoring and control systems
- process focused prototype development of coating systems or their core modules
- components for PVD and CVD systems
- atmospheric pressure plasma assisted CVD sources
- measurement systems for the characterization of coatings and the non-destructive part testing using laser acoustic and spectroscopic methods
- systems for the spectroscopic monitoring of gas mixtures
- software and control techniques

Process simulation

The IWS develops complete modules to simulate:

- thermal hardening and laser hardening,
- laser welding,
- laser powder buildup welding,
- vacuum arc coating,
- gas and plasma flow dynamics in CVD reactors,
- optical properties of nano layer systems.

The simulation results are used for process optimization. We also use additional commercially available simulation modules.

Business fields \ Core services	Laser materials processing	Plasma coating processes	Materials / Nanotechnology	System technology	Process simulation
Removal / Cutting	□		▫	■	▫
Joining	■		■	■	□
Surface treatment	□	▫	□	■	□
Thermal coating	□	■	□	□	□
PVD - Vacuum coating technology		■	■	□	▫
CVD - Atmospheric coating technology		■	□	▫	□

Internet: www.iws.fraunhofer.de

Equipment

Laser beam sources

several CO_2 lasers, up to 8 kW

several fiber lasers, up to 8 kW cw

disk laser, 5 kW

TEA and sealed-off CO_2 laser

several Nd:YAG lasers up to 4.4 kW cw (diode pumped) and 1 kW pm

Nd:YAG laser (1064, 532, 355 nm) with pulse lengths in the ns range

Nd:YAG laser with OPO (400 - 700 nm)

mobile Nd:YAG laser for surface structuring and cleaning

several high power diode lasers, 1 - 10 kW

fiber laser (16 mJ pm, 20 W cw)

excimer laser (193 nm and 248 nm)

View of the IWS technology hall

Handling systems

3D double gantry system, 22 axes with 3D processing heads, speeds of up to 40 m min^{-1}, working space 10 x 3 x 1.5 m^3

several CNC laser processing systems with up to 8 axes, speeds of up to 20 m min^{-1}, working space 4 x 3 x 1.5 m^3

High-speed 3D laser cutting system with linear drives

laser induction hybrid system with 5 axes (6 kW CO_2 laser, 80 kW MF induction generator)

2D and 3D milling machines with retrofitted laser and plasma powder buildup welding

laser system for the simultaneous processing with two cooperating robots, swivel unit and two fiber coupled 6 kW diode lasers

Laser beam welding system with 6 kW CO_2 high power laser

2D cutting system with linear direct drive (max. 300 m min^{-1} feed rate)

3D cutting system with two processing optics (synchronous and tandem processing)

2D and 3D cutting head systems for CO_2, Nd:YAG and fiber lasers

two laser processing stations with industrial robots

several precision systems with up to 8 CNC axes in combination with several laser beam sources

micro structuring systems with excimer lasers (193 nm and 248 nm)

Coating systems

vacuum arc coating systems (laser arc, pulsed high current arc, direct current arc, magnetic filter)

deposition systems for ultra precision multilayers based on ion beam sputtering and magnetron sputtering

combination coating system, electron beam (40 kW) and high current arc

laser PVD coating system (Nd:YAG, excimer, TEA-CO_2-laser) in high vacuum and ultra high vacuum

systems for atmospheric pressure plasma spraying (APS) and the high velocity oxygen fuel (HVOF) thermal spraying with powders and suspensions

systems for the plasma assisted CVD at atmospheric pressure

system for plasma etching at atmospheric pressure

test stand for atmospheric pressure plasma sources (linear dc arc discharge)

Special components

static and flexible dynamic beam shaping systems for laser powers of up to 10 kW

remote processing optics for CO_2, Nd:YAG and fiber lasers with working areas of up to 1 x 1 m^2

CNC or sensor controlled wire feeder for laser welding and coating

mobile MF and HF induction sources (4 - 20 kHz, 100 - 400 kHz)

modular powder nozzle system COAXn for laser beam buildup welding

process monitoring systems for thermal spraying, laser beam buildup welding, laser welding and cutting

software package DCAM for the offline programming of robots and CNC systems

sensor systems for the 3D geometry scanning (automatic teach in) for laser processing of parts (online and offline contour tracing)

beam diagnosis systems for CO_2, Nd:YAG and fiber lasers

LOMPOC-Pro + EMAqs-camera

measurement system for high speed process analysis (4 channel high speed image intensifying camera)

UV / VIS-, FTIR and NIR diode laser process spectrometer for the in-situ analysis of process gases and plasmas

Measurement devices

equipment for the analysis of materials microstructures including preparation techniques:
- metallography
- transmission electron microscopy
- scanning electron microscopy

equipment for materials testing:
- servo hydraulic testing machines (pull-pressure: ±500 kN and ±100 kN; torsion / axial: 8 kN / 40 kN)
- mechanical strain / compression testing machine
- computer assisted micro hardness tester
- resonance fatigue tester
- flat bending torsion system
- several wear testers (abrasive, cavitational, oscillating in sliding contact)
- salt spray fog test

laser acoustic tester for the determination of the E-modulus of coatings

laser shock measurement system with high speed pyrometer

equipment for analyzing surfaces and coatings:
- scanning atomic force microscope (AFM)
- EUV reflectometer
- fully automated spectral ellipsometer (270 - 1700 nm)
- UV-VIS spectrometer
- raman micro spectrometer
- FTIR-NIR spectrometer
- FTIR spectrometer, FTIR microscope
- registering indenter
- scratch tester
- roughness measurement equipment
- tribometer
- intrinsic stress measurement equipment

X-ray diffractometer (CuKα, MoKα)

particle counter (CPC + SMPS) and nano spectral analyzer

optical 3D coordinate measurement system

impedance spectrometer

3 axes and 5 axes CNC milling machines with laser processing modules for the complete machining with laser buildup welding and milling

Laser scanning microscope LSM Pascal 5 for high precision characterization and analysis of surfaces in the micro and nano meter range

Laboratory for the fabrication of single wall carbon nanotubes

Organization and contacts

External Project Groups

CCL - USA
Prof. J. Asmussen
phone: +1 (0) 517 355 4620

Laser Applications
C. Bratt
Coating Technology
Dr. T. Schülke

DOC
Dr. A. Zwick
phone: +49 (0) 231 84 43 512

PCW - Polen
Prof. Dr. E. Chlebus
phone: +48 (0) 71 320 2705

Executive Director Prof. Dr. E. Beyer

Deputy Director Dr. A. Leson
Deputy Director Dr. A. Techel
Assistant Mrs. R. Weinberg
phone: +49 (0) 351 2583 420

Infrastructure

Administration, Technical Support, Public Relations

Dr. A. Techel
ext.: 473

Surface Engineering and Coatings

PVD- and Nano-technology

Dr. A. Leson
ext.: 317

- **X-Ray and EUV Optics** – Dr. S. Braun, ext.: 432
- **Nanotubes and Particles** – Dr. O. Jost, ext.: 477
- **Carbon Coatings** – Dr. V. Weihnacht, ext.: 247
- **PVD Coatings** – Dr. O. Zimmer, ext.: 257

CVD Thin Film Technology

Prof. S. Kaskel
ext.: 331

- **CVD Technology** – Dr. I. Dani, ext.: 405
- **Prozess-Monitoring** – Dr. W. Grählert, ext.: 406
- **Chem. Surface Technology** – Dr. H. Althues, ext.: 476

Thermal Coating

Dr. S. Nowotny
ext.: 241
Dr. L.-M. Berger
ext.: 330

- **Thermal Spraying** – Dr. L.-M. Berger, extl.: 330
- **Cladding** – Dr. S. Nowotny, ext.: 241

Laser Materials Processing

Joining and Surface Treatment

Prof. B. Brenner
ext.: 207

- **Welding** – Dr. J. Standfuß, ext.: 212
- **Surface Treatment** – Dr. S. Bonß, ext.: 201
- **Bonding** – Dr. I. Jansen, phone.: +49 (0) 351 46 33 5210
- **Materials Characterization** – Dr. J. Rödel, ext.: 384

Ablation and Cutting

Dr. L. Morgenthal
ext.: 322

- **Laser Cutting** – Dr. T. Himmer, ext.: 238
- **Microprocessing** – Dr. U. Klotzbach, ext.: 252
- **Surface Functionalization** – Dr. A. Lasagni, ext.: 007
- **Fiber Laser and Scanner Technology** – Dr. L. Morgenthal, ext.: 322

Network Nano
Dr. O. Zimmer
ext.: 257
Dr. A. Leson
ext.: 317

Innovation Cluster 'nano for production'
Dr. A. Leson
ext.: 317

Network LiFt
Dr. S. Bonß
ext.: 201
C. Zellbeck
ext.: 332

TECHNISCHE UNIVERSITÄT DRESDEN

Lehrstuhl Laser- und Oberflächentechnik LOT

Chair for Laser and Surface Technology
Prof. Dr. E. Beyer
Deputy Prof. Dr. U. Günther
Assistant Mrs. J. Petermann
phone: +49 (0) 351 46 33 1993

Guest companies located at Fraunhofer IWS:

- EFD Induction GmbH Freiburg, Dresden Branch
- ALOtec Applied Laser and Surface System Technology GmbH Dresden
- AXO Dresden GmbH

Connection to the University of Technology (TU Dresden)

Chair for Laser and Surface Technology

During 2008, 34 colleagues were employed in the university department. The third party revenues yielded more than 1.0 million euros.

The department of laser and surface technology is the driving component of the institute for surface and manufacturing technology at the faculty of mechanical engineering. The performed projects are more basically oriented and are intended complementaryly to the work of the IWS. The teams deal with following subjects:

- production design
- laser technology
- surface technology
- film technology
- adhesive bonding
- ablation technology

The following courses were offered:
- Prof. Beyer: Manufacturing technology II
- Prof. Beyer: Laser basics
- Prof. Beyer: Laser system technology
- Prof. Beyer: Plasmas in manufacturing technology
- Prof. Beyer: Rapid prototyping
- Prof. Beyer: Laser robotic, lasertronic
- Dr. Leson: Nanotechnology
- Prof. Schultrich: Thin film technology
- Prof Günther: Micro and finish processing

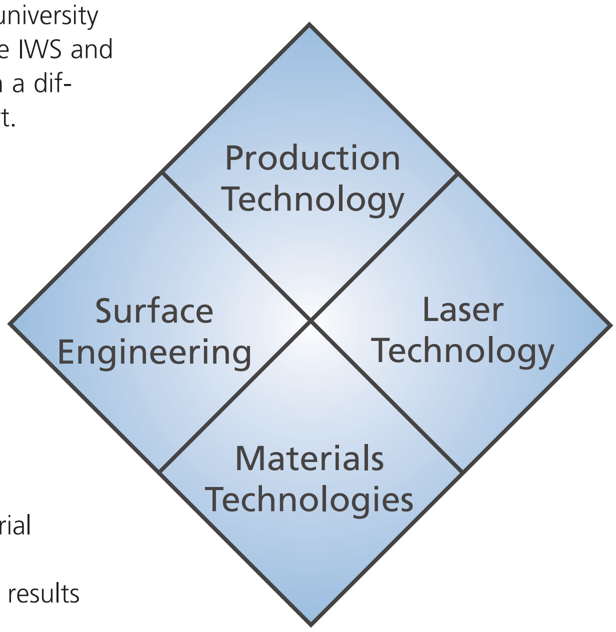
Lehrstuhl
Laser- und Oberflächentechnik LOT

Cooperation Fraunhofer IWS - TU Dresden

A special agreement regulates the cooperation between the IWS and the TU Dresden. Prof. Beyer works simultaneously as the executive director of the IWS as well as a chairman at the University. The work is distributed as follows: Research and education are performed at the university and applied research and development are performed at the IWS. IWS employees are tied into projects at the university and vice versa. In the end the IWS and university form one unit with a different emphasis for each part.

The advantages for IWS are:
- cost effective basic research
- education of junior scientists for the IWS
- access to scientific helpers

The advantages for the TU are:
- R&D involvement in industrial projects
- integration of newest R&D results into education
- training of students on the most modern equipment



CD for laser technology course

CD for plasmas in manufacturing technology course

Industrial project group at the Dortmunder OberflächenCentrum (DOC) at the ThyssenKrupp Steel AG

Dr. Axel Zwick
Manager of the project group
at DOC in Dortmund
phone: +49 (0) 231 844 3512

The ThyssenKrupp Steel AG (TKS) concentrated its resources and competences in surface technologies with the formation of the DOC in which the Fraunhofer-Gesellschaft participates.

The DOC is the largest research and development center in the area of surface treatments for sheet steel in Europe. At DOC employees of TKS and the Fraunhofer IWS work jointly together in a new form of cooperation called the **"Public Private Partnership"**. A common goal is the development of innovative surface engineering processes and their transfer to industrial manufacturing.

One early outstanding result of this cooperation is a novel zinc alloy coating (ZE-Mg). At only half the layer thickness, these new coatings combine the very good corrosion protective properties of proven zinc coatings with a substantially improved laser weldability.

In addition hybrid and combination processes have been developed. Of special note are the hybrid welding of high strength steel components and the combination processes of cleaning and welding and welding and post galvanizing.

Beyond this the Fraunhofer project group offers in its 1,100 m^2 facility a number of complementing surface technologies. With modern equipment it is possible to produce nearly pore free and extremely adherent plasma spray coatings. Areas on components and tools facing aggressive wear can be coated with millimeter thick wear protection coatings through laser deposition welding techniques. Meter-long and ton-heavy parts can be coated in vacuum with nano- and micrometer high performance coatings such as the Diamor® film system, which provides an extreme surface hardness and excellent low-friction sliding properties. Coating systems are being developed with additional corrosion protection.

The wide spectrum of the available processes and their combinations together with the expertise of the involved Fraunhofer Institutes guarantees cost effective and optimized problem solutions for our customers, whether it is TKS, a TKS-customer, or any other company. With the help of a novel compact 8 kW solid-state laser with high beam quality, it becomes possible to perform process development as well as "trouble shooting" directly on site at the industrial customer production facility.

Facility of the Dortmunder OberflächenCentrum

www.iws.fraunhofer.de/doc

Fraunhofer Project Center for Laser Integrated Manufacturing (PCW)

"To jointly shape the future" is the goal of German and Polish engineers and scientists who are collaborating at the "Fraunhofer Project Center for Laser Integrated Manufacturing". In the presence of Germany's chancellor, Dr. Angela Merkel, the research center was officially inaugurated in Wrocław on September 24^{th} 2008.

At the Fraunhofer project center, German and Polish researchers will bundle their know-how in a holistic approach to further develop and improve rapid prototyping technologies. Fraunhofer IWS engineers are experienced in the development of laser technologies and the scientists from the TU Wrocław are specialists in manufacturing and process technologies. Together they can explore and develop new technology areas. The development of new prototyping techniques requires joint competences.

A series of joint projects is lined up. For example, one project will utilize a laser process to build structures, which are mechanically finished in between and post processing steps in one and the same machine setting. This and similar projects aim at the expansion of rapid prototyping to rapid manufacturing with the ultimate goal to develop generating fabrication processes for individualized manufacturing of unique products.

From Wrocław the team wants to develop international markets. Potential customers for innovative rapid prototyping are automotive suppliers and manufacturers of household and electro appliances in East and West.

The partnership with the Technical University in Wrocław represents the first Fraunhofer cooperation in Poland. The effort plays a vanguard role in establishing German-Polish collaborations in applied research.

Prof. Dr. Edward Chlebus
Executive director of institute
TU Wrocław
phone: +48 (0) 71 320 2705

Dr. Jan Hauptmann
Project coordination
Fraunhofer IWS
phone: +49 (0) 351 2583 236

Prof. Dr. Edward Chlebus, Prof. Dr. Eckhard Beyer and Prof. Dr. Hans-Jörg Bullinger in discussion with Dr. Bogdan Dybala at the rapid prototyping laboratory of the TU Wrocław (from left to right)

Fraunhofer Center for Coatings and Laser Applications (**CCL**)

Prof. Jes Asmussen
Center Director
CCL / USA
phone: +1 (0) 517 355 4620

The US market is one of the most important international benchmarks and innovation driving forces for applied research and development. Since 1997 the Fraunhofer IWS Dresden has been concentrating its USA activities within the "Fraunhofer Center for Coatings and Laser Applications" (CCL).

The Fraunhofer Center for Coatings and Laser Applications mirrors the main activities of the IWS in laser and coating technologies. With an annual turnover of $4.4 Mio the center is one of the strongest Fraunhofer centers in the USA. Since 2003, Dr. Jes Asmussen heads the CCL. He is a professor at Michigan State University and his previous work in diamond coatings and synthesis ideally complement the know-how of the Fraunhofer IWS in the area of Diamor® coatings.

The CCL consists of two divisions, the "Coating Technology Division" at the Michigan State University in East Lansing and the "Laser Applications Division", which is situated at the Fraunhofer USA Headquarters location in Plymouth, Michigan.

Coating Technology Division

Prof. Jes Asmussen and Dr. Thomas Schuelke lead a group of experienced Fraunhofer researchers and German students in collaboration with faculty members and students of the Michigan State University. The team works in the following research areas:

- technologies involving amorphous diamond-like carbon coatings,
- chemical vapor deposition of ultra-nano-, poly- and single crystalline diamond materials,
- doping of diamond materials,
- physical vapor deposition technologies.

The amorphous diamond-like carbon coating research program utilizes the Laserarc® process, which was developed at the IWS Dresden. Since several years CCL engineers have been applying this technology to coat tools for the machining and processing of aluminum materials. The amorphous diamond-like carbon coating significantly improves the lifetime of these tools. The Coating Technology Division collaborates closely with Michigan State University's Formula Racing Team. High performance wear resistant coatings are tested on various racecar components under race conditions. The collaboration provides the racing team with a competitive advantage and also returns critical information to CCL engineers for improving coating performance.

www.ccl.fraunhofer.org

In recent years the Coating Technology Division focused on research in the area of microwave plasma assisted chemical vapor deposition of diamond materials and in particular on the synthesis of doped and undoped single crystalline diamond. Here the team established an international reputation. Due to the tight integration in the University structure the team also offers analysis services for materials composition and the characterization of coating and component.

Laser Applications Division

The laser group of the CCL is located in Plymouth (Michigan), which is "next door" to the American automotive industry in Detroit. The group performs numerous laser beam welding projects of power train components such as differential gear sets, transmissions and drive shafts. In 2007 the CCL was presented with the Henry Ford Technology Award in recognition for the development of a laser beam welding process to improve the roof strength of Super Trucks.

A highlight of the research work is the development, patenting and licensing of a laser buildup welding process to generate highly abrasion resistant coatings. The coating consists of nearly mm-sized synthetic diamond particles, which are embedded in a metallic matrix. The technology is applied to drilling equipment for the oil production in the USA and Canada.

The close connection to the Fraunhofer CCL offers several advantages to the IWS. The awareness of the supply and demand situation helps to quickly recognize trends in the United States, which influence the technology development efforts at the IWS.

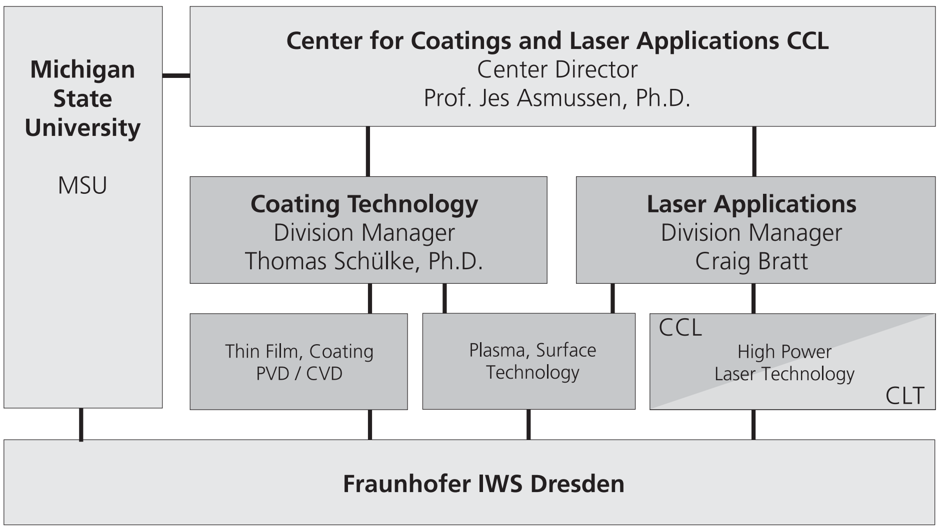
The research and development work performed in the United States generates additional know-how and competencies, which benefit the project acquisition in German and European markets. An exchange program offers IWS researchers the opportunity to work in the United States, which provides them with experiences that are beneficial for their entire career.

Dr. Thomas Schülke
Division Manager
Coating Technology
phone: +1 (0) 517 432 8173

Craig Bratt
Division Manager
Laser Applications
phone: +1 (0) 734 738 0550

Building of CCL in East Lansing, Michigan

Building of CCL, CLT (Center for Laser Technology), and Fraunhofer USA Headquarters in Plymouth, Michigan



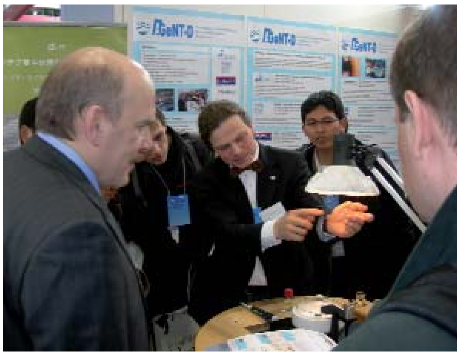
Nanotechnology competence center

Project coordination

Dr. Andreas Leson
phone: +49 (0) 351 2583 317
andreas.leson@iws.fraunhofer.de

Dr. Ralf Jäckel
phone: +49 (0) 351 2583 444
ralf.jaeckel@iws.fraunhofer.de

website: www.nanotechnology.de
www.iws.fraunhofer.de



Interested visitors at the AGenT-D booth receive information

The Fraunhofer IWS and companies present technologies and products at the booth of Saxony's Economic Development Corporation

Nanotechnology competence center "Ultrathin Functional Films"

Nanotechnology belongs to the key technologies of the 21st century. Already today there are products ready for the market. Examples include computer hard disk drives and read / write heads for data storage, which are coated with layers only a few nanometer thick. Another example is the scanning electron microscope that makes the world of atoms and molecules visible. Ultrathin films are a key element of nanotechnology.

Since September of 1998, 51 companies, 10 university institutes, 22 research institutions and 5 associations, who bundled their know-how and formed a resources network, jointly pursue the persistent development of industrial application opportunities. The Fraunhofer IWS coordinates this effort, which is recognized by the German Federal Ministry for Education and Research as a national competence center for ultrathin functional films.

In February 2007, a group of nine competence centers with a focus in nanotechnology joined forces by forming the "Working group of nanotechnology competence centers in Germany (AGeNT-D)". The participating centers are located across Germany and jointly cover the entire area of different nanotechnologies.

Participation of the nanotechnology competence center Dresden at the Nanotech 2008 exhibition and conference in Tokyo

The nanotechnology competence center supported Saxony's Economic Development Corporation to exhibit at the worldwide largest nanotechnology show "Nanotech Tokyo 2008" from February 13 - 15, 2008. The "Working Group of Nanotechnology Competence Centers in Germany" (AGeNT-D) presented in Tokyo as well.

Over three days 49,400 visitors attended the exhibition, which marked a new record. In the area of nanotechnology the Federal Republic of Germany supports coordinated efforts of companies to participate in overseas exhibitions. For the third time German industry used this opportunity at the Nanotech 2008. Saxony's Economic Development Corporation enriched the program by organizing accompanying events such as a seminar on "Highlights of Germany's latest nanotechnology in Saxony presented by young scientist". Several members of the Nano-CC actively participated with presentations at the conference.

Nanotechnology innovation cluster "nano for production"

Nanotechnology innovation cluster "nano for production"

From the automotive to the medical device industries – all branches can profit from nanotechnologies. German researchers and industries cooperate to accelerate the development of applications of these technologies. The Dresden region is a successful location for nanotechnology innovation. Here companies and researchers collaborate in the innovation cluster "nano for production". The goal of the innovation cluster is to advance nanotechnology related basic research results toward commercialization. In addition, the cluster develops and evaluates essential elements of nanoproduction technology and makes them accessible to a wide range of potential users.

The innovation cluster's core activities provide education events and support for joint projects to commercialize scientific research results. An example is the collaboration of several companies and research institutions with the company Q-Cells to introduce atmospheric plasma processes in the manufacturing of solar cells. Within this cooperation several projects have been successfully worked on. The current focus is on establishing a pilot production line applying the new processes, which will be launched in 2009.

"nano for production" at the Hannover Tradeshow

"nano for production" and six other innovation clusters joined forces at the Hannover Tradeshow presenting their results at a Fraunhofer booth. The state government of Saxony in collaboration with the innovation cluster "nano for production" organized a Saxon-Japanese evening event to intensify existing and establish new contacts. Nanotechnology was one of the evening main topics.

Nanofair and Nanofair career forum

Participants and presenters from Europe, Japan, North America, Australia and Mexico met at the congress center in Dresden to join technical presentations and discussions about nanotechnologies. The technical presentations were structured into several events. On March 10th 2008 the "Nanofair Career Forum" offered students the opportunity to inform themselves about career options in this area.

Project coordination

Dr. Andreas Leson
phone: +49 (0) 351 2583 317
andreas.leson@iws.fraunhofer.de

Dr. Otmar Zimmer
phone: +49 (0) 351 2583 257
otmar.zimmer@iws.fraunhofer.de

website: www.iws.fraunhofer.de/innovationscluster

The president of the Fraunhofer-Gesellschaft, Prof. Bullinger, visits the booth of the innovation cluster "nano for production"

Nanofair career forum: Attentive listeners during the technical presentations.

Laser integration in production technology
Initiative LiFt

Laser integration in manufacturing with strong Saxon partners

The initiative

The LiFt initiative aims at applying laser technologies to secure and expand the competitiveness of Saxony's machine and plant engineering and building industries. The initiative was launched in 2007 when the concept won the innovation competition "Industry meets Science", which was sponsored by the Federal Ministry of Transportation, Building and Urban Affairs (BMVBS).

Within the LiFt initiative the Fraunhofer IWS Dresden cooperates with the University of Applied Sciences in Mittweida and the Institute for Innovative Technologies, Education and Continuing Education (ITW) e.V. in Chemnitz. The institutions aim at commercializing innovations in the area of laser materials processing.

Project Goal

The goal of this network is to point out potential opportunities and offer services to machine builders and manufacturers. The potential advantages are:

- time and cost savings by shortening process chains,
- increase efficiency of manufacturing processes and products,
- unique selling features at the highest technology level.

As developers of technologies and educators, the LiFt project partners offer their services to small and medium sized companies not only in Saxony but also in other regions.

Integration concepts

The requirements for process chain optimizations vary by manufacturer. A low volume production scenario typically requires a maximum of flexibility. High volume manufacturing on the other hand, often focuses on cost optimization. These varying requirements result in a wide variety of integration concepts:

- Direct integration into a machine for mechanical processing. This is a solution when the laser processing time is short compared to the cycle time of mechanical processing. In some cases it is possible to sequentially utilize the laser at several machines.
- Cycle time parallel integration is used when the laser processing time is comparable to the time required for mechanical processing.

The laser can be integrated in almost any conventional process chain to shorten the manufacturing time.

Activities

The LiFt initiative was introduced at several tradeshows such as the Intec Leipzig, SIT Chemnitz, Hannover Industry Tradeshow and the specialized Lasys show on system solutions in laser materials processing. Jointly with the German Society of Tool and Die Makers, the LiFt initiative exhibited at the Fakuma tradeshow in Friedrichshafen. Innovative tool making solutions and holistic process chain approaches were introduced at the Euromold tradeshow.

Engineers from the area of Saxony appreciated the offer to participate in the event "Process efficiency through laser integration" and to learn about the latest possibilities of laser manufacturing integration. The network was introduced at the 5th meeting of the automotive cluster Southwest Saxony as well as at events of engineering service companies such as the "innovation evening" hosted by the company Euro Engineering.

Designers, manufacturing planners and CEOs are interested in technology transfer in the area of laser materials processing. A highlight was the 7th workshop on "Industrial Laser Applications of High Power Diode Lasers" hosted by the Fraunhofer IWS Dresden. Here Laser manufactures, industrial users and laser technology developers met to discuss their experiences with a focus on the integration of laser technologies in manufacturing.

The project is funded by the Federal Ministry for Transport, Building and Urban Affairs (contract number 03WWSN019).

Demand analysis

A special database was developed to gather information on possibilities and user demands for potential laser applications. All project partners despite their different IT guidelines can use this database. Interested users have the option to easily contact project partners. Using a simple form, they can describe their needs and explain the technology interests and special circumstances. Laser experts will respond and contact the interested user.

Consulting and testing

Consulting as a core project activity is based on already installed solutions as well as on individual requirements. In addition to information and consulting services the project also provides limited testing services.

Project coordination

Dr. Steffen Bonß
phone: +49 (0) 351 2583 201
steffen.bonss@iws.fraunhofer.de

Mrs. Claudia Zellbeck
phone: +49 (0) 351 2583 332
claudia.zellbeck@iws.fraunhofer.de

website: www.laserintegration.de
www.iws.fraunhofer.de

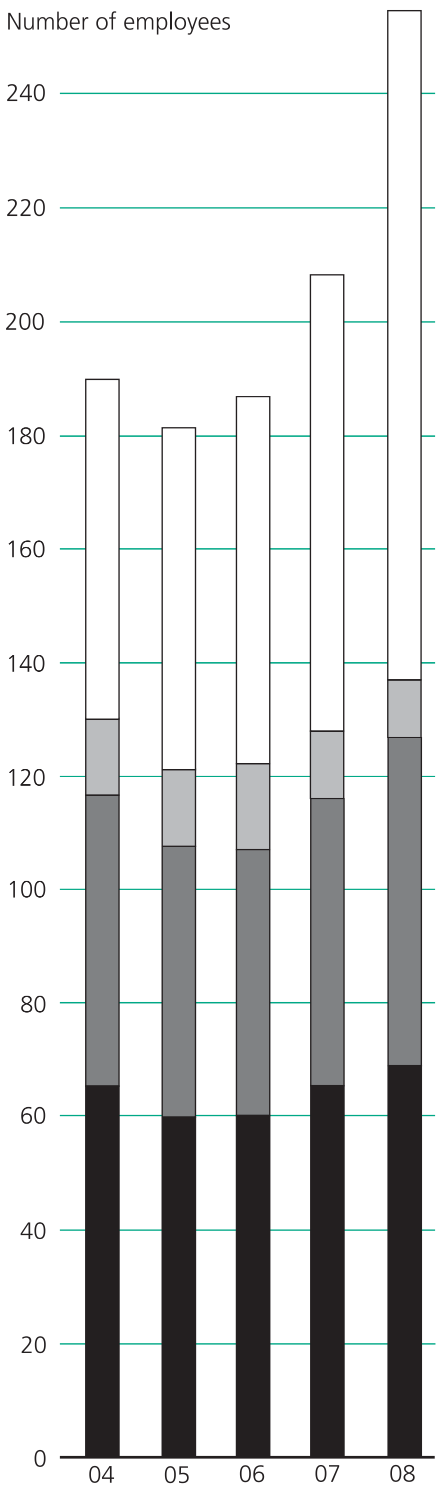
Andreas Wessel-Terham (BMVBS) and Wilfried Wascher (PtI) during the 1st status seminar "Industry meets science" on November 12 / 13 2008 at the IWS Dresden

The LiFt iniative exhibits at the Fakuma tradeshow

Total employees

The TU Dresden (chair for laser and surface technology) and the Fraunhofer IWS are connected through a cooperation agreement. A number of university employees are working closely with IWS employees on joint projects. Basic research is conducted at the university; application related process development and system technical work is done at IWS.

For 2008 the employees are divided up as follows:



Employees of Fraunhofer IWS

	Number
Staff	**127**
- scientists	69
- technical staff	49
- administrative staff	9
Apprentices	**10**
Research assistants	**104**
Employees CCL USA	**16**
Total	**257**

Employees of Chair for Laser and Surface Technology of TU Dresden

	Number
Staff	**34**
- scientists	28
- technical staff	5
- administrative staff	1
Research assistants	**17**
Total	**51**

Building	**8400 m^2**
- processing technology areas	2000 m^2
- lab space, workshops	3070 m^2
- office space	2630 m^2
- conference rooms, seminar rooms etc.	700 m^2
Technology area at the DOC (Dortmund)	**1100 m^2**

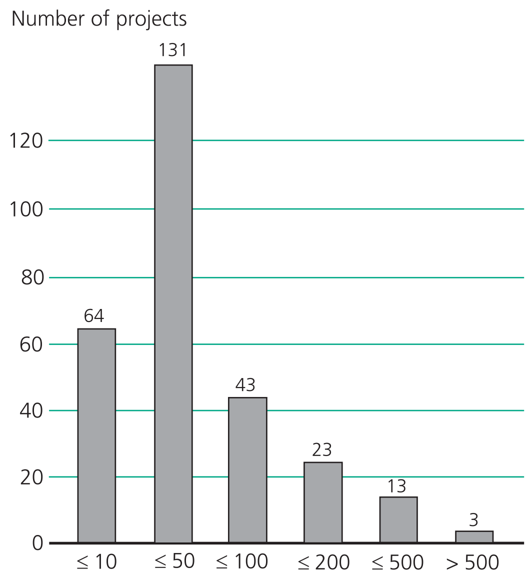
- Research assistants
- Apprentices
- Technical and admin. employees
- Scientists and doctoral students

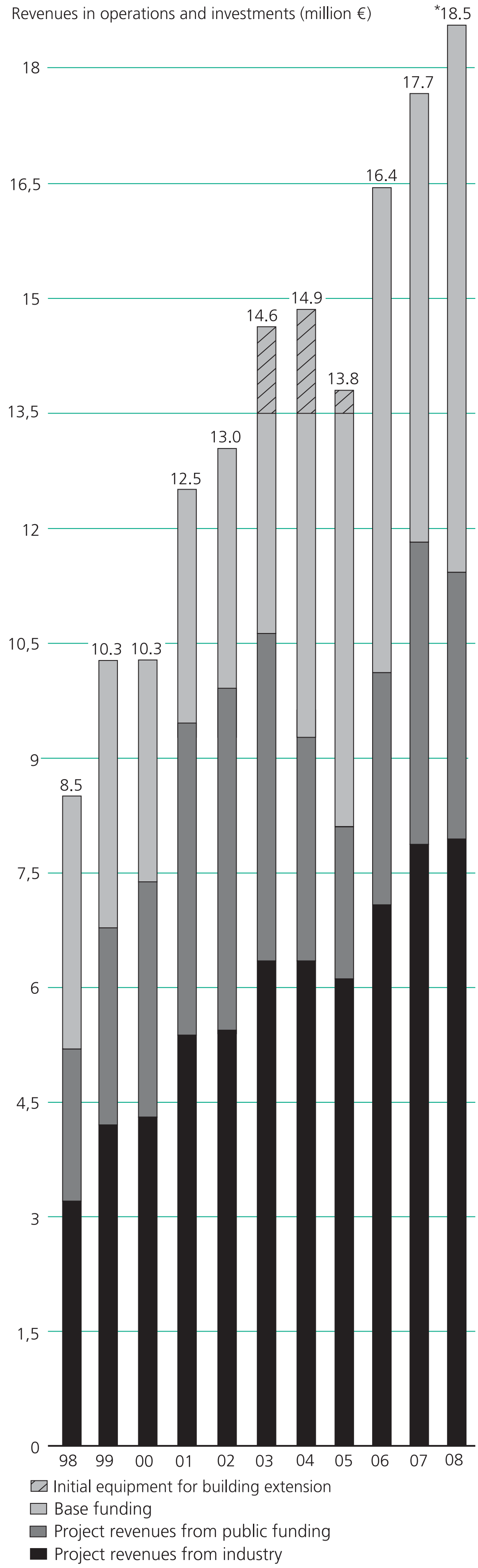
Budget and revenue 2008 (preliminary*)

	million €	
Operational costs and investments 2008	**18.5**	
Budget	**16.4**	
- personnel costs	8.3	
- other expenses	8.1	
Investment	**2.1**	
	million €	**%**
Revenue 2008	**18.5**	
Revenue operations	**16.4**	
- industrial revenues	7.7	47
- revenues of public funded projects	3.5	21
- base funding IWS	5.2	32
Revenue investment	**2.1**	
- industrial revenues	0.1	
- revenues of public funded projects	-	
- base funding IWS	1.3	
- strategic investment	0.7	

Projects

In 2008, IWS handled 277 projects. The distribution of the projects with respect to their volume is shown in the graphic below. One hundred thirty one of the projects were for 10 to 50 T€ (thousands of euro), for example.





Board of trustees

The advisory committee supports and offers consultation to the Fraunhofer IWS. Members of the advisory committee in 2008:

P. Wirth, Dr.
Chairman of Rofin-Sinar Laser GmbH, committee chair

R. Bartl, Dr.
Manufacturing management of Siemens AG Transportation Systems

U. Jaroni, Dr.
Member of the board of directors - automotive division - ThyssenKrupp Steel AG

F. Junker, Dr.
Member of the board of directors of the Koenig & Bauer AG,

H. Kokenge, Prof.
President of the Dresden University of Technology

T. G. Krug, Dr.
Managing director Hauzer Techno Coating BV, Niederlande

P. G. Nothnagel, Mr.
Saxony Ministry of Economic Affairs and Labor

H. Riehl, Dr.
Federal Ministry of Education and Research, manager of the production systems and technologies department

The 18th committee meeting took place on February 14, 2008, at Fraunhofer IWS in Dresden.

I. Bey, Dr.
Research management Karlsruhe

T. Fehn, Dr.
General manager Jenoptik Laser, Optik, Systeme GmbH

D. Fischer, Mr.
General manager EMAG Leipzig Machine Factory GmbH

R. Ruprecht, Dr.
Manager of the Research Center Karlsruhe (project performing institution) and the production and manufacturing technologies section at the Research Center Karlsruhe GmbH

R. Zimmermann, Dr.
Saxony Ministry of Science and Art

Institute management committee

The institute management committee advises the executive director and participates in decision making concerning the research and the business policy of IWS.

Members of the committee are:

Prof. Dr. E. Beyer	Executive director
Dr. A. Leson	Deputy director
Dr. A. Techel	Deputy director Head of administration
Prof. Dr. B. Brenner	Department head
Dr. S. Kaskel	Department head
Dr. L. Morgenthal	Department head

Guests are:

Prof. Dr. U. Günther	Agent of the chair / university
Dr. U. Klotzbach	Office manager VOP
Dr. A. Wetzig	Department head (since Jan. 2009)

Scientific technical council (WTR)

Scientific technical council of the Fraunhofer-Gesellschaft supports and advises divisions of the Fraunhofer-Gesellschaft with regard to technical and scientific policy. The council consists of members of the institute management and an elected representative of the scientific and technical staff of each institute. IWS members of WTR in 2007 were:
- Prof. Dr. E. Beyer
- Dr. S. Bonß

The Fraunhofer-Gesellschaft

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 57 Fraunhofer Institutes. The majority of the 15,000 staff are qualified scientists and engineers, who work with an annual research budget of €1.4 billion. Of this sum, more than €1.2 billion is generated through contract research. Two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Only one third is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated research centers and representative offices in Europe, the USA and Asia provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

VOP

Fraunhofer Verbund Oberflächentechnik und Photonik

The institutes of the Fraunhofer-Gesellschaft have organized themselves into seven research alliances, each specializing in a specific area of technology, in order to promote collaboration in related disciplines and offer customers a unique source of coordinated joint services.

Participating Fraunhofer institutes

Applied Optics and Precision Engineering IOF
www.iof.fraunhofer.de

Electron Beam and Plasma Technology FEP
www.fep.fraunhofer.de

Laser Technology ILT
www.ilt.fraunhofer.de

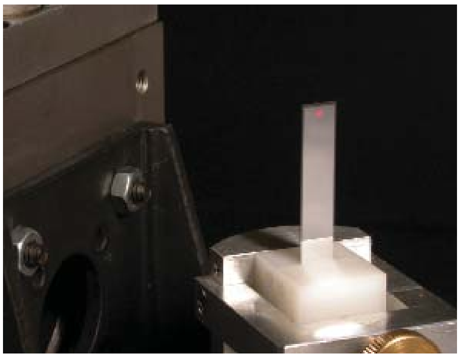
Physical Measurement Techniques IPM
www.ipm.fraunhofer.de

Surface Engineering and Thin Films IST
www.ist.fraunhofer.de

Material and Beam Technology IWS
www.iws.fraunhofer.de

Fraunhofer Surface Technology and Photonics Alliance

Surface technology and photonics are two of the core competences of the Fraunhofer-Gesellschaft. The former is of essential importance in the manufacture of optical and optoelectronic components and products. The latter, and laser technology in general, is becoming increasingly common in production processes and metrology in connection with surface engineering. They are both key technologies, being employed to a growing extent in a variety of applications, including production systems, optical sensors, information and communication technology, and biomedical engineering.



Core competences	FEP Dresden	ILT Aachen	IOF Jena	IPM Freiburg	IST Braunschweig	IWS Dresden
Coating and surface engineering	●	●	●	●	●	●
Beam sources	●	●	●	●		
Micro and nano technology		●	●	●	●	●
Materials treatment	●	●			●	●
Optical measurement techniques		●	●	●	●	●

top: Fraunhofer FEP
middle: Fraunhofer IPM
bottom: Fraunhofer ILT

In order to coordinate the targeted application of their expertise and define joint strategy plans, six Fraunhofer Institutes employing a total of around 1080 staff and working with a budget of €86 million have joined forces in the Fraunhofer Surface Technology and Photonics Alliance (VOP). The core competences of the alliance lie in the development of thin-film systems and coating processes for a wide variety of applications, surface functionalization, the development of laser sources and micro-optical and precision-engineered systems, materials processing and optical metrology.

In the immediate future, the alliance intends to focus its research activities on the advanced development of innovative laser sources such as fiber lasers and to nurture the industrial deployment of terahertz technologies.

Chairman of the alliance:

Prof. Dr. Eckhard Beyer

phone: +49 (0) 351 2583 324
fax: +49 (0) 351 2583 300
eckhard.beyer@iws.fraunhofer.de

Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS
Winterbergstraße 28
01277 Dresden

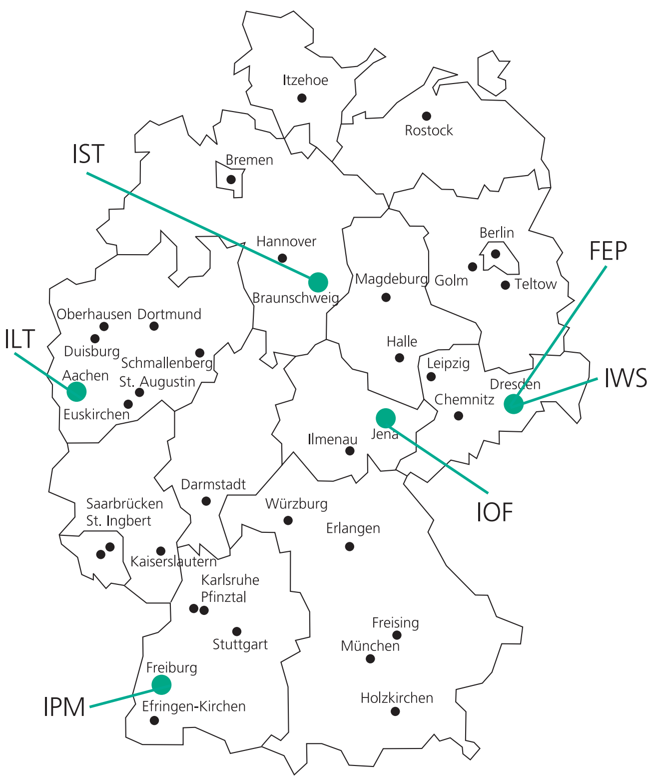
Central office:

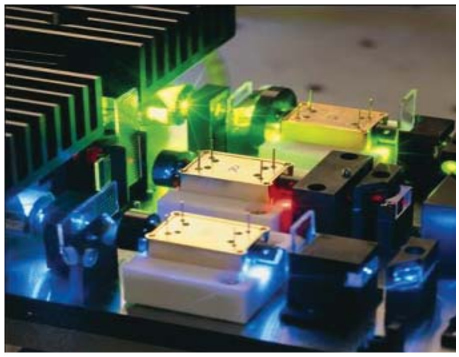
Dr. Udo Klotzbach

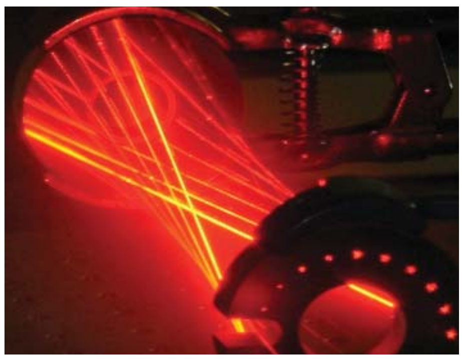
phone: +49 (0) 351 2583 252
fax: +49 (0) 351 2583 300
udo.klotzbach@iws.fraunhofer.de

Fraunhofer-Verbund Oberflächentechnik und Photonik
Winterbergstraße 28
01277 Dresden

website: www.vop.fraunhofer.de







top: Fraunhofer IST
middle: Fraunhofer IOF
bottom: Fraunhofer IWS


B-2555
B-2554

Editor: You always emphasize that your department attaches a special value to holistic solutions. How is this reflected?

Prof. Brenner: Yes indeed, in short this concept implies an all-encompassing approach when developing solutions. In detail this means to us that we consider three influencing factors as most essential for the effective fabrication of new and value adding products: materials – technology – component performance. The relevance of these factors needs to be comprehensively understood and purposefully utilized.

Let me illustrate this approach based on one of our most important areas: the laser beam welding of powertrain components for automobiles and trucks. Here we are meanwhile crack free laser welding materials and material combinations that were considered non-weldable only a few years ago. There are no specific data available that describe the static and cyclic loading performance of welded joints from material combinations such as steel / cast iron. This difficulty arises due to several factors such as the multidimensional loading and that the formation of residual stresses strongly depends on the part geometry, the welding parameters, and the weld seam location and the welding processing sequence. Additionally, the static and cyclic component strength increasingly depends on the material as well as the hardening of the weld seam, which makes it difficult to estimate its order of magnitude. The automotive industry uses transmission test stands. However, these tests are expensive and typically the weld seams are not critical during part failure. As a result, a non-tolerable uncertainty remains when designing laser welded powertrain components. Subsequently these welds are substantially over dimensioned. On the other hand, we also know from failure analysis about painful surprises during prototype manufacturing. From 2009 on we will be able to improve the situation. We designed and built a special axial torsion test stand to be able to test the loading and strength limitations of transmission typical laser welded joints under realistic conditions. Subsequently we will be able to develop concepts for the optimized dimensioning of welded powertrain components.

Editor: What is new in the other main area, surface technologies?

Prof. Brenner: In 2008 we made a most important development step by integrating laser beam hardening into a machine tool. We believe that this was possible as a result of the confidence that our customers have in our performance. Together with project partners we designed and implemented an industrial manufacturing unit consisting of two automated lathes, a central high power diode laser, an intelligent beam delivery switch and an additional laser hardening station for special geometries.

The laser beam hardening of hydraulic components runs at close to identical cycle times using the second spindle of a rod turning machine. After the laser-hardening step the part is being finished in the very same machine. We consider this industrially successful solution as a very important step because it opens the door to a multitude of similar opportunities to cost effectively integrate laser beam hardening into cutting and forming machine tools.

A challenge is the best motivation
Peter Ebeling

Prof. Dr. Berndt Brenner
Department head
(phone: +49 (0) 351-2583-207,
berndt.brenner@iws.fraunhofer.de)

Dr. Steffen Bonß
Team leader surface treatment technologies
(phone: +49 (0) 351-2583-201,
steffen.bonss@iws.fraunhofer.de)

Optimized technologies for the hardening of steel components through laser and / or induction

If conventional hardening technologies are not suitable because of certain geometric shapes, material and wear conditions, laser hardening can be ideal to produce wear-resistant parts with an increase in service life. This technology is especially suitable for the selective hardening of multi-dimension faces, inner or hard to reach surfaces, sharp edges steps, bores and grooves, as well as for low distortion hardening. With a strong foundation of long term experience in the broad fields of wear protection and hardening, we are able to offer:

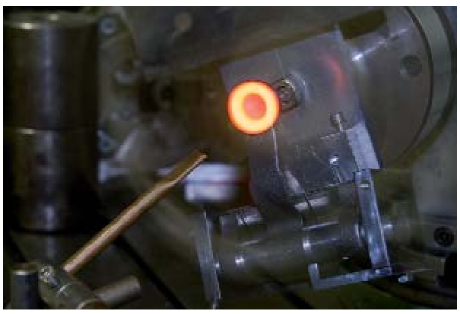
- development of surface hardening technologies with high power diode lasers, CO_2 lasers, Nd:YAG lasers and / or induction,
- prototype, process and system optimization.

Dr. Jens Standfuß
Team leader welding
(phone: +49 (0) 351-2583-212,
jens.standfuss@iws.fraunhofer.de)

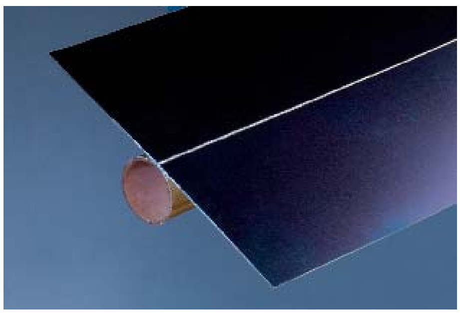
Welding of hard to weld materials

Laser welding is a modern welding process that is widely utilized in industry, especially in mass production. Such welding with a laser using an integrated heat treatment cycle, developed at IWS, offers a new process for the manufacturing of crack-free welded joints of hardenable steels, austenitic steels and special alloys. With our extensive experience in metal physics and an unique welding station with our integrated heat treatment process, we are able to offer:

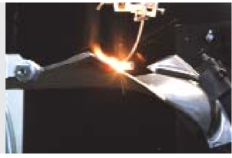
- development of welding technologies,
- prototype welding,
- process and system optimization,
- preparation of welding instruction.



Process development for the loading adapted laser beam hardening



Laser beam welded Al-Cu joints for solar panels



further information:
www.iws.fraunhofer.de/projekte/001/e_pro001.html
www.iws.fraunhofer.de/branchen/bra01/e_bra01.html

Dr. Johannes Rödel
Team leader materials characterization
(phone: +49 (0) 351 2583 384,
johannes.roedel@iws.fraunhofer.de)

Dr. Irene Jansen
Team leader bonding
(phone: +49 (0) 351-463-35210,
irene.jansen@iws.fraunhofer.de)

Complex materials and component characterization

The control of modern joining and surface engineering processes requires knowledge from structural changes to the resulting component properties. Based on long term experience and extensive equipment in the area of structural, microanalytical and mechanical materials characterization we offer:

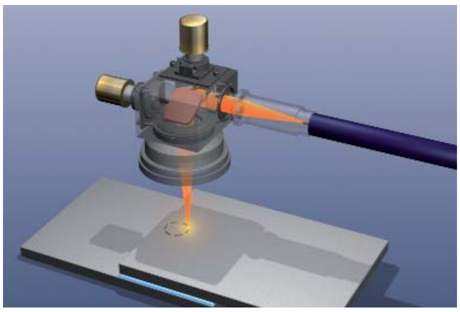
- metallographic, electronmicroscopic (SEM, TEM) and microanalytical (EDX) characterization of the microstructure of metals, ceramics and compound materials,
- determination of material data for component dimensioning and quality assurance,
- property evaluation of surface treated and welded components,
- strategies for materials and stress adapted component design,
- failure analysis.

Surface pretreatment and constructive adhesive bonding

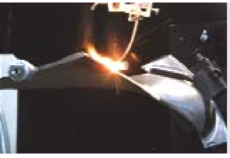
An adhesive bonding process includes a step to treat the mating surfaces of the parts prior to applying the adhesive. The goal is to achieve good wetting of these surfaces with the adhesive and thus to generate a high strength bond. We are using primarily plasma and laser technologies in this area. The surfaces and the bonded compounds are then being characterized by contact angle, roughness and thickness measurements, optical microscopy, SEM / EDX and spectroscopic methods. A new direction is to integrate carbon nanotubes into the adhesives, which can increase the bonding strength and / or provide electrical conductivity to the compounds.
We offer the following services:
- pretreatment of mating surfaces and characterization of the surfaces,
- constructive adhesive bonding of various materials,
- measuring the bonding strength and aging behavior of adhesive bonds.

Example of projects 2008

Servo hydraulic axial torsion test stand in action



Combination of remote laser welding and adhesive bonding



Integration of laser beam hardening in high performance turning machines

Task

The availability of high power diode lasers and a number of recently developed system technology solutions helped to establish laser beam hardening as a potential process to locally protect parts from wear in addition to classical hardening methods. Like many heat treatment processes, laser beam hardening is typically applied outside of the main manufacturing process chain. However, manufacturers prefer a continuous part flow without additional logistics and storage to save time and costs. Here the laser beam hardening offers excellent opportunities.

A leading specialist for drive and control technologies required the partial hardening of the outer surface of a valve for mobile hydraulic applications (Fig. 1). Conventionally the company used an induction hardening process with subsequent tempering. The parts were initially processed in a soft state, and then heat-treated and finally finished in a hardened state. The overall processing from the raw material to the finished valve took approximately 20 hours. It was therefore difficult for the manufacture to quickly respond to changes in demand. This was compensated by sufficient inventory. The production process was also based on batches, which required numerous logistic steps. The investment goal was to find solutions that would overcome these limitations while maintaining the part quality.

Solution

Initial tests proved successful to laser harden the hydraulic components. In discussions with the client it was agreed that the favored solution would be to integrate the laser beam hardening process right into the turning machine (Fig. 2). Since the machine has two spindles it is possible to continue the turning operation almost throughout the entire laser hardening process. The optical path and the process chambers are kept clean by pressurized air and the laser process can be performed simultaneously with the wet cutting operation (Fig. 3). The new technology processes parts from the rod. First the soft processing is performed on the main and the opposite spindles. Then the hardening process and the hard processing are performed in the very same setting. The part leaves the machine after it is fully processed and moves on to assembly.

Fig. 1: Typical application of mobile hydraulics made by Bosch Rexroth AG

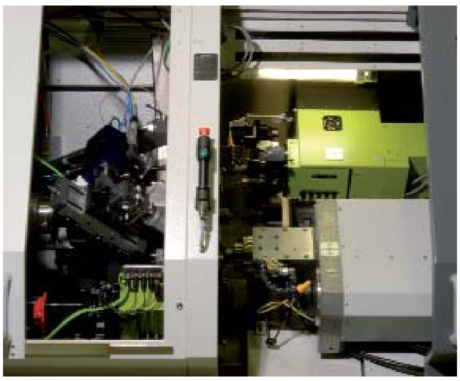


Fig. 2: Benziger turning machine with integrated laser optics in the drive chamber (left)

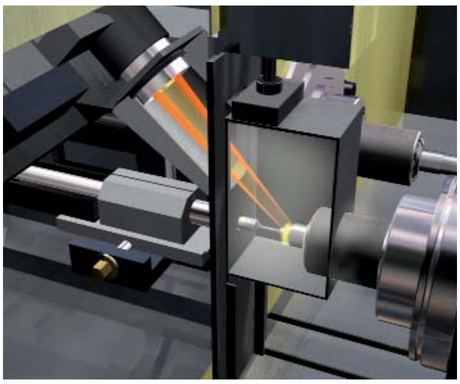
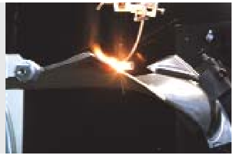


Fig. 3: Image from a process animation, which shows a situation during the hardening process in a pneumatically delivered protection chamber with laser beam and pressurized air nozzle operation



Process management

The laser beam hardening process uses a fiber coupled high power diode laser and is performed while the part is rotating. One laser shot hardens a ring shaped zone around the part without leaving a soft spot. During the process the surface temperature is measured with the camera based temperature acquisition system "E-MAqS" (Fig. 5). The data are supplied to the controller module "LompocPro", which in turn regulates the laser power to maintain a constant surface temperature. The complete manufacturing line consists of two turning machines with integrated hardening modules. An additional machine hardens other parts belonging to the same assembly in an inert gas atmosphere. The laser is located in the center between the other machines and the beam is distributed to those machines using a beam switch. An intelligent switch controller optimizes the beam delivery based on the processing time of each turning machine to minimize downtimes (Fig. 4). The process uses only a single "LompocPro" controller that quickly switches between processes. All critical process and calibration data are stored. The individual components are connected using a profi-bus system. This concept allows the efficient exchange of messages between the laser, the machine tools, the switch controller and the overall process controller.

Results

During the valve manufacturing the lathes machine processes unalloyed steel. The laser treatment affects approximately half the wall thickness of the part, leaving only a small material volume underneath the hardened zone. To nevertheless achieve the required material performance under these conditions, the engineers implemented a self-quenching effect, which is a common method applied during laser beam hardening processes. Compressed air is blown at the processed part to assist self-quenching.

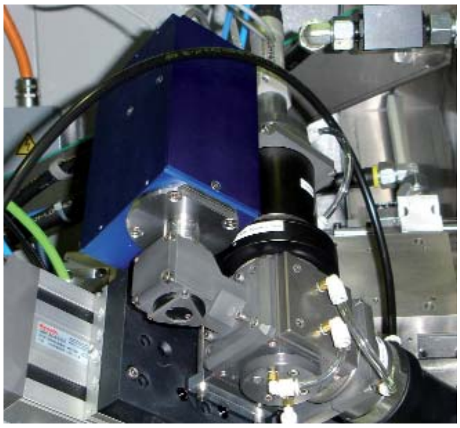


Fig. 5: The laser optics with temperature acquisition system "E-MAqS" is located in the drive compartment of the turning machine

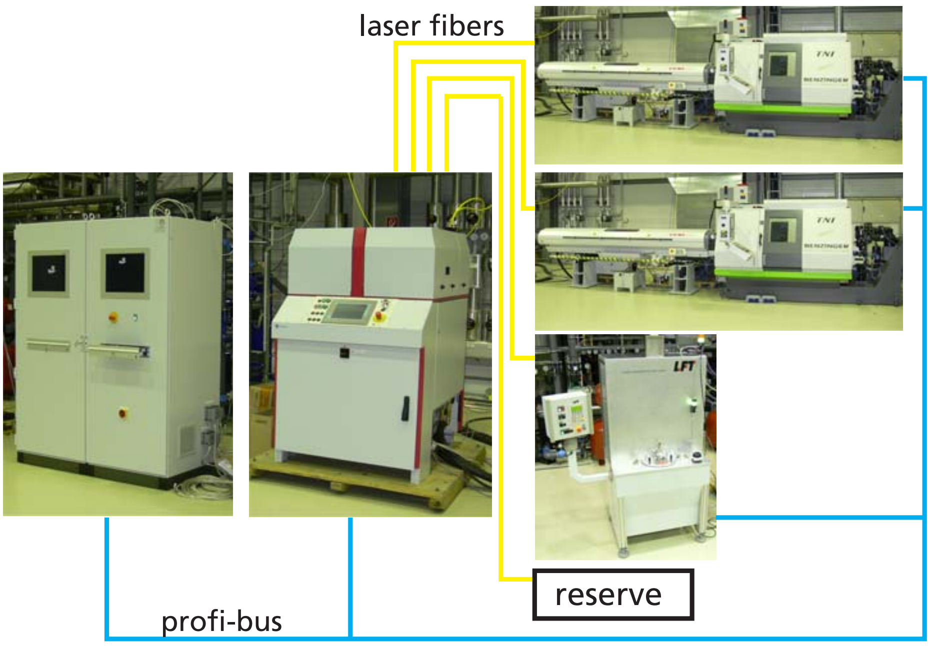
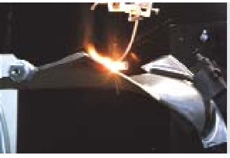


Fig. 4: System installation consisting of a fiber coupled high power diode laser, a controller cabinet for the laser beam splitter and process controller "LompocPro", and two turning machines and inter gas hardening machine

Contact

Dr. Steffen Bonß
phone:
+49 (0) 351 2583 201
steffen.bonss@iws.fraunhofer.de



Process technology solutions for laser beam welding of powertrain applications

Task

Transmission components consist of shafts with mechanically mounted or welded components such as gears, cams, clutch parts, cardan forks, and others. These components are typically manufactured from hard-to-weld materials such as heat-treatable and casehardening steels. Thus these materials make it extremely difficult to use modern joining technologies such as laser beam welding. From the viewpoint of weldability several factors have to be considered (Fig. 1).

The implementation of welding technologies for transmission applications typically has to overcome the following challenges:

- materials with strongly limited weldability or combinations of different materials (Fig. 2),
- risk of crack formation in stiff components due to the limited possibility for shrink relaxation in axial and radial weld seams,
- temperature sensitive weld seam region, for example in hardened gears (Fig. 3), bearing surfaces,
- high cyclical and dynamical load requirements for the application.

These complex challenges require tailored solutions that address specific materials and components.

Solution

The reliable and crack-free joining of powertrain components requires laser beam welding processes that are adapted to the specific materials. Primarily the processes are designed to avoid cold cracking in materials with a high carbon content and limited weldability. There are two principle approaches to tailor the process. One approach is to adjust the temperature-time relationship during the process. This influences the phase transformation timing of the materials and helps to suppress the formation of brittle phases (laser induction welding). A second approach is to use additional material specific filler materials. These can also be designed to achieve defined mixing ratios when welding different materials (alloy welding).

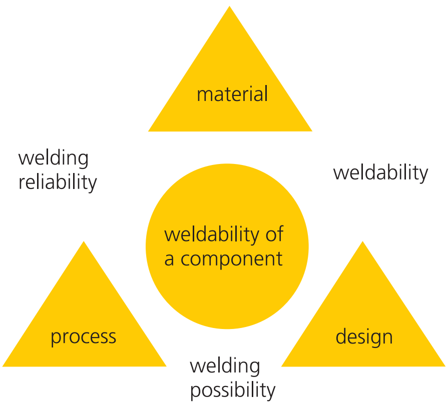


Fig. 1: Factors that influence weldability

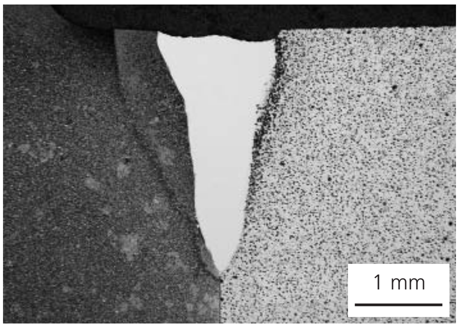


Fig. 2: Example of a mixed joint welded from cast iron and casehardened steel

Fig. 3: Casehardened gear close to the weld seam

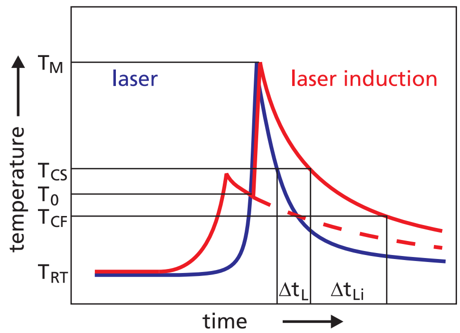
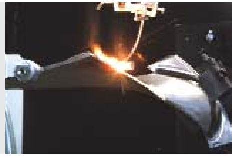


Fig. 4: Principle of laser induction welding



Results

Martensitic hardenable carbon steels can be crack-free laser welded using a coupled process of laser beam welding and short-term localized inductive heating. The localized heating suppresses the formation of the martensitic phase and thus reduces the risk of a delayed crack formation when the part cools down (Fig. 4). This process combination can be applied to numerous materials such as heat treatable, casehardening and induction hardenable steels that are used in powertrain applications (Fig. 5).

However, there are also many components that exclude the possibility of using the localized induction heating assisted laser beam welding process due to material or design reasons. An example is the joining of differential transmission cases made from cast iron with casehardened gears, which cannot be done with conventional welding methods. Here a ductile and crack-free high performance laser beam welded joint can be achieved by using special filler materials in the area of the weld seam (Fig. 6).

Both laser beam welding process variations have been tested and demonstrated in numerous industrial applications. The induction heating and filler material assisted laser beam welding processes offer cost efficient possibilities to weld numerous powertrain components and to replace conventional mechanical joining techniques (Fig. 7).

A new advantageous solution for the crack-free welding of casehardened components avoids the costly removal of the casehardened layer. This layer is instead removed during the process with an integrated laser ablation step prior to the laser beam welding process with filler materials.

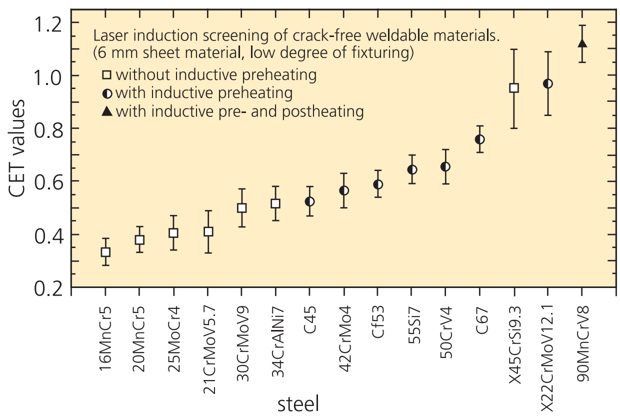


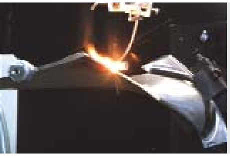
Fig. 6: Laser induction screening of crack-free weldable materials

Fig. 7: Laser beam welding with filler material, differential transmission case (cast iron) with gear (casehardened steel)

Fig. 5: Examples for laser beam welding in the field of powertrain applications

Contact

Dr. Jens Standfuß
phone:
+49 (0) 351 2583 212
jens.standfuß@iws.fraunhofer.de



An innovative torsion-axial testing system to evaluate laser welded power train components

Task

Automotive powertrain components are frequently made from material combinations including case-hardened and multiple alloyed steels. Advanced laser beam welding processes are applied to weld these material pairs using integrated heat treatments and filler materials resulting in crack-free axial or radial round seams. A typical example is the welding of shafts and gears. During the component's application in the vehicle, these welds are exposed to a combination of torsion and bending loads. Currently there are no reliable fatigue strength values and dimensioning guidelines for laser beam welding joints for components experiencing torsion-bending loads.

Typically the weld seams do not fail when these components are tested in transmission testing stands. Thus, while these time consuming and costly tests are indispensible for quality assurance, they do not provide data that are relevant to reflect the fatigue strength of the weld seams. Therefore it was necessary to develop a new test system that directly evaluates the fatigue strength of laser-welded joints under conditions similar to the actual loading conditions. This work included the development of a test component (Fig. 1) that is on the one hand similar to typical poere train components, and on the other hand makes the welded seam its weakest joint when component failure occurs. The test machine was to be designed to allow the independent loading with bending and torsion forces. The machine was also required to be able to test real parts (i.e. drive shafts, tubes) in addition to the specifically designed test components.

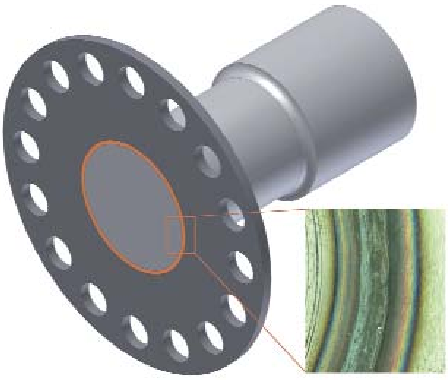
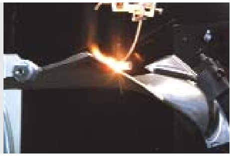


Fig. 1: Model test component (shaft-disk) with weld seam

Solution

Fraunhofer collaborated with a testing equipment manufacturer on the development and implementation of the testing machine (grant from the Federal Ministry for Education and Research, 02PB2073). Axial force and torque cylinders are mounted at both ends of the horizontal machine axis (Fig. 2). Both loading forces are decoupled using a hydraulically mounted crosshead. This setup is used to apply phase synchronized or phase shifted cyclic axial and torsion loads. The sample fixtures are mounted to the test axes using cardan joints. This method avoids additional loads caused by clamping of the welded transmission components, which naturally suffer from a certain degree of distorsion.

Fig. 2: Torsion-axial testing system



The design of the machine and the clamping system makes it possible to study in detail how the fatigue strength of a weld is influenced by factors such as welding distortion, welding depth, notches, filler material, stiffness of the seam area and the integrated heat treatment. The components are mounted using chuck cone systems for cylindrical shafts and threaded flanges. The force cylinders can apply torques as high as ±8 kNm at maximal rotation angles of ±50°. In axial direction forces can be applied of up to ±40 kN at maximal displacements of ± 50 mm. The maximal loading frequency for both axes is 50 Hz. Test specimens can be sample parts and components with diameters of up to 300 mm and lengths of up to 1250 mm. The acquisition of critical test data is performed at a frequency of up to 10 kHz and includes torque, torsion angle, axial force, axial displacement and data from strain gauges.

Results

After the machine was delivered to the Fraunhofer IWS, its function was thoroughly tested. The experiments aimed at evaluating the usefulness of specific model test component (Fig. 4). It was demonstrated that the design of the specimen was indeed capable of applying the highest loads to the welded joints, which leads to crack initiation and failure in the weld (molten or heat influenced zone, Fig. 5).

Additionally the test component also presents realistic welding conditions with respect to welding depth and thermal conductivity. The testing components are also easy to manufacture at low costs.

The first experiments were performed applying varying torsion and torsion-axial loading patterns. The test components were laser welded using shafts made from 42CrMo4 and disks made from 16MnCr5. Fig. 3 shows the results in form of a Woehler diagram. The application of the forces and torques results in stresses at the weld seam, which were calculated as equivalent stresses using FE modeling. First results indicate that a combined loading with torsion and axial forces causes the disk to bend and thus reduces the overall fatigue strength if compared to pure torsion loads.

The successful implementation of the axial-torsion test machine delivers the Fraunhofer IWS with a very important testing capability. The system provides specific material data that will enable the engineering team to properly lay-out and dimension lightweight laser welded components in particular for future power train components.

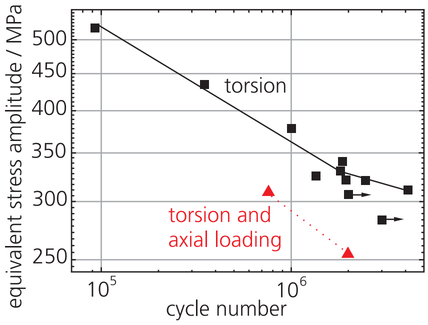


Fig. 3: Fatigue strength of welded disk-shaft test components

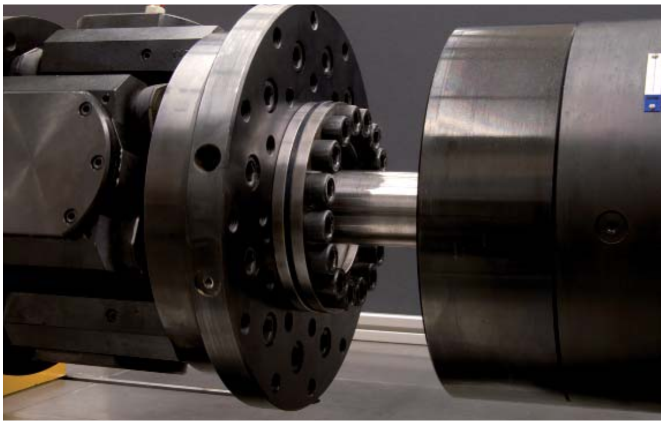


Fig. 4: Test component, clamp flange and cardan joint of the test system during a torsion experiment

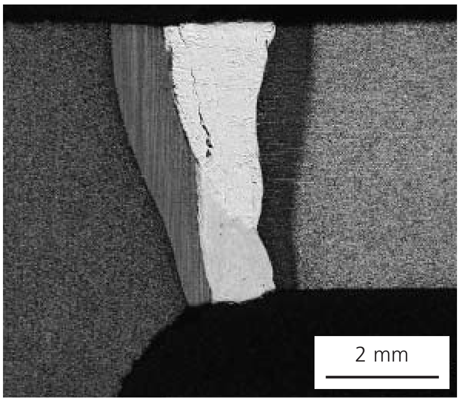
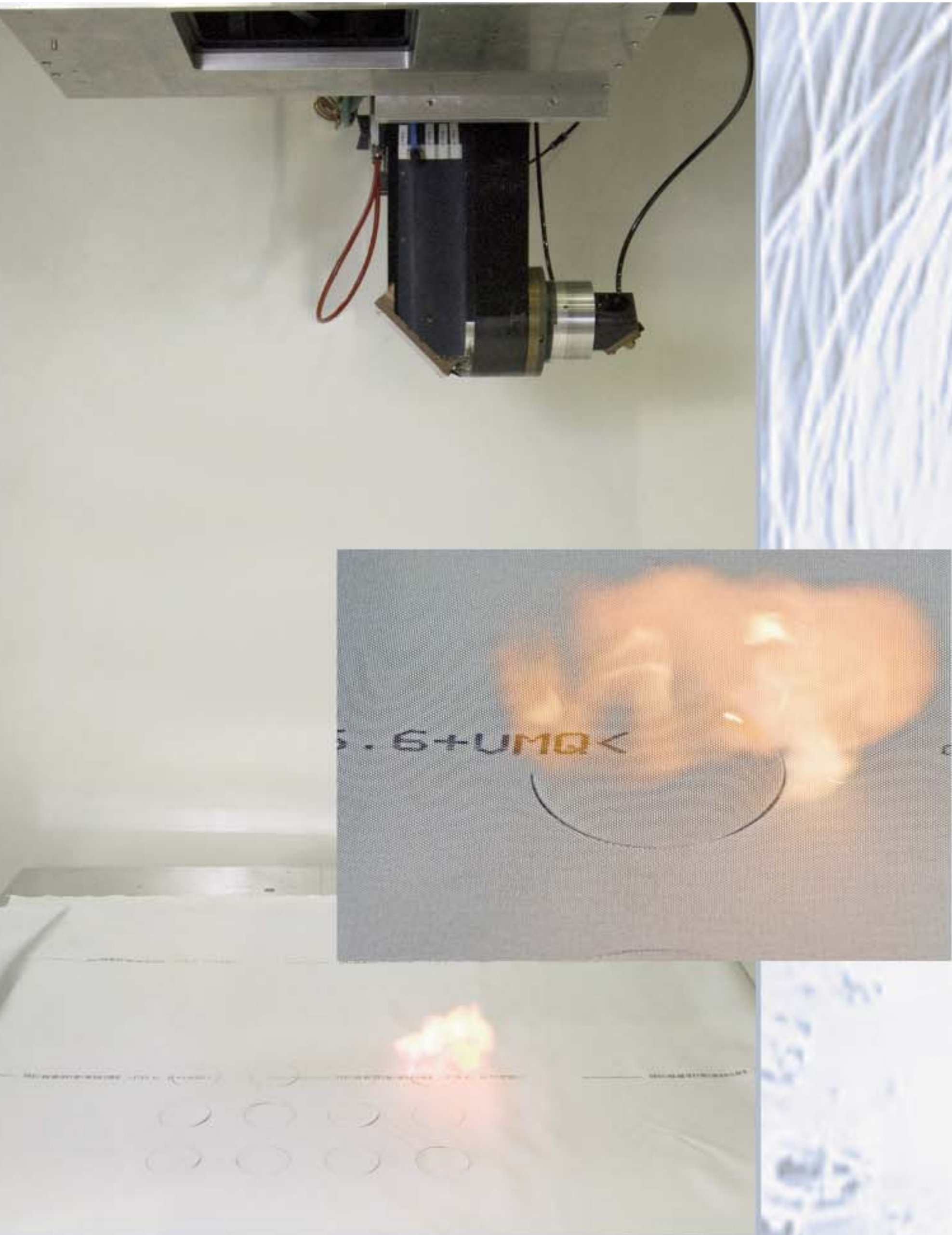


Fig. 5: Polished cross section through a cracked weld seam of a disk-shaft test component after torsion-axial loading

Contact

Dr. Jörg Bretschneider
phone:
+49 (0) 351 2583 217
joerg.bretschneider@iws.fraunhofer.de




R&D-offer: Laser ablation and cutting, system engineering

Editor: What are the new results in the area of laser beam cutting with fiber lasers?

Dr. Morgenthal: Fundamental mode fiber lasers can cut metallic materials up to a thickness of 0.7 mm. One can expect that the next generation of higher brilliance radiation sources will further increase the material thickness that can be cut. In 2008 IWS engineers used a disk laser of highest brilliance to perform cutting experiments with thick sheet metal. The results showed a similar quality and productivity as can be achieved with a fiber laser.

Editor: Which challenges does the department face with respect to developments in the area of system technologies?

Dr. Morgenthal: The potential of using remote technologies for laser processes such as welding, cutting, structuring, and surface treatment is by far not exhausted. These developments are essentially aiming at increasing the processing speed by using lasers with ever increasing beam quality, power and pulse energies. Modern disk and fiber lasers are well suited for this task. Further development is required in the area of laser optics that is integrated in the processing system so that it can precisely deliver the laser beam to effectively process the parts.

Editor: For many years your department has been utilizing IWS competences in materials and laser technology to restore art and cultural possessions. What is new in this business field?

Dr. Morgenthal: The development of new laser systems, and in particular those based on fiber lasers, lead to portable and autonomous equipment solutions that do not require an onsite power outlet. These systems are exceptionally useful for field operations to clean art and cultural objects. One of these developments was successfully tested to clean the burial chamber of the Nepherhotep in Egypt. However, laser technology applications in the area of art and cultural possessions are multifaceted. Since several years for example, we have been working on uncovering and analyzing hidden wall paintings, including thus far unknown defects. Here we use laser generated terahertz radiation. For example, many churches have hidden wall paintings that have never been revealed. The non-destructive unveiling of the iconographic contents of these works of art and the investigation of the different stages of their making as well as of damages promises essential knowledge about the character and the development of iconoclastic movements and their societal, religious and cultural backgrounds during various cultural conflicts.

An accepted idea turns into work.
Guenter F. Gross

Dr. Lothar Morgenthal
Department head
(phone: +49 (0) 351-2583-322,
lothar.morgenthal@iws.fraunhofer.de)

Dr. Lothar Morgenthal
Team leader system engineering
(phone: +49 (0) 351-2583-322,
lothar.morgenthal@iws.fraunhofer.de)

Dr. Thomas Himmer
Team leader cutting
(phone: +49 (0) 351-2583-238,
thomas.himmer@iws.fraunhofer.de)

System engineering and laser processing

New or further developed and more powerful technologies in laser materials processing frequently require new system technologies or components in order to optimally use them. In cases where this system technology is not yet commercially available, we offer the development, testing, prototyping, and demonstration of these solutions. For example:

- processing optics with enhanced functionality, such as high speed and / or precision beam scanning for remote processing,
- control technology and CAD / CAM tools for remote and on-the-fly processing,
- system technology and software for online process monitoring and control.

Cutting technology

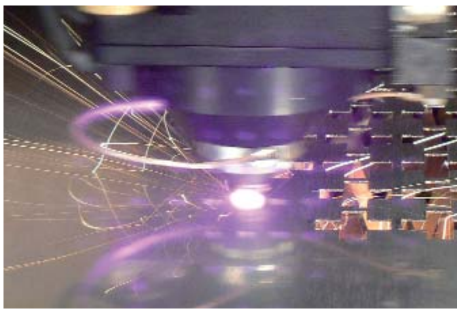
The IWS is equipped with CO_2 and solid-state lasers, and especially fiber lasers, in a wide range of powers and beam qualities, which can be used for cutting of all materials that are used in modern manufacturing.

Research topics include the development of technologies to optimize process and cycle time. We are using highly dynamic 2D and 3D cutting machines with direct linear drives as well as modern robots. Aside from using commercial processing optics we also apply internally developed scanner systems for remote processing.

We offer:

- technology and system development, testing, and optimization,
- comparison tests,
- feasibility studies with prototype manufacturing.

Scanner optics for fiber laser HF-SAO1.06(2D)



High speed cutting with on-the-fly nozzle system

further information:
www.iws.fraunhofer.de/projekte/005/e_pro005.html
www.iws.fraunhofer.de/projekte/036/e_pro036.html
www.iws.fraunhofer.de/branchen/bra06/e_bra06.html

Dr. Udo Klotzbach
Team leader microprocessing
(phone: +49 (0) 351-2583-252,
udo.klotzbach@iws.fraunhofer.de)

Micro structuring with laser

Extensive and modern equipment as well as our know-how foundation enable us to perform applied research in the area of micro and fine processing with laser beams for the miniaturization of functional elements in machine, system, and automotive engineering as well as for biomedical applications. Examples are 3D structures in the sub mm range and area structures on polymers, metals, ceramics or quartzitic and biocompatible materials.

We offer:
- micro structuring of different materials with excimer, fiber and Nd:YAG lasers,
- micro drilling with high aspect ratios and different bore geometries,
- cleaning with laser technology.

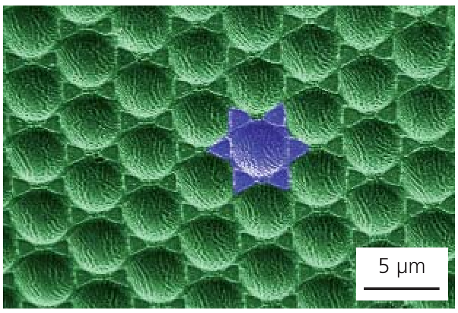
Dr. Andrés-Fabián Lasagni
Team leader surface functionalization
(since Sept. 2008)
(Tel. 2583 007,
andres-fabian.lasagni@iws.fraunhofer.de)

Advanced topographic design

New methods for micro/nano fabrication of two and three dimensional structures are essential for new goals in several areas of science and technology. The Surface Functionalization group offers the possibility to fabricate advanced architectures on polymers, metals, ceramics and coatings with micro/nano features on macroscopic areas. In addition to topography, also the electrical, chemical, and / or mechanical properties can be varied locally and periodically obtaining a macroscopic response with a better performance. These patterned surfaces can be used for several applications in bioengineering, photonics and tribology, between others.
We offer:
- design of two and three dimensional structures on different materials,
- photopolymerization, ablation and metallurgical patterning,
- high speed fabrication of high density patterns.

Examples of projects 2008

Mobile system for the anti-slip preparation of natural stones



Fabrication of periodic arrays on polymeric substrates for bio-applications.

Selective cutting of composite materials – Highly productive and flexible due to remote cutting

Task

The excellent beam quality of fiber lasers holds an enormous potential to increase the productivity of laser materials processing operations. For example, the application of a fiber laser with brilliant beam quality in combination with scanner optics for beam deflection allows the cutting of the material without a cutting gas. The material is evaporated layer by layer. A contour cutting speed of more than 200 m min^{-1} is possible for thin materials (Fig. 2). However, thin materials (i.e. metal foil) in particular are difficult to handle.

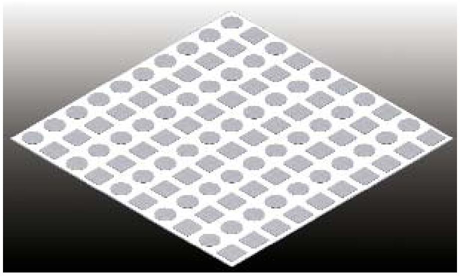


Fig. 1: Final parts on a carrier material made by "kiss cutting"

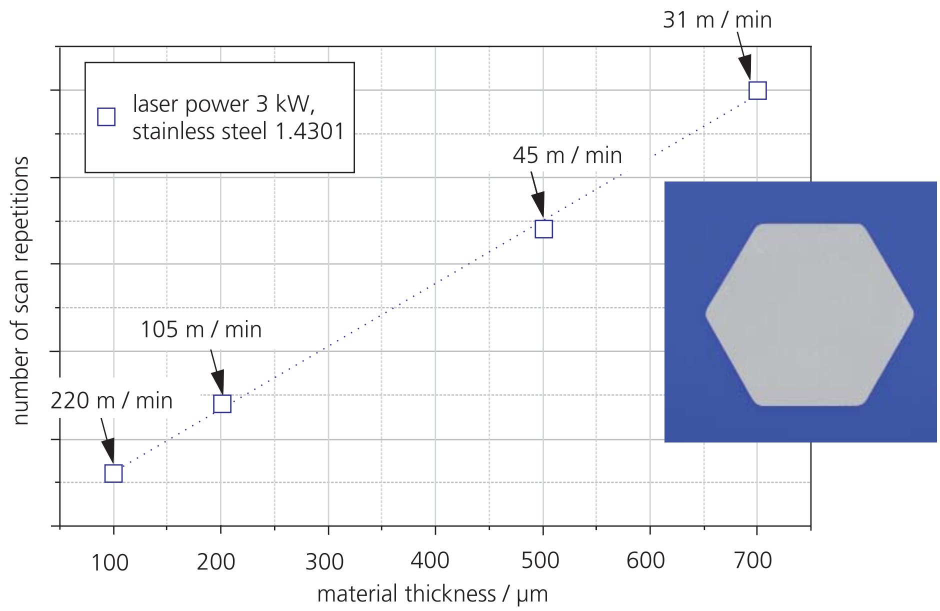


Fig. 2: Contour cutting speeds for fiber laser remote cutting, example geometry: hexagon

Solution

A process named "kiss cutting" may help. The basis of this process is a composite material, which consists of the material to be cut, and a carrier material. Both materials are joined but can be separated after the cutting. The cutting process only cuts the metallic material, whereas the carrier material remains intact. The metal film is then removed but the cut pieces remain on the carrier material (Fig. 1).

Results

Remote cutting allows the selective separation of the composite material. A central element is the remote cutting with fiber lasers. The extremely high intensities evaporate the material. The evaporated material is removed upwards and not downwards as in conventional laser cutting. Thus, by carefully selecting the laser process parameters, it is possible to only cut the metallic film along the desired contour without damaging the carrier material.

Remote "kiss cutting" allows fast cutting speeds at high flexibilities. The heat-affected zone is minimal and the cut quality is excellent. Additional advantages of "kiss cutting" over punching processes include a low noise level and a part generation without edge warpage.

Contact

Dipl.-Ing. Matthias Lütke
phone:
+49 (0) 351 2583 292
matthias.luetke@iws.fraunhofer.de

Fast laser cutting with highly dynamic beam deflection optics

Task

Laser cutting processes are widely used in today's manufacturing industry. However, in particular when cutting contours, the high-speed cutting potential of the laser is in many cases not fully utilized due to limited dynamics of the cutting machines. Modern fiber and disk lasers with higher brilliance make this discrepancy even more obvious. This is especially evident in the field of cutting thin and medium thick sheet metal. Solutions are sought that utilize the laser beam along the cutting contour at speeds that correspond to its cutting capability. Simultaneously, cutting precision and edge quality have to be maintained.

Solution

The solution to this problem is to integrate additional motion axes into the laser cutting head, which take over the highly dynamic motion of the laser beam during phases of high acceleration and jerks while the main machine performs a simplified motion path for the laser head. The superposition of the motion ranges of the main (yellow in Fig. 2) and additional head axes (red in Fig. 2) allow positioning of the laser spot quickly at any desired location. An intelligent planning algorithm considers all conditions such as working field dimensions, jerks, acceleration and speed for main and additional axes and determines a motion path that minimizes the cycle time.

Results

IWS engineers developed the 2D beam deflection optics for the processing head. This optics synchronizes the laser beam with a separately driven cutting gas nozzle. Nozzle and laser beam move highly dynamically close to the process. Splitting up the motion of laser beam and gas jet reduces the required weight for each additional axis to less than 300 g. Subsequently the drastically reduced inertia of the additional axes allows accelerations of 80 m s^{-2}.

A prototype was developed to evaluate the system and technological limitations of this concept. Processing time savings of more than 60 % were demonstrated for complex cutting geometries if compared to conventional cutting without additional axes. Simultaneously, it was also observed that this method significantly relieved the main machine axes.

The application of this solution makes sense where sheet metal of average thickness (1 – 5 mm) has to be cut into complex shapes at great flexibility and high productivity. An example is the manufacturing of stator and rotor segments for motors and generators. Here the method offers an alternative to the highly productive but inflexible stamping or flexible but slow conventional laser cutting processes.

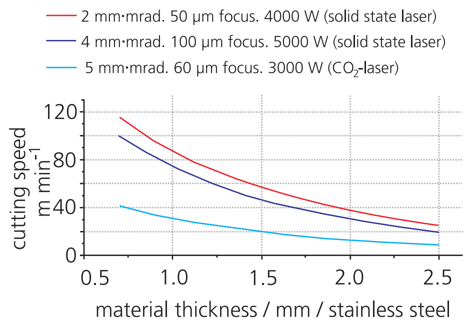


Fig. 1: Cutting speeds as a function of material thickness and laser type (straight cut)

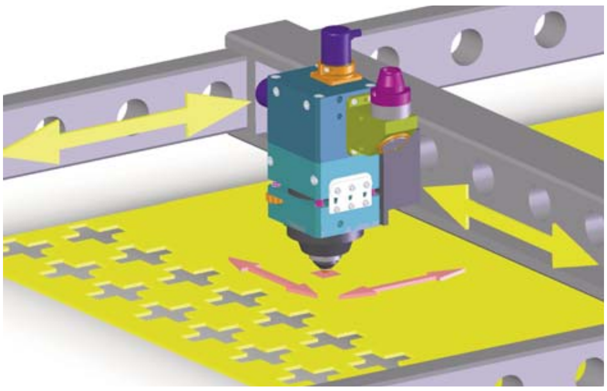
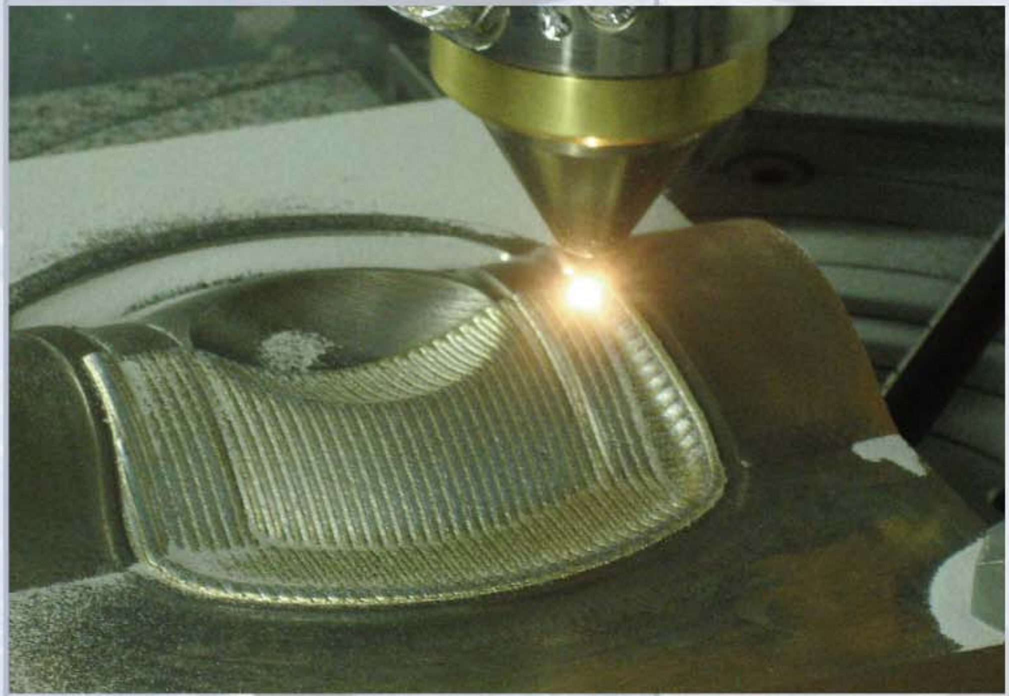
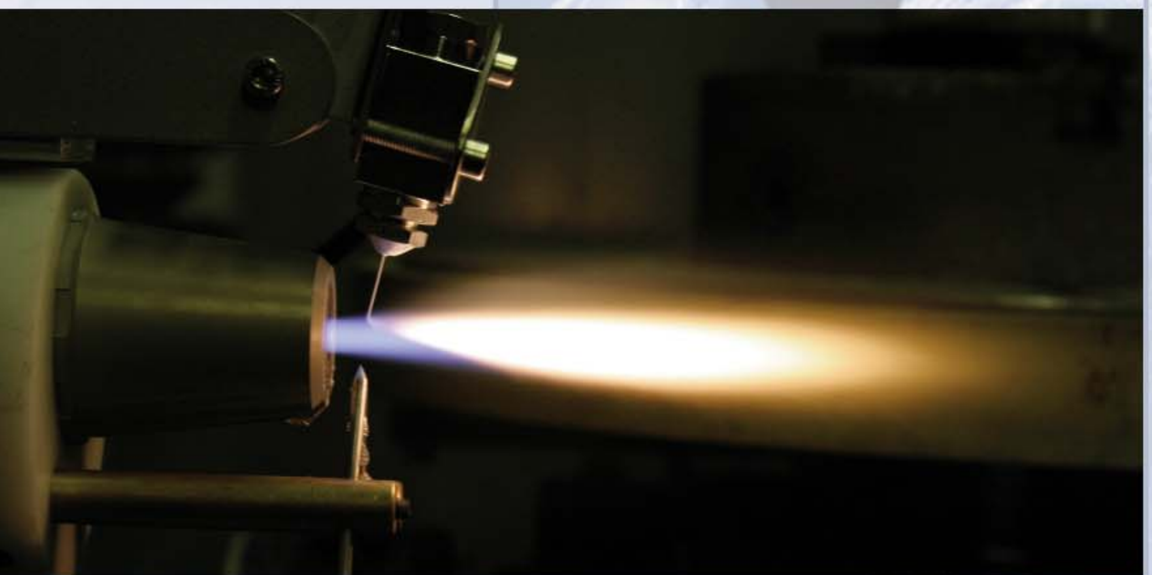


Fig. 2: CAD model of the coupled axes system (yellow: main axes, red: additional axes)

Contact

Dipl.-Ing. Florian Bartels
phone:
+49 (0) 351 2583 233
florian.bartels@iws.fraunhofer.de





R&D-offer: Thermal coating

Editor: For the last annual report you announced your plan to develop new system technological solutions in the area of buildup welding. What is the progress?

Dr. Nowotny: We successfully finished a BMBF production research program and demonstrated a CNC milling center which integrated the three-dimensional complete processing by applying both laser buildup welding and milling. In collaboration with the company Arnold, we integrated a laser processing head directly into the original tool holder of the milling spindle. This solution provides a larger workspace, simplifies programming and allows for a quicker change between laser processing and milling.

Editor: Tell us about the laser processing head.

Dr. Nowotny: The system is equipped with a well focused 1.5 kW diode laser, which is coupled to the processing head via a 400 µm fiber. Coaxial nozzles deliver the welding powder. Our latest development is COAX13, which is an extremely long and narrow nozzle shaped for the least possible disturbance. This nozzle type is preferably used for parts with limited accessibility, for example to repair turbines.

Editor: These coaxial nozzles work with powder only, don't they?

Dr. Nowotny: Exactly. They do have some essential limitations even with excellent powder utilization. Therefore we researched the possibility of using wires for directionally independent buildup welding. The solution is comprised of a new beam shaping optics, which allows the wire feed exactly through the center along the laser beam axis.

Editor: What are the main topics in thermal spraying?

Dr. Berger: Decades of development work in the area of spraying technology achieved a high level of technology. However, what did not change over the last 50 years is the selection of sprayed materials. Substantial materials research is required to enable new applications. We will be primarily working on the development of oxide ceramic materials based on Al_2O_3-Cr_2O_3-TiO_2 as well as on hard metals.

Editor: Does that mean that your work will exclusively focus on materials development?

Dr. Berger: No. Over the past few years we established the technology to spray suspensions. Instead of using powders for APS and HVOF we are using suspensions, which behave completely different during the spraying process and open up new possibilities.

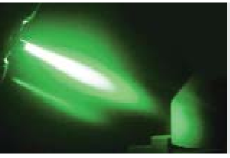
Editor: What is planned in detail?

Dr. Berger: In principle we count on coatings with multiple functions. In particular the material system Al_2O_3-Cr_2O_3-TiO_2 offers surprising possibilities. For example, it is possible to generate dielectric as well as electrically conductive coatings. We intend to combine both coating materials to form novel function coating systems for example of heating elements based on sprayed coatings.

Editor: What about the hard metals?

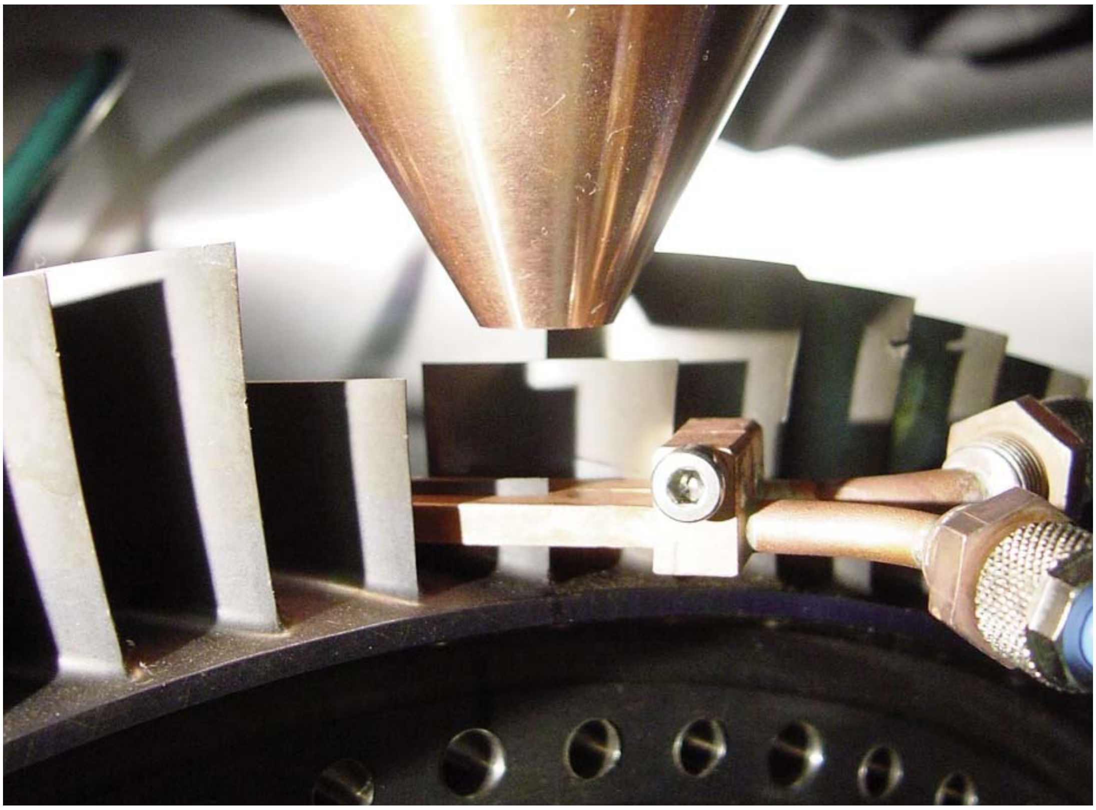
Dr. Berger: Here we would like to develop coatings that can be widely used in fatigue conditions such as rolling contact applications. Until recently these applications were considered impossible.

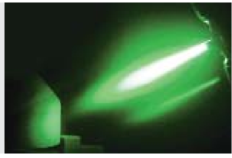
Problems are disguised opportunities.
Henry Ford 1



Examples of projects 2008

further information:
www.iws.fraunhofer.de/branchen/bra09/e_bra09.html
www.iws.fraunhofer.de/projekte/1-17/e_pro1-17.html





Dr. Lutz-Michael Berger
Team leader thermal spraying
(phone: +49 (0) 351-2583-330,
lutz-michael.berger@iws.fraunhofer.de)

Wear protection and functional coatings

The IWS offers thermal spray technology development based on atmospheric plasma spraying (APS) and high velocity oxygen fuel spraying (HVOF). Powders and suspensions are used to coat parts made from steel, lightweight metals or other materials with metals, hard metals and ceramics.

Based on the most modern spraying equipment, and in cooperation with other institutes of the Fraunhofer Institute Center in Dresden we offer:

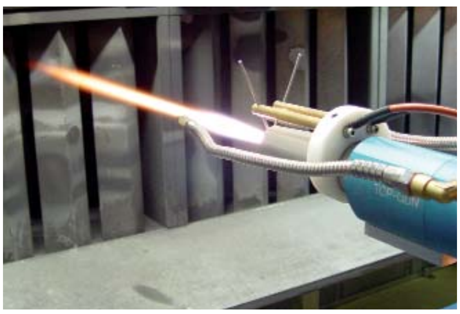
- conception of stress adapted coating systems,
- development of complete coating solutions from the material to the coated part,
- development and manufacturing of system components,
- participation in system integration,
- support of the user with technology introduction.

Dr. Steffen Nowotny
Team leader cladding
(phone: +49 (0) 351-2583-241,
steffen.nowotny@iws.fraunhofer.de)

Repair and generating

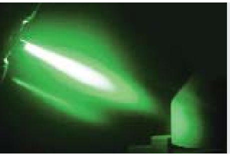
Laser beam and plasma powder cladding as well as hybrid technologies in combination of laser, plasma, and induction sources are available at the IWS for the repair and coating of components, moulds, and tools. Cladding, alloying or disperging of metal alloys, hard materials and ceramics can generate coatings and 3D structures. The complete process chain from digitizing and data preparation to the final processing can be utilized for all the technologies. For these application fields we offer:

- simulation of buildup welding processes,
- coating and shape forming laser buildup welding at highest precision,
- processing heads and CAM software of the industrial application of laser technology,
- on-site support of production implementations.



TopGun® HVOF pistol in use

Repair of gas turbine blades through buildup welding with high power diode laser



Thermally sprayed hard metal coatings for fatigue reducing rolling contact applications

Task

Conventional thermal spray coatings are primarily used to reduce abrasive, erosive and friction/sliding wear. However, modern spraying technologies such as high velocity oxygen fuel thermal spraying (HVOF) in combination with further developed materials have the potential to generate protective coatings for parts that are exposed to high rolling contact loads. Good examples are high performance transmissions.

Solution

The IWS, IKTS, LBF and IWU formed a strategic alliance of Fraunhofer institutes with an industrial focus (WISA). The alliance aims at developing new solutions to increase the performance of thermal spray coatings so that they can be applied in high loading applications. The project considers the entire technology chain to understand the importance of each processing step for the final application performance. The particular IWS focus is on the development, fabrication and characterization of thermal sprayed coatings.

Results

Preliminary experiments were performed to study the rolling contact performance of casehardened 16MnCr5 steel rolls, which were coated with WC-17%Co. Experiments continued using non-hardened 16MnCr5 steel substrates normalized to a hardness of HB190 and commercially available coating materials WC17%Co and WC-(W,Cr)$_2$-7%Ni. The samples were prepared using the HVOF process to deposit two coating thicknesses with 100 and 600 µm. The Hertzian contact reference stress maximum was located in the substrate when using a 100 µm coating thickness and directly in the coating at 600 µm coating thickness. The rolling contact experiments were performed at the Fraunhofer LBF in Darmstadt using a ZF roll test stand with a slippage of -25% and transmission oil SAE80 at a temperature of 80 °C in the rolling contact.

The experimental results demonstrated the improved performance of the coated rolls in comparison to the uncoated samples. In particular when applying 600 µm of coating it was possible to use non-hardened substrate materials to outperform casehardened but uncoated 16MnCr5 samples. There was no noticeable sign of wear (Fig. 1) even after 50 million rolling cycles at a Hertzian contact pressure of 2000 MPa. If the load is increased the relatively soft substrate materials leads to failure. Therefore the continuation of this project focuses in addition to qualifying diverse coating materials on the understanding the relation between substrate hardness and application performance.

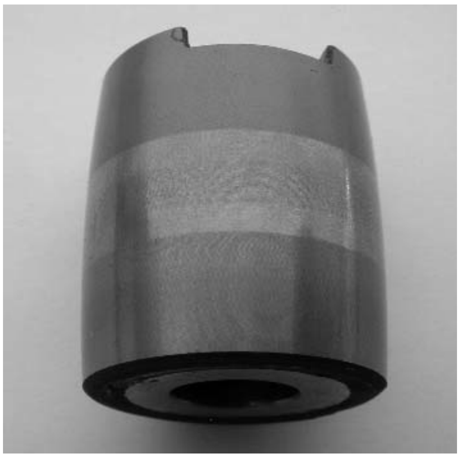


Fig. 1: Undamaged WC-(W,Cr)$_2$C-7%Ni coated sample after rolling fatigue test

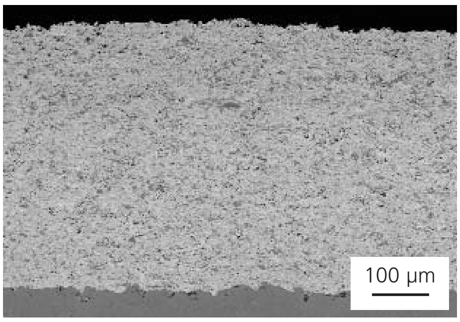
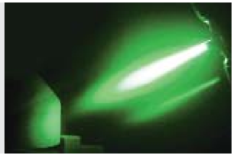


Fig. 2: Microstructure of the WC-(W,Cr)$_2$C-7%Ni coating for fatigue reducing rolling contact applications (SEM micrograph)

Contact

Dr. Lutz-Michael Berger
phone:
+49 (0) 351 2583 330
lutz-michael.berger@iws.fraunhofer.de



Process and system technology for laser beam buildup welding in jet engine repair

Task

Laser powder buildup welding is an established manufacturing process to repair damaged aircraft engines. The processing of aerospace titanium alloys was demonstrated in past projects such as AWFORS and FLEXILAS.

The objective of the work presented here was to repair a blisk of the first compressor stage of an aircraft jet engine. The blades of a blisk are exposed to sucked in debris, and therefore face an enormous risk to get damaged. Due to their size they are not completely regenerated during repair. Instead, the worn off material is replaced layer by layer. A special challenge was the absence of any possibility to mask or cool the processing region. In addition their accessibility was limited.

Solution

As a first step IWS engineers collaborated with MTU Aero Engines GmbH to perform extensive investigations on regenerating the desired geometry. These experiments were part of an extension to the BMBF project FLEXILAS.

In particular when generating the first layers, heat gets trapped which melts the blade and can easily lead to the destruction of the entire part. A proper processing regime was developed in a series of welding experiments. The reproducibility of fabricating the desired geometry was demonstrated (Fig. 2).

The process was performed in an argon atmosphere to avoid oxidation of the repaired blades. The laser source was a 4.4 kW solid state laser.

Results

As anticipated, the pore free characteristic material structure was reproduced layer by layer. The structure is dense and fine crystalline. A broader scale structure is formed due to epitaxial crystal growth between welding layers (Fig. 3).

Fig. 1: COAX13 powder nozzle

The results also showed limitations in accessing the regions which have to be repaired. The blisk geometry is complicated and conventional powder delivery nozzles could not reach far enough. Therefore the COAXn family of nozzles was expanded. The COAX13 nozzle is very long and narrow (Fig. 1). This 300 mm long and 31 mm diameter nozzle can be used to repair blisks with blade distances of less than 20 mm. The powder is not delivered through a ring shaped gap. Instead, a specially designed set of powder/gas channels feeds the powder to the processing region.

Currently the regenerated blades are being tested for vibration performance at the customer.

Fig. 2: Repaired edge geometry of a damaged blisk prior to the final finishing step

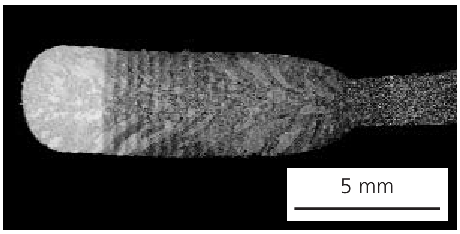
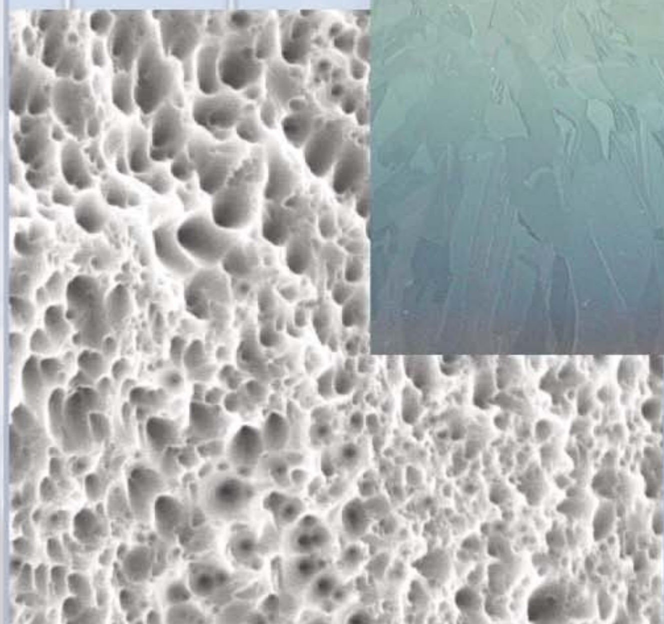


Fig. 3: Polished cross-section of the added structure. The individual layers are recognizable as well as the several layer spanning broad range structure

Contact

Dipl.-Ing. Robert Münster
phone:
+49 (0) 351 2583 188
robert.muenster@iws.fraunhofer.de





R&D-offer: CVD thin film technology

Editor: Your department develops CVD processes for large area applications. What are the key challenges?

Prof. Kaskel: New thin film technology solutions benefit from a parallel development of processes and machine technology. Particular challenges and solutions we see are in the area of the photovoltaic industry for which we develop processes and systems. The department focuses on chemical vapor deposition at atmospheric pressure. Here we see the opportunity to support the solar cell manufacturing industry, which is facing an ever increasing cost pressure. This is true for the manufacturing of crystalline as well as thin film solar cells. The advantage is self-evident. Complex vacuum system technology is expensive and requires a large footprint whereas compact atmospheric pressure processing heads can be easily moved toward the part to be coated and allow a continuous processing setup.

Editor: What are the new results in this application area of photovoltaics?

Prof. Kaskel: In 2008 we managed to significantly improve our in-house developed arc technology. Today we can homogeneously coat a width of 25 cm in pass-through inline reactors. Next year we will further increment the width to continuously coat 60 cm wide parts.

For the manufacturing of solar cells we developed a continuous plasma etching process, which leads to an increased efficiency of the cells. Our antireflective coating increases the light absorption. In comparison to conventional processes, our new technology does not require vacuum making possible a continuous processing.

CVD methods at atmospheric pressure are also advantageous in thin film photovoltaics. Here we developed in 2008 processes to deposit transparent conductive oxides, which are the basis of thin film solar cells.

Editor: How important is process monitoring for the development work?

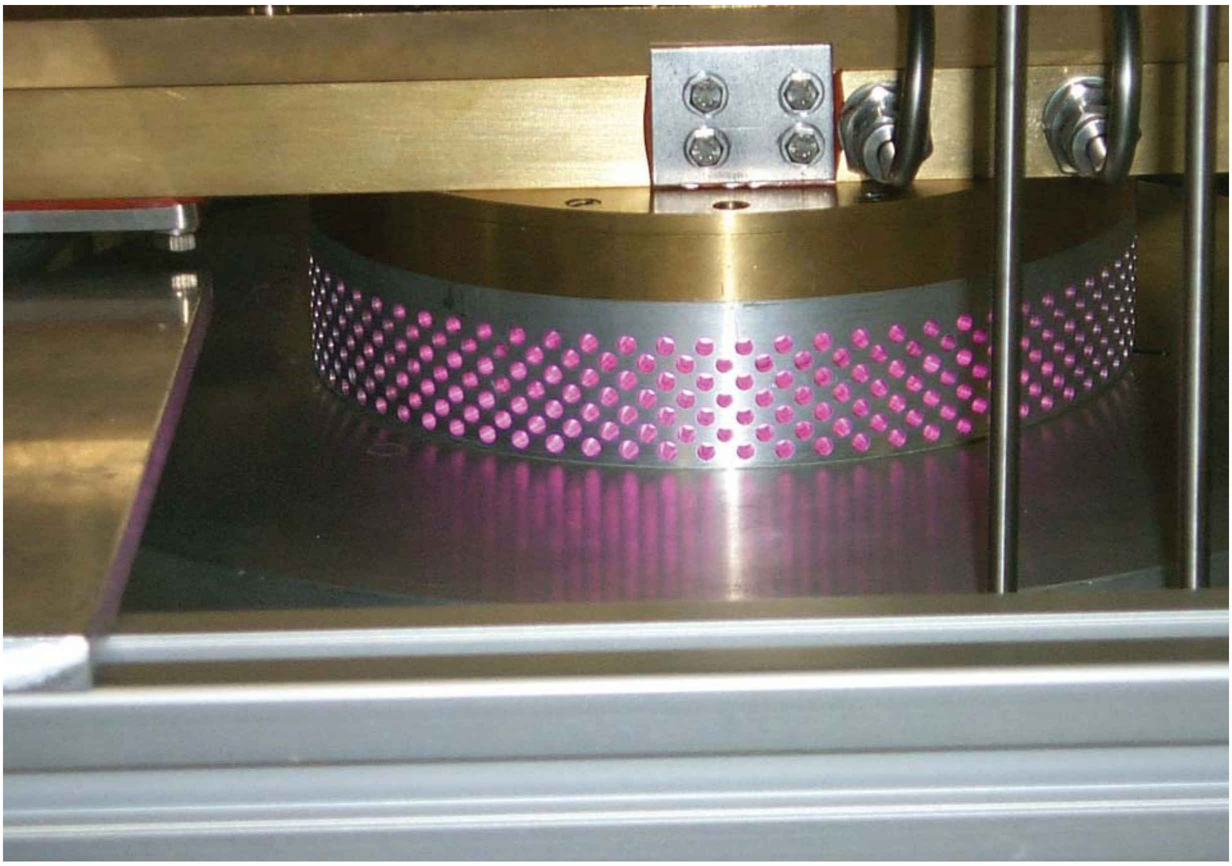
Prof. Kaskel: Our processes would only be half as efficient if we would not use the most modern inline monitoring methods. These include, for example, laser diode spectroscopy to detect trace amounts of water in processes. Using these methods allows us to optimize the utilization of precursors. The monitoring also enables process control methods to make them safe and environmentally sensitive by eliminating the emission of poisonous substances, for example. In 2008 we significantly expanded in this area. It turned out that the developed monitoring techniques proved to be excellent control tools for manufacturing processes in the chemical industry. The spectrum spanned from simple drying processes to the fabrication of nanoparticles.

New challenges present
wonderful opportunities
to discover more about oneself.
Ernst Ferstl

Prof. Stefan Kaskel
Department head
(phone: +49 (0) 351-2583-331,
stefan.kaskel@iws.fraunhofer.de)

Examples of projects 2008

further information:
www.iws.fraunhofer.de/projekte/1-27/e_pro1-27.html
www.iws.fraunhofer.de/projekte/1-28/e_pro1-28.html



Dr. Ines Dani
Team leader atmospheric pressure CVD
(phone: +49 (0) 351-2583-405,
ines.dani@iws.fraunhofer.de)

Dr. Wulf Grählert
Team leader process monitoring
(phone: +49 (0) 351-2583-406,
wulf.graehlert@iws.fraunhofer.de)

Dr. Holger Althues
Team leader chem. surface technology
(phone: +49 (0) 351-2583-476,
holger.althues@iws.fraunhofer.de)

Plasma enhanced CVD processes at atmospheric pressure

Plasma enhanced chemical vapor deposition processes at atmospheric pressure produce large area and high quality functional coatings without the need for costly vacuum systems. The processes can continuously coat at high deposition rates on temperature sensitive (i.e. special steels, lightweight metals, glasses and plastics) flat as well as slightly curved materials. At the Fraunhofer IWS we develop prototype inline reactors for the synthesis of oxide and non-oxide coatings as well as plasma chemical etching processes at atmospheric pressure. The optimization of the reactor design is based on experimental results and thermo-fluid dynamic simulations. The modular reactor design promotes a cost efficient adaptation of the processes to new applications and coating materials.

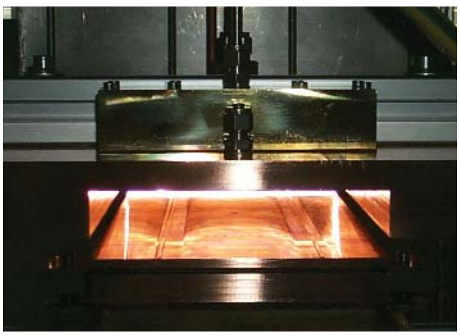
Process monitoring

In many cases the optimal function of industrial equipment and the quality of the manufactured products depend directly on the gas atmosphere inside the system. Therefore its composition has to be monitored at tight tolerance levels. An industry compatible gas analytics is essential for the quality control of chemical deposition, etching, and sintering processes and for monitoring the emissions of industrial machines. For customer specific solutions to continuously monitor the chemical composition of gas mixtures, IWS is using sensors that are alternatively based on either NIR diode laser or FTIR spectroscopy.

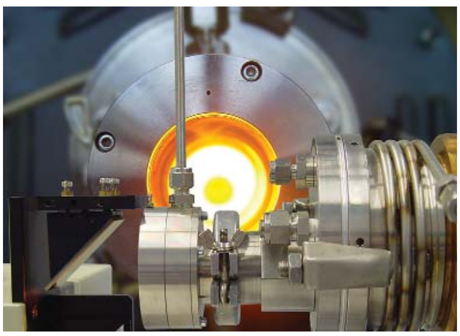
Furthermore we analyze surfaces and coating systems with spectroscopic methods such as FTIR spectroscopy, spectro-ellipsometry or Raman microscopy.

Chemical surface technology

Engineered material surface properties and functions vary widely depending on the application. The requirements, for example, include corrosion and scratch protection, anti-fingerprint or self-cleaning functions, optical transparency and electrical conductivity. In addition, surfaces of functional elements such as electronic components may have to perform very specialized functions. All the properties can be engineered by applying special functional coatings or surface treatment processes. This step requires cost effective and often large area processes. The chemical surface technologies group at IWS develops chemical vapor deposition (CVD) and wet chemical processes and combines them to generate a diverse range of surface functionality on various substrates.



View of the coating area of the ArcJet-PECVD system



FTIR monitoring of high temperature processes

Hydrophilic / hydrophobic structured surface on a stainless steel sheet

Transparent conductive oxide (TCO) for solar cells

Task

Transparent conductive oxides (TCO) have many applications including heatable glazing and transparent electrodes for displays and solar cells.

Fluorine doped tin dioxide (SnO_2:F, FTO) presents a cost effective alternative to the commonly used tin doped indium oxide (In_2O_3:Sn, ITO). For thin film photovoltaic applications these films have to be highly transparent and conductive. In addition they require a well-defined surface structure to efficiently couple the light via scattering effects (Fig. 1).

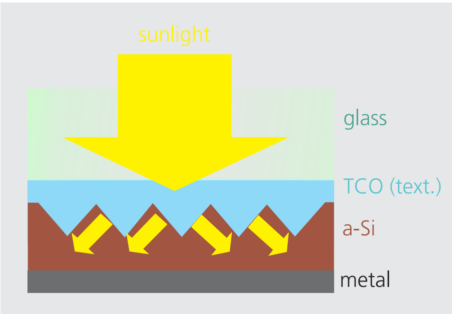


Fig. 1: Schematic design of a thin film solar cell

Solution

At the Fraunhofer IWS, engineers and scientists develop chemical vapor deposition processes that operate at atmospheric pressure (AP-CVD, Fig. 2). These processes allow the large area and continuous treatment of substrates without the need for costly vacuum systems. AP-CVD can deposit various metal oxides including SnO_2:F at medium temperatures (< 400 °C) onto many temperature sensitive substrate materials such as heat treatable steels, aluminum or preformed glass. The coatings are homogeneous, conform and adhere well with thicknesses up to 1000 nm.

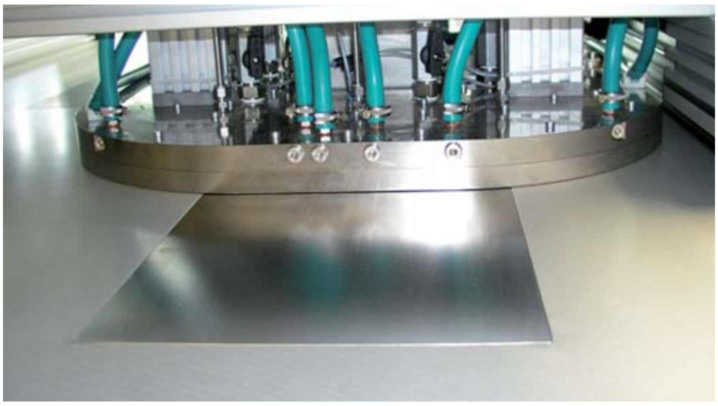


Fig. 2: Mobile AP-CVD processing head for the deposition on substrates of up to 300 x 300 mm^2

Results

The AP-CVD process was used to deposit FTO at deposition temperatures between 200 - 350 °C onto several substrates. The deposited films were then analyzed with respect to their optical, structural and electrical properties.

Coated glasses show a high diffuse transmission exceeding 85 % in the visible spectrum. X-ray diffractometry analysis revealed a crystalline rutile structure. AFM imaging demonstrated the synthesis of smooth as well as textured coatings. The produced surface roughnesses ranged from R_a = 7 nm to R_a = 40 nm. The sheet resistance was measured using a four-point probe method yielding only 10 Ω / □. The specific resistance was measured at 10^{-3} Ω cm. The FTO coating combines properties such as transparency, electrical conductivity and adjustable surface texture. They have a great potential as electrode material for photovoltaic and illumination applications. The AP-CVD process is in particular useful for the coating of large area substrates at temperatures of < 400 °C.

Contact

Dipl.-Ing. Thomas Abendroth
phone:
+49 (0) 351 2583 294
thomas.abendroth@iws.fraunhofer.de

Atmospheric pressure plasmas for large area applications in photovoltaics

Task

Continuous fabrication processes become increasingly important in solar cell manufacturing due to their improved material flow and reduced wafer breakage. The overall manufacturing process can be substantially simplified by introducing inline plasma technologies for etching and deposition steps and the transition from vacuum to atmospheric pressure operation. The challenge is to develop larger area plasma sources and pass through reactors for the operation at atmospheric pressure.

Solution

Two complementary atmospheric pressure plasma sources are used to process 156 x 156 mm² wafers. One source is a linear direct current arc discharge (Fig. 2) and the other is a microwave plasma generator. An argon / nitrogen gas mixture streams through the plasma sources. The excited species leave the plasma source and flow toward the substrate. There the reactive precursors are added to perform either etching or deposition reactions.

Etching chemistries, that are typically used in the semiconductor industry, are also here applied to etch silicon. Typical gases are NF_3 and SF_6. Silicon nitride is deposited to form passivating and antireflective layers. The precursors are silane or a metal organic precursor and ammonia. The engineering of the flow dynamics in the plasma sources and the reactor is based on fluid dynamic simulations (Fig. 3).

Results

All process steps marked in green in Fig. 1 have been successfully demonstrated in the laboratory. The IWS process for edge isolation has also been successfully tested in several industrial experiments. During these tests the wafers were processed with industrial standard processes onsite at the customer facility. Only the edge isolation step was performed at the Fraunhofer IWS. The backside and the edges of the wafers were plasma chemically etched using NF_3 achieving etching rates in the order of 3.7 µm m min^{-1}. The so plasma processed wafers showed an increased efficiency of 1.6 % (rel.) if compared to wafers that were conventionally edge isolated.

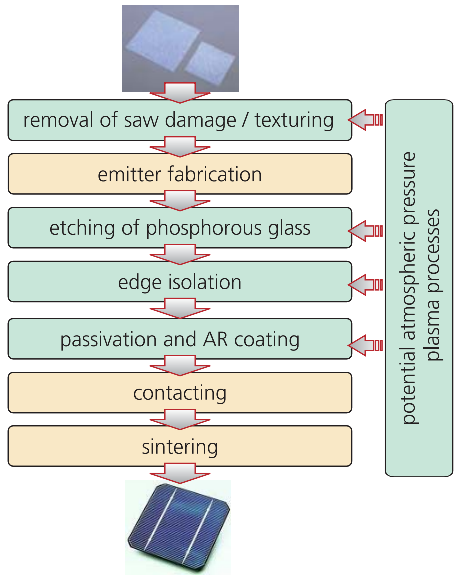


Fig. 1: Schematic representation of the production flow to fabricate solar cells, the boxes marked in green are processing steps that were researched at the IWS

Fig. 2: Direct current arc discharge plasma source with a working width of 250 mm

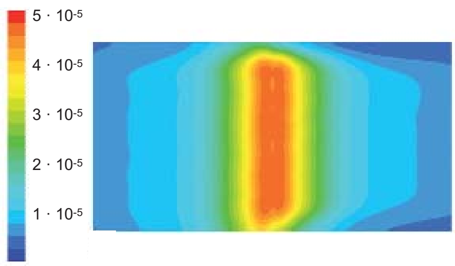


Fig. 3: Fluid dynamic simulation of layer deposition within the reaction zone

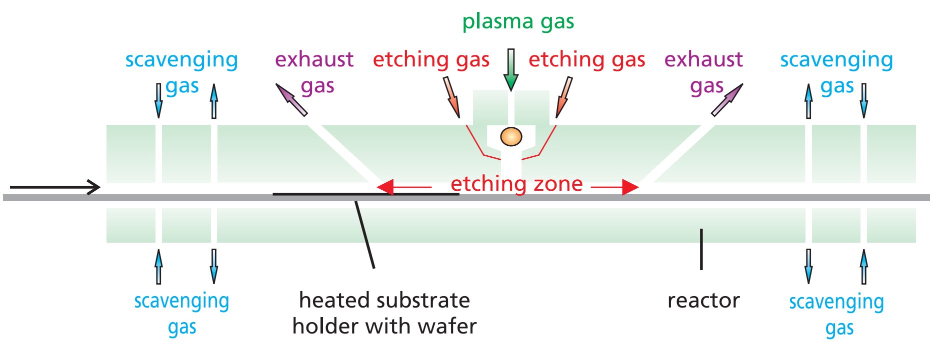
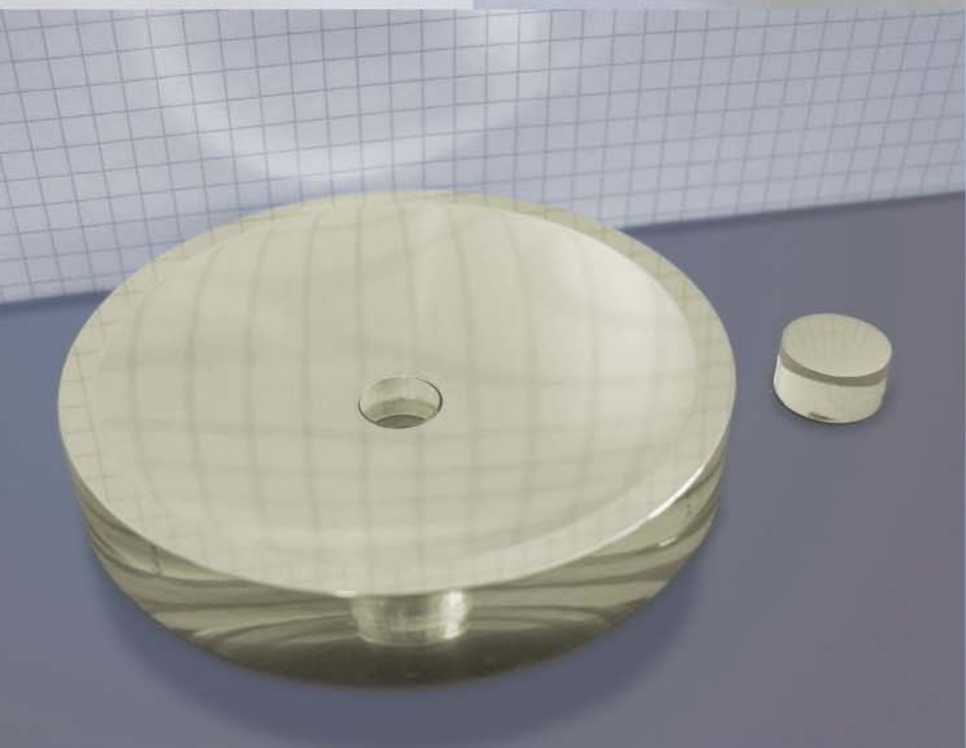


Fig. 4: Schematic representation of an atmospheric pressure reactor for plasma chemical etching

Contact

Dr. Gerrit Mäder
phone:
+49 (0) 351 2583 262
gerrit.maeder@iws.fraunhofer.de



R&D-offer: PVD- and Nanotechnology

Editor: The employees in your department are working on various aspects and applications of PVD thin film technology. What special progress was made in 2008?

Dr. Leson: In the area of classic hard coatings we worked on very thick layers exceeding 50 µm. Normally such thick layers tend to be inhomogeneous and flake off the substrate. By applying a special coating design, we managed to overcome these conventional limitations. We are now able to deposit very thick, smooth and adhering coatings, which can be mechanically post processed. Interesting applications are envisioned in the area of fabricating long lasting machine components and tools.

In the field of carbon coatings we continue to focus on our Diamor® films. Their outstanding properties such as the very high hardness and extremely low friction coefficients provide great potential for the automotive industry. Last year we optimized the reliability of Diamor® coating systems for extremely high loading conditions. In conjunction with the associated deposition machine technology, the coatings are ready for industrial applications.

Editor: Your department is also working on the fabrication of single wall carbon nanotubes. How is your approach different from the many other groups working on this topic?

Dr. Leson: We developed a process to produce larger quantities of single wall carbon nanotubes of high quality. Other groups and manufacturers focus on the simpler manufacturing of multi wall carbon nanotubes. This provides us with a unique selling proposition, because the exceptional properties that are expected of carbon nanotubes can only be achieved with the single wall version.

Editor: Aside from the established areas you also picked up new subjects.

Dr. Leson: A very interesting recent topic is the development of reactive multilayers. These are nanometer film stacks of two different materials, which can rapidly release energy when a chemical reaction between them is initiated. The amount of released energy is precisely adjustable by changing the materials and film thicknesses. The reaction and energy release timing can also be adjusted. In combination with soldering foils it is possible to join components with very high accuracy. The heat is released directly in the region were the materials are joined, which keeps the overall thermal load on the component very low. This qualifies the process especially as a micro joining technology. But we are also looking at other applications for which we developed different reactive multilayers. This work clearly benefits from our experience and know-how in developing multilayer thin films for EUC and X-ray optical applications.

Ideas won't keep;
something must be done about them.
Alfred North Whitehead

Dr. Andreas Leson
Department head
(phone: +49 (0) 351-2583-317,
andreas.leson@iws.fraunhofer.de)

Dr. Stefan Braun
Team leader X-ray and EUV optics
(phone: +49 (0) 351-2583-432,
stefan.braun@iws.fraunhofer.de)

Fabrication and characterization of nanometer precision coatings

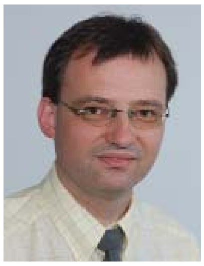
Nanometer single layer and multilayer coatings are used in EUV and X-ray optics for beam shaping and monochromator applications. For the deposition of metallic and dielectric coatings we use magnetron and ion beam sputter deposition as well as pulse laser deposition. The coating systems are characterized by:

- highest thickness precision,
- smallest roughness,
- high chemical purity,
- excellent lateral homogeneity,
- very good reproducibility.

In addition to the development and fabrications of precision coatings, we are offering our long-term experience in characterizing and modeling of nanometer coatings. The following technologies are available in our laboratory:

- X-ray reflectometry,
- EUV reflectometry,
- X-ray diffractometry,
- residual stress measurements.

Mirrors with reflective coating

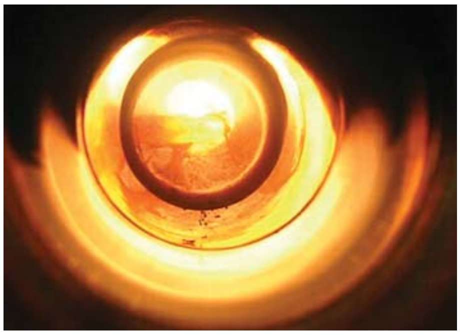


Dr. Oliver Jost
Team leader carbon nanotubes
(phone: +49 (0) 351-2583-477,
oliver.jost@iws.fraunhofer.de)

Carbon nanotubes

Carbon nanotubes show a number of interesting properties such as high strength, very good thermal and electrical conductivity, and interesting optical properties. Only small quantities of carbon nanotubes added to composite materials can open completely new functionalities for the matrix material while simultaneously maintaining the conventional matrix properties and keeping established production lines unchanged.

At Fraunhofer IWS we developed a novel process for the synthesis of high-quality single wall carbon nanotubes with a very narrow property spectrum. We are currently up-scaling the process. For the development of composite materials with special properties we are offering carbon nanotubes in different qualities and processing stages. The development of composite materials can be supported by modeling and extensive characterization.



Arc synthesis of filaments made of carbon nanotubes

Dr. Volker Weihnacht
Team leader carbon coatings
(phone: +49 (0) 351-2583-247,
volker.weihnacht@iws.fraunhofer.de)

Dr. Otmar Zimmer
Team leader PVD coatings
(phone: +49 (0) 351-2583-257,
otmar.zimmer@iws.fraunhofer.de)

further information:
www.iws.fraunhofer.de/branchen/bra07/e_bra07.html
www.iws.fraunhofer.de/projekte/1-22/e_pro1-22.html

Coating with super hard amorphous carbon

Amorphous carbon coatings with tetrahedral diamond bonds (ta-C) combine high hardness, low friction, and chemical inertness. Therefore they are exceptionally useful as protective coatings. The IWS developed ta-C coating systems (Diamor®) can be deposited with excellent adhesion in the thickness range from a few nanometers up to several tens of micrometers. The deposition occurs at low temperatures in vacuum through a special developed pulsed arc process. For the commercialization of Diamor® coatings the IWS delivers jointly with partners the technology as well as the necessary deposition sources and coating equipment. The offer also includes the laser acoustic quality control and process optimization equipment LAwave®.

Coating through activated high rate processes

Processes involving the physical deposition from the vapor phase (PVD = physical vapor deposition) allow for the deposition of high quality tribological and functional coatings in the thickness range from a few nanometers to several tens of micrometers. At the IWS, we have a number of technologies at our disposal from high rate evaporation to highly activated plasma processes and their combinations. A special focus is the extensive utilization of arc discharges, which are the most effective source of energy rich vapor jets. Based on these technologies we offer:

- sample coatings,
- coating characterization,
- development of coating systems,
- customer specific adaptation of coating technologies,
- feasibility and cost studies,
- development and manufacturing of adapted equipment components.

Examples of projects 2008

Equipment for the deposition of super hard amorphous diamond-like carbon coatings (Diamor®) based on the Laser-Arc process

Metal evaporation through electron beam technology

Hard coatings > 20 µm – new possibilities for thin film technology

Task

PVD (physical vapor deposition) deposited classic hard coatings such as nitrides, oxides and carbon films are typically thinner than 10 µm. However, special applications could greatly benefit from hard coatings thicker than 20 µm. For example, machine components and tools could experience a drastically increased service life. An increased coating thickness also offers the possibility to post process the material and to structure it, for example.

Thick coatings often tend to delaminate or form cracks due to residual stresses in the film. Also, the coating process becomes more and more time consuming with increasing thickness and the deposited coatings turn increasingly inhomogeneous. The reason for the latter is the formation of larger growth defects in the coating throughout the process.

Solution

The key to produce thick coatings with PVD methods lies therefore in effectively preventing the growth of existing defects (e.g. particle deposited on the substrate during vacuum arc deposition, the PVD process used for the here presented results). Another factor is to embed the defects into the coating structure without destroying it. The initial thought was that the growth of defects could only be interrupted if the original defect is covered with a layer from a different material. This layer should prevent the further growth of the defect's microstructure. Therefore a multilayer structure is useful for suppressing defect growth. Investigations with various multilayer coatings demonstrated that it is possible to stop the growth of existing defects and to further build up the coating to become flatter and more homogeneous while completely embedding the defect (Fig. 1). The coatings can be further improved by reducing the thickness of the individual layers to the nanometer range (nanolayers, Fig. 2).

Results

Using the nanolayer architecture it was possible to deposit 60 µm thick coatings. An important goal is the possibility to mechanically process the coatings; for example by grinding. This was demonstrated on thickly coated test specimen made from hard metal. A sample was ground to show the transition from the hard metal substrate to the coating, which allows the comparison of both (Fig. 3). The edge in the coating material is clearly smoother and more homogeneous than the hard metal. There are no coating damages (i.e. spalling) or defects visible. And the coating is substantially harder than the hard metal.

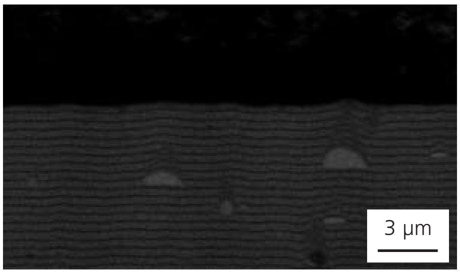


Fig. 1: Successful embedding of growth defects by subsequently deposited CrN/TiN multilayers

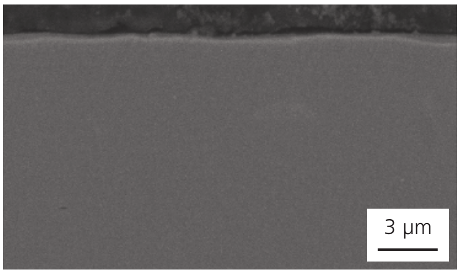


Fig. 2: Homogeneous coating structure due to individual layer thicknesses of only a few nanometers (CrN/TiN)

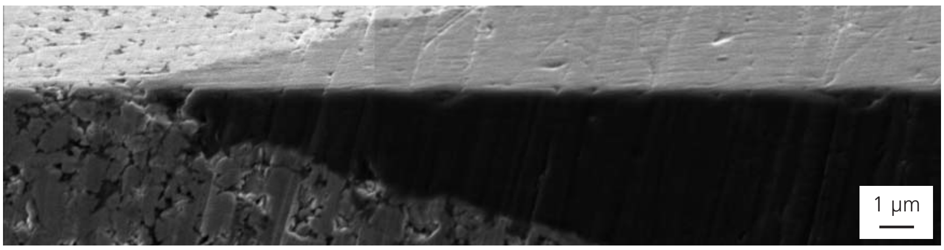
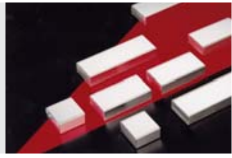


Fig. 3: Ground edge of a coated test specimen

Contact

Dr. Otmar Zimmer
phone:
+49 (0) 351 2583 257
otmar.zimmer@iws.fraunhofer.de



Optimization of high performance ta-C coatings systems

Task

Diamond-like carbon coatings (DLC) are known for a unique combination of high wear resistance and low friction properties. They are used in industrial applications for numerous tools and sliding components. However, still problematic for many applications are the high compressive stresses and the low plasticity of the coatings. The compressive stresses and low plasticity reduce the dynamic loading capacity of the coatings and can lead to failures such as spalling. IWS engineers are therefore developing DLC coatings especially for high load bearing applications such as gears.

Solution

So far metal doping has been the approach for a-C:H coatings, which increases the toughness but also increases friction and reduces wear resistance. Another solution was to design coating stacks with additional support layers, which means additional effort and costs.

The IWS developed ta-C coatings in order to increase the stability under high loads. The development aims at multilayer structures made from softer graphitic as well as hard diamond-like coatings. The optimization of these coating stacks is supported by numerical simulation of critical stresses in the coating-substrate compound. Based on a given loading profile the simulation determines for different coating architectures the stress distributions. Thus, it is possible to identify those coating designs that minimize the critical stresses for the given application.

Results

Initial 2.5µm thick ta-C and a-C coatings were produced from a graphite cathode using a pulsed arc process. Coatings with varying fractions of diamond bonds are produced by different process parameters. As a result the E-modulus of the coatings can be adjusted between 180 and 430 GPa. Corresponding with the E-modulus the compressive stresses can be reduced from 3 GPa to 0.2 GPa.

The measured E-modulus and residual stress values provided input for the simulation of the elastic contact loading to determine an optimal sequence of soft and hard layers. The calculated layer sequence was then produced on steel samples to test their fatigue resisting performance. These tests were performed using an especially developed threshold load tribometer. The machine applies a complex loading pattern consisting of dynamic compression and oscillating sliding (Fig. 2).

At a given average compressive load the samples were exposed to oscillating fretting until significant coating failure occurred. Fig. 1 plots the resulting data for an optimized ta-C/a-C multilayer in comparison to a standard ta-C film in a Woehler diagram. As indicated by the plot the optimized coating has a 100-fold increased load performance. These optimized coating architectures are for example applied on high performance gears.

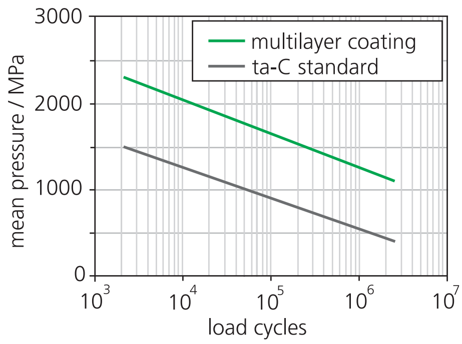


Fig. 1: Mechanical strength of two coating types measured in the threshold load tribometer (Woehler diagram)

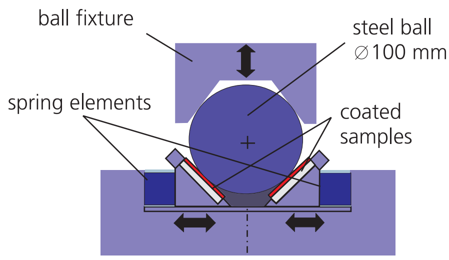


Fig. 2: Schematic design of the threshold load tribometer to characterize the load performance of coatings under lubricated conditions

Fig. 3: A gear coated with an optimized ta-C/a-C multilayer coating

Contact

Dr. Volker Weihnacht
phone:
+49 (0) 351 2583 247
volker.weihnacht@iws.fraunhofer.de

Nanometer reactive multilayers as precisely controllable energy storage devices

Task

Numerous industrial processes require a very well defined and quick release of energy. For example, when joining temperature sensitive materials, it is necessary to apply the required temperature only very briefly to avoid damaging the components and thermal warpage.

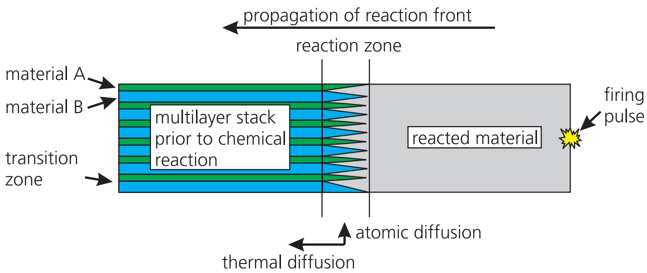


Fig. 1: Schematic design and principle of reactive multilayer coatings

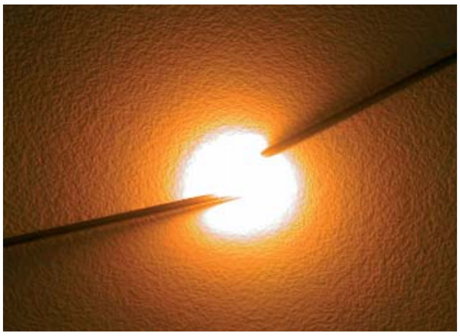


Fig. 2: Electrical ignition of a reactive multilayer coating

Fig. 3: Freestanding Ni/Al reactive multilayer coating,
thickness 25 µm, diameter 50 mm

Contact

Dipl.-Ing. Georg Dietrich
phone:
+49 (0) 351 2583 287
georg.dietrich@iws.fraunhofer.de

Solution

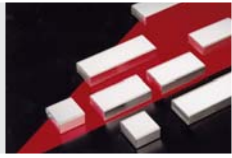
Nanometer multilayers offer an extremely precise opportunity to store and release energy. These multilayers consist of different materials that release energy when chemically reacting with each other. The multilayer design allows to very accurately adjust the amount of stored energy and thus to tailor the process to specific applications. Since 2007, engineers at the Fraunhofer IWS in Dresden have been working on the development of these reactive multilayer coatings (RMC) in addition to developing high precision nanometer multilayers for X-ray and EUV optical applications. The RMCs consist of several hundreds, up to thousands, of 10 – 100 nm thick individual layers of at least two different materials, which react exothermally with each other (Fig. 1).

Physical vapor deposition technologies such as magnetron sputtering and ion beam sputtering are applied to fabricate RMCs with total thicknesses of up to 100 µm. The RMCs are deposited directly onto the component or fabricated as a freestanding foil, which makes it very flexible for various applications.

Each RMC stores a defined amount of energy, which can be used as a localized source of heat. The RMC is ignited by an external energy source such as an electric spark (Fig. 2) or a laser pulse. As a result of the ignition the materials of the individual layers interdiffuse and undergo a chemical reaction while releasing energy. The reaction zone subsequently propagates and so does the heat front. In a very short time the stored energy is released into a narrow region. Using this heat source to fabricate soldered joints minimizes the heat and stress introduction to the adjacent components. The heat is released exactly at the location where it is needed to form the joint.

Results

Tailoring the design of the RMC allows adjusting the propagation velocity of the reaction front, the amount of released heat and the maximum temperature. It is possible to achieve localized temperatures of up to 2000 °C and propagation velocities from 2 – 20 m s^{-1}. IWS engineers are working on improving the performance of already known material systems such as Ni/Al and Ti/Al. They are also researching alternative material systems to develop a wide range of energies and to explore new application fields for RMCs such as brazing. Special emphasis is also placed upon the scaling of the technology to large area and freestanding reactive foils (Fig. 3).



Ion beam processing of optical surfaces

Task

The shaping, smoothing and coating of optical surface requires highly sophisticated processing techniques. Important parameters are the accuracy of the contour as well as the surface roughness. Both are particularly difficult to manage for X-ray optical components. Typical X-ray mirrors for example have a 2-dimensionally curved aspherical contour, which is mostly fabricated from flat or spherical substrates (silicon or quartz glass). The required micro roughness of the mirror surface as well as the coatings is in the order of 0.1 nm to achieve sufficient reflectance.

Solution

Ion beams are a well-defined and reproducible tool to process solid state matter. Simultaneously they do not penetrate deeply into the material. Thus they represent an ideal tool to process optical surfaces. They can be used to shape the contour of a component and to polish and clean its surface by removing material. Ion beams are also used to deposit layers onto the optical surfaces.

The ion beam sputtering machine "IonSys 1600" is capable of performing all the mentioned processes to fabricate (X-ray) optical components. The processing can be done in one system since the machine has a primary ion beam to sputter the coating material and a secondary assisting ion beam, which can be directed toward the substrate itself. Intermediate venting of the chamber between process steps can be completely avoided, which protects the surface. Each processing step requires specific energies and rates. Both ECR ion sources can be adjusted to stable energies between 50 and 2000 eV. The system is designed with linear ion source. It is possible to homogenously and reproducibly treat large area substrates of up to 500 x 200 mm².

Results

Fig. 1 shows the 1-dimensional contour profile of a curved (R = 10 m) quartz glass mirror prior to and after ion beam processing. It can be seen that the final contour matches the theoretical elliptical curve. The data were obtained by laser triangulation. The measurements allow to estimate a figure slope error of $\Delta\Theta < 0.01°$ (0.2 mrad) in comparison to the target geometry. This error is approximately equal to the half width of the reflectance maximum (1st Bragg peak) of the subsequently deposited multilayer coating.

Fig. 2 shows AFM images of the initial and final roughnesses of the quartz glass surface. Across the 20 x 20 µm² AFM scanning area the micro roughness is reduced from 0.73 nm to 0.26 nm. Fig. 3 shows examples of X-ray optical component which were processed in the "IonSys 1600" machine.

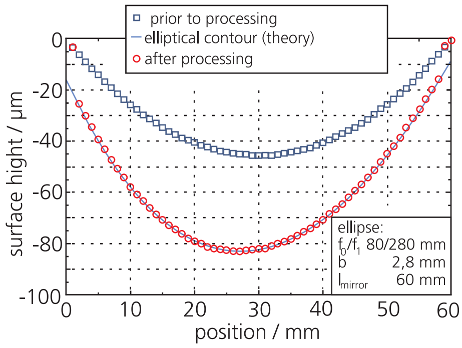


Fig. 1: Surface profiles of an elliptical X-ray mirror prior to and after processing in the "IonSys" machine

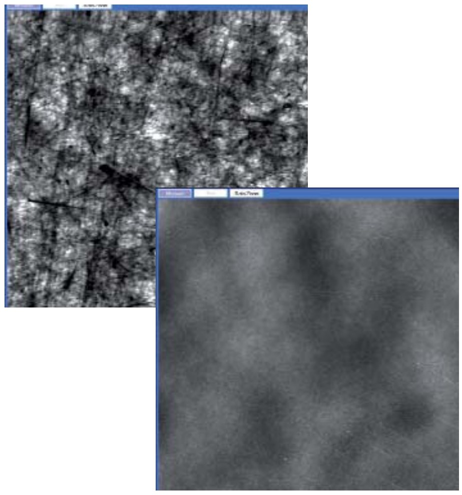


Fig. 2: AFM images (20 x 20 µm²) prior to (upper) and after (lower) ion beam processing

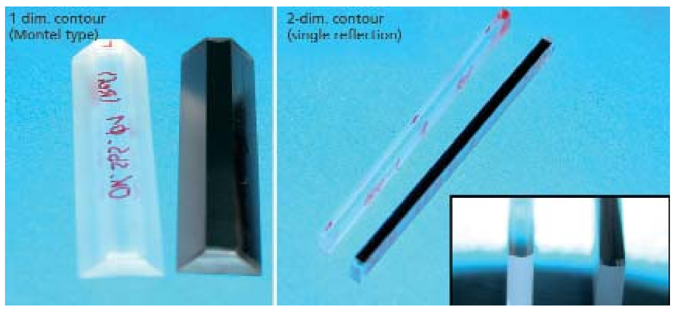


Fig. 3: Examples of 1- and 2-dimensionally curved X-ray mirrors prior to and after ion beam processing and coating

Contact

Dipl.-Phys. Peter Gawlitza
phone:
+49 (0) 351 2583 431
peter.gawlitza@iws.fraunhofer.de

Special Events

January 31st, 2008
Colloquium "New materials, innovative processes and their applications" in honor of the 63rd birthday of Dr. habil. Volkmar Hopfe

February 12th - 13th, 2008
TAW symposium "Thermal coating with laser based manufacturing processes" , held by the Technical Academy Wuppertal e.V. in collaboration with the Fraunhofer IWS and the Rofin Sinar GmbH in Dresden

March 10th, 2008
"Young talent forum" event during the "Nanofair 2008"
(organizer: Fraunhofer IWS Dresden)

March 11th - 12th, 2008
6th International nanotechnology symposium "Nanofair – New ideas for industry" at the International Congress Center in Dresden (co-organizer: Fraunhofer IWS Dresden)

March 13th, 2008
"Nanotechnologies for energy and energy efficiency" – Special event during the "Nanofair 2008" (organizer: Fraunhofer IWS Dresden)

April 17th, 2008
"Aerospace Day", held by the Federal Association of the German Aerospace Industry (BDLI) e.v. and the Aerospace Technology Competence Center Saxony / Thuringia e.V. at the Fraunhofer IWS Dresden

April 22nd - 23rd, 2008
Workshop "Laser systems & photovoltaics", held by the Carl-Hanser publishing house in Fellbach near Stuttgart (co-organizer: Fraunhofer IWS Dresden)

April 24th, 2008
Fraunhofer institutes center participation in the nationwide "Girls Day"

May 16th, 2008
4th meeting of former colleagues and alumni of the Fraunhofer IWS Dresden and the University of Technology Dresden department LOT

June 24th - 25th, 2008
7th workshop "Industrial applications of high power diode lasers" at the Fraunhofer IWS Dresden

July 4th, 2008
Fraunhofer Institutes Center participation in the "Long Night of the Sciences" in the state capital, Dresden

Saxony's Minister President Prof. Georg Milbradt participated in the "Aerospace Day" of the BDLI e.V. (April 17th, 2008)

July 25th, 2008
"Technology Day" in Bozen (Italy) – An event held by the Steibneis Technology Group and the TIS Innovation Park Bozen. The Fraunhofer IWS signs a contract with 8 additional European partners to collaborate in the area of technology and knowledge transfer, education and continuing education as well as the exchange of experts.

September 24th, 2008
Ceremonial opening of the "Fraunhofer Project Center for Integrated Manufacturing" at the Technical University Wroclaw. Federal Chancellor Dr. Angela Merkel participated and was granted an honorary doctorate by the TU Wroclaw.

October 14th, 2008
DPS customer day 2008 "Fascination 4D" at the Fraunhofer IWS Dresden

October 17th, 2008
Workshop "Surface technology in production – coatings in lubricated and non-lubricated systems", held by the journal "Metal Surface" and the Fraunhofer IWS Dresden

October 27th, 2008
2nd German-British Nanoforum "Commercializing Future Technologies for Energy and Automotive Applications" in London (co-organizer: Fraunhofer IWS Dresden)

November 5th - 6th, 2008
4th International workshop "Fiber Laser" at the International Congress Center in Dresden
(organizer: Fraunhofer IWS Dresden and Fraunhofer IOF Jena)

November 12th - 13th, 2008
Status seminar "Industry meets sciences", held by the project sponsor Juelich at the Fraunhofer IWS Dresden (organizer of the seminar: Fraunhofer IWS Dresden)

November 27th - 28th, 2008
Workshop "Laboratory sources for short wavelengths", held by the European Cooperation in the Field of Scientific and Technical Research (COST) at the Fraunhofer IWS Dresden (organizers: AXO Dresden GmbH and Fraunhofer IWS Dresden)

Surface Engineering und Nanotechnologie (SENT)

The Fraunhofer IWS in collaboration with Fraunhofer Technology Academy and the TU Dresden launched a series of continuing education courses addressing industrial thin film technology. These courses are offered as general lectures at the IWS and as special on-site packages for industrial customers.

October 18th - 20th, 2008
"Optical thin film systems"

November 4th,6th,11th,13th, 2008
"Processes to deposit thin films"

Mr. Andreas Wessel-Terharn (Federal Ministry for Transportation) opens the 7th workshop "Industrial Applications of High Power Diode Laser" (June 24th - 25th, 2008)

Three-dimensional presentation of the InFoCar during the Long Night of the Sciences (July 4th, 2008)

Long Night of the Sciences at the Fraunhofer IWS Dresden (July 4th, 2008)

Committees

Dr. L.-M.Berger:
Association of Thermal Sprayers e.V. (GTS) e.V.

Dr. L.-M.Berger:
European Powder Metallurgy Association

Prof. E. Beyer:
Member of the Executive Committee of the Fraunhofer-Gesellschaft

Prof. E. Beyer:
Chairman of the Fraunhofer Surface Technology and Photonics Alliance VOP

Prof. E. Beyer:
Director of the Institute for Surface and Manufacturing Technology IOF (TU Dresden)

Prof. E. Beyer:
Chairman of the work group "Engineering Sciences" as well as member of the board of the scientific society for laser technology WLT e.V.

Prof. E. Beyer:
Member of the Materials Research Association Dresden e.V.

Prof. E. Beyer:
Member of the Dresden discussion forum of economy and science

Prof. E. Beyer:
Member of the Sachsenberg-Gesellschaft e.V.

Prof. E. Beyer:
Member of the Federal Association of Medium-sized Industries e.V.

Prof. E. Beyer:
Member of the European Research Society "Thin Films" e.V. (EFDS)

Prof. E. Beyer:
Member of the competence center "Aerospace Technology Saxony / Thuringia e.V."

Prof. E. Beyer:
Member of the University Center for Aerospace (UZLR) of the TU Dresden

Prof. E. Beyer:
Member of the advisory board of the European Laser Institute (ELI)

Prof. E. Beyer:
Member of the review committee of the AiF

Prof. E. Beyer:
Member of the board of directors of the Laser Institute of America (LIA)

Prof. E. Beyer:
Member of the board of stakeholders of the Technology Platform Photonics21

Prof. E. Beyer:
Member of the Society for Chemical Technology and Biotechnology e.V. (DECHEMA)

Prof. E. Beyer:
Member of the international advisory board of the Journal of Laser Applications (JLA)

Prof. B. Brenner:
Technical committee 9 of the AWT

Prof. B. Brenner:
Member of the review committee of the AiF

Dr. I. Jansen:
Member of the Society for Chemical Technology and Biotechnology e.V. (DECHEMA)

Dr. I. Jansen:
Member of the industrial task force "Intlaskleb" of the BMBF

Dr. R. Jäckel:
Working committee "Fairs and Public Relations" of the Materials Research Association, Dresden

Dr. G. Kirchhoff:
Working committee "Acoustic Emission Analysis" of the DGzfP

A. Kluge:
Speaker for the computer operators of the Fraunhofer-Gesellschaft

Dr. A. Leson:
Member of the Advisory Board of the magazine "NanoS"

Dr. A. Leson:
Speaker for the nanotechnology competence center "Ultrathin Functional Films"

Dr. A. Leson:
Committee member of the magazine "Vacuum and Research in Practice"

Dr. A. Leson:
Member of the International Expert Panel for the Nanomat-Program of Norway

Dr. A. Leson:
Board member of the working group of nanotechnology competence centers in Germany

Dr. A. Leson:
Member of the advisory council of the VDI

Dr. A. Leson:
Chairman of the VDI working circle "Study Programs in Nanotechnology"

Dr. A. Leson:
Member of the program committee of the VDI scientific advisory board

Dr. A. Leson:
Member of the international advisory board of the journal "Micromaterials and Nanomaterials"

Dr. A. Leson:
Member of the Board of the European Center for Micro and Nano Reliability e.V.

Dr. A. Leson:
Member of the board of directors of the European Research Society "Thin Films" e.V. (EFDS)

Dr. A. Leson, Dr. H.-J. Scheibe,
Prof. B. Schultrich:
Task force plasma surface technologies of the DGO

Dr. S. Nowotny:
DVS working committee
V9.2 / AA 15.2 "Laser Beam Welding and Related Techniques"

Dr. B. Winderlich:
Work group "Stability and Construction" of the DVS-BV Dresden

F. Bartels during the bestowal ceremony of the Institute's award for best scientific-technical performances

K. Zenner receives the Special award for her outstanding contributions to the visualization of scientific-technical processes

IWS prizes in 2008

1. Best innovative product idea

   Jan Hannweber, Stefan Kühn, Michael Melde, Sven Bretschneider
   "Traps - eine neuartige Laserschutzwand"
   "Traps – a novel laser safety wall"

2. Best scientific technical performance

   Michael Leonhardt, Dr. Carl-Friedrich Meyer
   "Modifizierung der Ionenkinetik zur Optimierung der mittels Laser-Arc-Modul (LAM) abgeschiedenen Kohlenstoffschichten auf 3D-Maschinenkomponenten"
   "Modification of the ion kinetics to optimize Laser-Arc-Module deposited carbon coatings for 3D machine components"

   Florian Bartels
   "Steigerung der Dynamik von Laserschneidanlagen durch Zusatzachssysteme auf Basis hochdynamischer Strahlablenkoptiken"
   "Increasing the dynamics of laser cutting machines by adding axes systems based on highly dynamic beam deflection optics"

3. Best scientific performance of a junior scientist

   Frank Brückner
   "Simulationsgestützte Optimierung von mit dem Faserlaser auftraggeschweißten filigranen Interfacestrukturen zur Verbesserung der Haftung plasmagespritzter Wärmedämmschichten"
   "Simulation based optimization of fiber laser deposited filigree interface structures to improve the adhesion of plasma sprayed thermal barrier coatings"

4. Best scientific student performance

   Sebastian Thieme
   "Flexilas – Innovative Laserstrahl-Präzisionstechnologie zum Auftragschweißen mit zentrischer Drahtzufuhr"
   "Flexilas – Innovative laser beam precision technology for the buildup welding with centric wire feed"

   Frank Kaulfuß
   "Experimentelle Untersuchungen zur Abscheidung von bearbeitbaren PVD-Hartstoffschichten"
   "Experimental investigations to deposit PVD hard coatings that can be mechanically post processed"

   Patrick Grabau
   "Optimierung einer Lichtbogenplasmaquelle für plasmachemische Ätzprozesse"
   "Optimization of an arc plasma source for plasma chemical etching processes"

5. Special award

   Kerstin Zenner
   "Herausragende Arbeiten zur Visualisierung von wissenschaftlich-technischen Prozessen"
   "Outstanding contributions to visualize scientific-technical processes"

Diploma theses

A. Bandowski
(Technische Universität Dresden)

"Erarbeitung technologischer Varianten für die Kühlschmierstoffreinigung"

"Developing technological variations for the cleaning of coolants and lubricants"

M. Busch
(Technische Universität Dresden)

"Vorbehandlung und Prozessparameter zum Wachstum von leitfähigen CVD-Diamantschichten und Empfehlung einer Markteintrittsstrategie"

"Preparation and process parameters to grow conductive CVD diamond films and recommendations for a market entry strategy"

F. Fräßdorf
(Technische Universität Dresden)

"Fertigungsgerechte Bauteilgestaltung - Eigen- und Fremdmotorenanalyse"

"Manufacturing oriented component design – Internal and external motor analysis"

R. Freigang
(Technische Universität Dresden)

"Evaluation einer Methodik zur Systemanalyse anhand einer Fallstudie am Beispiel des Laserauftragschweißens"

"Evaluation of a system analysis method based on a case study on laser buildup welding"

S. Glinka
(Hochschule Bochum)

"Ermittlung von Verbesserungspotenzialen beim Hybridschweißen von Feinkornbaustählen durch den Einsatz eines 8 kW-Faserlasers und geeigneter Optiken"

"Improving the hybrid welding of fine grain steels by using a 8 kW fiber laser with suitable optics"

A. Grafe
(Technische Universität Dresden)

"Reproduzierbare Preformfertigung für textilverstärkte Kunststoffe durch Kleb- und Laserfixierung"

"Reproducible preform fabrication for textile reinforced plastics through adhesive and laser fixing"

J. Grübler
(Hochschule Mittweida (FH))

"Untersuchungen zur optisch-spektroskopischen Bestimmung der Permeabilität von Ultrabarrierematerialien"

"Optical spectroscopy investigations to determine the permeability of ultra barrier materials"

M. Haehnel
(Technische Universität Dresden)

"Steuerung für ein konfokales laser-Scanning-Mikroskop mit einer lateralen Auflösung im Submikrometer-Bereich"

"Controller for a confocal laser microscope with a lateral resolution in the sub micrometer range"

S. Hampsch
(Technische Universität Dresden)

"Parameteroptimierung beim Glattwalzen zylindrischer Proben bis zu einer Härte von 55 HRC im Einstech- und Durchlaufverfahren"

"Parameter optimization for the smooth rolling of cylindrical samples up to a hardness of 55 HRC using the plunge cutting or pass through processes"

C. Haschlar
(Technische Universität Dresden)

"Qualifizierung und Entwicklung eines Systems zur automatisierten Geometrieerfassung für das Laser-Präzisions-Auftragschweißen"

"Development and qualification of system to automatically acquire the geometry for laser precision buildup welding processes"

H. Hillig
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Herstellung von karbidhaltigen Verschleißschutzschichten auf Bohrkronen mittels Laser-Pulver-Auftragschweißen"

"Fabrication of carbide based wear resistant coatings on drilling crowns using laser powder buildup welding "

H. Höfer
(Technische Universität Dresden)

"Laserschweißbare Leichtbau-Bewegungseinheit für die Zweikopf-Laserschneidanlagen der TruLaser Serie 7000"

"Laser weldable lightweight motion unit for dual head laser cutting machines of the TruLaser 7000 series"

C. Jordan
(Technische Universität Dresden)

"Verfahrensoptimierung zur Herstellung thermisch gespritzter Hartmetallschichten zum Einsatz unter Rollermüdung"

"Process optimization to fabricate thermal spray hard metal coatings for rolling fatigue reducing applications"

F. Kaulfuß
(Technische Universität Dresden)

"Experimentelle Untersuchungen zur Abscheidung von bearbeitbaren PVD - Hartstoffschichten"

"Experimental investigations to deposit PVD hard coatings that can be mechanically post processed"

C. Kowanda
(Technische Universität Dresden)

"Untersuchungen zur Überführung der Schneidtechnologie von 2D-Wasserabrasivstrahlen von holzartigen Werkstoffen"

"Investigations to commercialize the 2D abrasive water jet cutting technology of wood-like materials"

M. Krätzsch
(Technische Universität Dresden)

"Laserinduktionsschweißen von hochfesten Feinkornbaustählen"

"Laser induction welding of high strength fine grain construction steels"

S. Langner
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Technologieentwicklung zur Einbringung nanopartikelhaltiger Suspensionen in den thermischen Spritzprozess"

"Technology development to introduce nanoparticle containing suspensions into the thermal spray processes"

S. Makowksi
(Technische Universität Dresden)

"Anwendungsnahe Charakterisierung von ta-C-Schichten"

"Application relevant characterization of ta-C coatings"

A. Naumann
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Datengestützte Strategieentwicklung auf dem Gebiet der Nanotechnologie"

"Data based strategy development in the area of nanotechnology"

M. Pfennig
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Prozessentwicklung zur Reparatur von Triebwerksverdichterschaufeln aus Udimet 720"

"Process development of gear blades made of Udimet 720"

R. Puschmann
(Technische Universität Dresden)

"Onlinemessung der Schichtdicke thermisch gespritzer Schichten"

"Online measurements of thermals spray coating thicknesses"

J. Richter
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Untersuchungen zum Remote-Laserstrahlschneiden"

"Investigations on remoter laser beam cutting"

J. Richter
(Hochschule Mittweida (FH))

"Entwickeln und Optimieren einer Technologie zum reproduzierbaren Fügen von Keramiken und Kunststoffen mittels Laserstrahlung"

"Technological development and optimatation for the repeatable joining of ceramics and plastics by laser beaming"

U. Richter
(Technische Universität Dresden)

"Dissoziation von Stickstoff an nanoskaligen Metallpartikeln"

"Dissociation of nitrogen on nanoscale metal particles"

T. Rönnefahrt
(Hochschule für Technik und Wirtschaft Dresden (FH))

"Konstruktive Weiterentwicklung von Strahlteileroptiken zum Laser-Auftragschweißen mit Pulver und Draht"

"Continuation of the constructive development of beam splitting optics for laser buildup welding with powder and wire"

D. Ruhland
(Hochschule Bochum)

"Ermittlung geeigneter Strahlkaustiken von Faserlasern hoher Strahlqualität für das Tiefschweißen im Stahlbau"

"Determination of suitable beam caustics of high beam quality fiber lasers for deep welding processes in steel construction"

J. Spatzier
(Technische Universität Dresden)

"Herstellung und Charakterisierung von karbidhaltigen Verschleißschutzschichten mittels Laser-Pulver-Auftragschweißen"

"Fabrication and characterization of carbide based wear protective coatings using laser powder buildup welding"

B. Süß
(Berufsakademie Sachsen, Staatliche Studienakademie Dresden (BA))

"Prototypische Entwicklung einer kamerabasierten Prozessüberwachung für das Laser-Pulver-Auftragsschweißen"

"Prototype development of a camera based process control system for laser powder buildup welding processes"

H. Teuber
(Berufsakademie Sachsen, Staatliche Studienakademie Dresden (BA))

"Wissenschaftliche Untersuchung verschiedener Aspekte bei der Produktion von 3D-Stereofilmen im Vergleich zu herkömmlicher 2D-Videotechnik anhand beispielhaft erstellter Filmszenen"

"Scientific investigations of the various aspects of producing 3D stereo movies in comparison to conventional 2D video technologies based on fabricated sample movie scenes"

T. Weinrich
(Technische Universität Dresden)

"Entwicklung komplexer prozessnaher Urformwerkzeuge zur Untersuchung und Bewertung der Eignung der MELATO-Technologie für den Lederfaserguss"

"Scientific investigations of the various aspects of producing 3D stereo movies in comparison to conventional 2D video technologies based on fabricated sample movie scenes"

Doctoral theses

G. Göbel
(Technische Universität Dresden)

"Erweiterung der Prozessgrenzen beim Laserstrahlschweißen heißrissgefährdeter Werkstoffe"

"Expansion of the process limits during the laser beam welding of hot crack sensitive materials"

G. Mäder
(Technische Universität Dresden)

"Atmosphärendruck-Plasma-Beschichtungsreaktoren"

"Atmospheric pressure plasma coating reactors"

H. Nizard
(Technische Universität Dresden)

"Untersuchung photokatalytischer Beschichtungsmaterialien. Abscheidungsmethoden, Charakterisierung der photokatalytischen Aktivität und Optimierung der Beschichtungsprozesse"

"Investigations of photo catalytic coating materials. Deposition methods, characterization of the photo catalytic activity and optimization of the deposition processes"

A. Ohnesorge
(Technische Universität Dresden)

"Bestimmung des Aufmischgrades beim Laser-Pulver-Auftragschweißen mittels laserinduzierter Plasmaspektroskopie (LIPS)"

"Determination of the mixing degree during the laser powder buildup welding process using laser induced plasma spectroscopy (LIPS)"

Stipends

F.-L. Toma
Docteur en Sciences pour l'Ingénieur
Humboldt-Stipend

Participation in fairs and exhibitions

Nanotech 2008 Tokyo, Japan, February 13th - 15th, 2008

The nanotechnology competence center "Ultrathin Functional Films" and the Fraunhofer IWS participated for the third time at the world's largest nanotechnology conference. The group exhibited at the booth of Saxony's Economic Development Corporation GmbH. 522 exhibitors from 23 countries presented across three exhibition halls at the trade fair grounds "Tokyo Big Sight". A new record of 49,400 visitors was achieved. The competence center was in particular involved in the preparation of the conference. Several members actively participated with presentations during accompanying events. The nano competence center was also represented at the AGeNT booth, a joint exhibition of the nanotechnology competence centers of Germany.

The initiative LiFt was present at the Intec and exhibited at the joint booth of the IHK Southwest Saxony

Intec 2008 Leipzig, February 26th - 29th, 2008

The Fraunhofer IWS Dresden participated at three booths during the "Intec – 11th Trade Fair for Production Technology, Machine Tools and Specialized Machine Building":

- ALOtec Dresden GmbH and IWS Dresden showed technologies to laser cut and harden at the booth of the company Reis GmbH & Co. KG Machine Factory Obernburg.
- The initiative LiFt (Laser Integration in Manufacturing Technology) presented at the joint booth of the Industrial and Commerce Chamber of Southwest Saxony.
- The workgroup, Adhesive Bonding, presented their portfolio at the joint booth "Research for the Future" of the TU Dresden.

Presentation of innovations in adhesive bonding technology at the Hannover Industry fair 2008, hall 2

Lasys 2008 Stuttgart, March 4th - 6th, 2008

The new international trade show for system solutions in laser materials processing "Lasys 2008" was held at the new fair grounds in Stuttgart. The Fraunhofer IWS Dresden demonstrated for the first time the laser remote cutting of metallic materials. With the help of a robot based laser system and scanner optics, it is possible to cut a matrix of holes (100 circles of 6.5 mm diameter) in less than 2 seconds out of 100 µm thick stainless steel sheet metal. This corresponds to a 100 % increase in productivity if compared to conventional linear drive systems.

Hannover Industry Fair 2008 April 21st - 25th, 2008

The IWS presented the latest generation technologies and applications of fiber lasers for laser materials processing using the example of laser hardening. The exhibition was held in Hall 5 in the "Subcontracting" area of the supplying industries. A particular focus was the localized hardening of precision components. Larger areas can be hardened by using scanner optics.

The joint booth "Research for the Future" was setup in hall 2. Here the Fraunhofer IWS and the TU Dresden Department for Laser and Surface Technology exhibited innovative solutions for the adhesive bonding of glass and textiles, as well as how to incorporate carbon nanotubes into adhesives.

The innovation cluster "nano for production" was present at the Fraunhofer Society booth in hall 2.

International Aerospace Exhibition ILA 2008 Berlin, May 27th - June 1st, 2008

The IWS participated at the ILA for the third time. The exhibition was held on the grounds of the airport in Schoenefeld. The joint booth was organized by Saxony's Economic Development Corporation with the help of the Competence Center for Aerospace Technology Saxony / Thuringia e.V.

Technology developments to laser weld aircraft fuselage structures and to characterize mechanical, thermal and tribological properties of laser treated aviation relevant components were exhibited.

O&S Fair 2008 Stuttgart, June 3rd - 5th, 2008

The international trade fair for surface coatings O&S was also a first time event at the Stuttgart trade fair grounds. This show emerged from the Galvanica fair. The Fraunhofer IWS showed exhibits in the area of friction reduction and photovoltaics. Due to interest generated by the show, the institute received requests ranging beyond the exhibited technologies which led to a lively exchange of experiences.

Impressions from the first "O&S" in Stuttgart

Plasma Surface Engineering PSE 2008 Garmisch-Partenkirchen, September 15th - 19th, 2008

The Fraunhofer IWS participated at the 11th Plasma Surface Engineering conference and exhibition in Garmisch-Partenkirchen. The Laser-Arc coating technology and applications in the area of wear protection were exhibited.

Technology Fair Euroblech 2008 Hannover, October 21st - 25th, 2008

For the fourth time the IWS participated in this International Technology Fair for sheet metal processing. A joint Fraunhofer booth was located in hall 11. The IWS presented four topics:

- laser remote cutting of thin sheet metal and fiber laser cutting of thick sheet metal,
- laser welding of car body parts,
- laser welding of lightweight metals, for vehicle and aircraft construction
- LiFt – Laser integration in manufacturing technology.

Fair Parts2clean 2008 Stuttgart, October 28th - 30th, 2008

The Fraunhofer alliance Cleaning Technologies operated a joint booth at this show at which the IWS presented system technology solutions to partially clean components with laser beams. The special characteristics of the presented solution are the integration of the cleaning step into the automated manufacturing flow, the implementation of short cycle times, the cleaning of the fully mounted part prior to the subsequent processing step and the avoidance of any solvents or other cleaning agents. This solution was demonstrated by removing coolant and lubricant contaminations as well as preservatives in the joints prior to laser beam welding.

Euromold 2008 Frankfurt / M., December 3rd - 6th, 2008

The Euromold is a trade fair for mold, die and tool makers. The Fraunhofer IWS presented a 5-axes computer controlled milling center with an integrated laser module. The module was mounted directly in a milling spindle and presented as the main attraction. The machine can completely process parts in one setting. The process includes the three dimensional laser buildup welding and the mechanical post processing using 5-axes mill cutters.

Laser remote cutting of thin sheet metal was presented in a live demonstration at the Euroblech 2008

The Free State of Saxony showed off her new design at the Aviation Show ILA 2008

Patent applications 2008

[P01] T. Abendroth, H. Althues, S. Kaskel, I. Dani

"Verfahren zur Herstellung photokatalytisch aktiver Titandioxidschichten"

Anmelde-Az.: DE 10 2008 052 098.5

[P02] F. Bartels, L. Morgenthal, T. Schwarz, T. Himmer

"Vorrichtung und Verfahren zum schneidenden Bearbeiten von Werkstücken mit einem Laserstrahl"

Anmelde-Az.: DE 10 2008 027 524.7

[P03] H. Beese, W. Grählert, V. Hopfe

"Vorrichtung und Verfahren zur Bestimmung der Permeationsrate mindestens eines Permeaten, durch ein eine Diffusionssperre bildendes Element"

Anmelde-Az.: PCT/DE2008/000904

[P04] E. Beyer, P. Pfohl

"Vorrichtung und Verfahren zur Bearbeitung von Bauteilen"

Anmelde-Az.: PCT/DE2008/000581

[P05] E. Beyer, I. Jansen

"Verfahren zum stoffschlüssigen Verbinden von Teilen mit einem Klebstoff"

Anmelde-Az.: DE 10 2008 025 891.1

[P06] E. Beyer, A. Mahrle

"Verfahren zum Schmelzschneiden von Werkstücken mit Laserstrahlung"

Anmelde-Az.: DE 10 2008 053 397.1

[P07] B. Brenner, V. Fux, K. Merz

"Verfahren und Vorrichtung zum Herstellen von metallischen Verbundwerkstoffen und Verbund-Halbzeugen"

Anmelde-Az.: DE 10 2008 036 435.5

[P08] S. Bretschneider, M. Melde, J. Hannweber, S. Kühn

"Laserschutzwandelelement für eine Umhausung bei Laserbearbeitungsanlagen"

Anmelde-Az.: PCT/EP2008/006528

[P09] P. Grabau, J. Roch, V. Hopfe, I. Dani

"Verfahren und Vorrichtung zum Zünden eines Lichtbogens"

Anmelde-Az.: DE 10 2008 018 589.2

[P10] T. Himmer, F. Bartels, L. Morgenthal

"Vorrichtung und Verfahren zum Schneiden von Werkstücken mit einem Laserstrahl"

Anmelde-Az.: DE 10 2008 025 044.9

[P11] T. Himmer, F. Bartels, T. Schwarz, L. Morgenthal

"Vorrichtung zur Bearbeitung von Werkstücken mit einem zweidimensional auslenkbaren Energiestrahl"

Anmelde-Az.: DE 10 2008 032 830.8

[P12] T. Himmer, F. Bartels, L. Morgenthal, M. Lütke

"Vorrichtung und Verfahren zum Laserstrahlschneiden"

Anmelde-Az.: PCT/DE2008/001458

[P13] O. Jost

"Aktorelement sowie seine Verwendung"

Anmelde-Az.: DE 10 2008 039 757.1

[P14] S. Kaskel, C. Schrage

"Beleuchtungselement und Verfahren zu seiner Herstellung"

Anmelde-Az.: DE 10 2008 039 756.3

[P15] A. Klotzbach, L. Morgenthal, D. Pollack, F. Kretzschmar

"Verfahren zum Texturieren polymerer Monofile"

Anmelde-Az.: DE 10 2008 037 317.6

[P16] A. Klotzbach, V. Fleischer, T. Schwarz, L. Morgenthal, B. Schirdewahn

"Verfahren und Vorrichtung zum Schweißen von mindestens zwei Lagen eines polymeren Materials mit Laserstrahlung"

Anmelde-Az.: EP 08 017 757.9

[P17] M. Lütke, L. Morgenthal, T. Himmer, E. Beyer

"Verfahren zur trennenden Bearbeitung von Werkstücken mit einem Laserstrahl"

Anmelde-Az.: DE 10 2008 027 130.6

[P18] M. Märcz, M. Leistner, V. Hopfe, W. Grählert, I. Dani, B. Schultrich

"Vorrichtung und Verfahren zur Herstellung von Kohlenstoff-Nanoröhren oder Fulleren"

Anmelde-Az.: DE 10 2008 033 660.2

[P19] C.-F. Meyer

"Anordnung zur Ausbildung von Beschichtungen auf Substraten im Vakuum"

Anmelde-Az.: PCT/DE2008/000727

[P20] C.-F. Meyer

"Anode für die Bildung eines Plasmas durch Ausbildung elektrischer Bogenentladungen"

Anmelde-Az.: PCT/DE2008/000728

[P21] C.-F. Meyer

"Vorrichtung und Verfahren zur Ausbildung von Beschichtungen auf Substraten innerhalb von Vakuumkammern"

Anmelde-Az.: PCT/DE2008/001650

[P22] A. Meyer-Plath, M. Jäger, F. Sonntag

"Sensor für elektrophysiologische Untersuchungen an lebenden Zellen und Verfahren zu seiner Herstellung"

Anmelde-Az.: DE 10 2008 056 277.7

[P23] S. Nowotny, S. Scharek

"Bearbeitungskopf mit integrierter Pulverzuführung zum Auftragschweißen mit Laserstrahlung"

Anmelde-Az.: US 12/219,149, GB 0815191.2

[P24] F. Sonntag, F. Mehringer

"Flusskanalsystem und Verfahren zum Anbinden von Analyten an Liganden"

Anmelde-Az.: PCT/DE2008/000404

[P25] F. Sonntag, F. Mehringer, N. Schilling, M. Jäger

"Zellkulturmesssystem und Verfahren für vergleichende Untersuchungen an Zellkulturen"

Anmelde-Az.: PCT/DE2008/001348

[P26] F.-L. Toma, L.-M. Berger, C.C. Stahr, T. Naumann, S. Langner

"Thermisch gespritzte Al_2O_3-Schichten mit einem hohen Korundgehalt ohne eigenschaftsmindernde Zusätze und Verfahren zu ihrer Herstellung"

Anmelde-Az.: DE 10 2008 026 101.7

[P27] V. Weihnacht

"Verschleißschutzbeschichtung für auf Reibung beanspruchte Oberflächen von Bauteilen sowie Verfahren zur Ausbildung"

Anmelde-Az.: DE 10 2008 022 039.6

Issued patents

[P28] E. Beyer, L. Morgenthal, A. Klotzbach, V. Fleischer

"Vorrichtung und Verfahren zur Bearbeitung von Werkstücken mittels Laserstrahlung"

Erteilungs-Nr.: DE 10 2004 045 408 B4

[P29] S. Bretschneider, M. Melde, J. Hannweber, S. Kühn

"Laserschutzwand für eine Umhausung bei Laserbearbeitungsanlagen"

Erteilungs-Nr.: DE 10 2007 038 780 B3

[P30] I. Dani, W. Grählert, V. Hopfe, G. Mäder

"Vorrichtung und Verfahren zur optischen Detektion von in Abgasen chemischer Prozesse enthaltenen Stoffen"

Erteilungs-Nr.: EP 1 751 521 B1

[P31] T. Himmer, F. Bartels, L. Morgenthal, M. Lütke

"Vorrichtung und Verfahren zum Laserstrahlschneiden"

Erteilungs-Nr.: DE 10 2007 042 490 B3

[P32] V. Hopfe, G. Mäder, D. Rogler, C. Schreuders

"Verfahren und Vorrichtung zur großflächigen Beschichtung von Substraten bei Atmosphärendruckbedingungen"

Erteilungs-Nr.: DE 102 39 875

[P33] U. Klotzbach, E. Hensel, K. Krautz, E. Beyer

"Wandelement zum Schutz vor Laserstrahlung"

Erteilungs-Nr.: DE 10 2006 036 500 B8

[P34] U. Krzywinski, H. Rödel, I. Jansen

"Verfahren zur Strukturfixierung von textilen Flächengebilden für Hochleistungs-Faserverbundbauteile und ein nach diesem Verfahren hergestelltes textiles Flächengebilde"

Erteilungs-Nr.: DE 10 2007 032 904

[P35] E. Lopez, I. Dani, V. Hopfe, R. Möller, M. Heintze

"Verfahren zum selektiven plasmachemischen Trockenätzen von auf Oberflächen von Silicium-Wafern ausgebildetem Phosphorsilikatglas"

Erteilungs-Nr.: DE 10 2006 042 329 B4

[P36] G. Mäder, D. Rogler, V. Hopfe, S. Krause, R. Spitzl

"Mikrowellenplasmaquelle"

Erteilungs-Nr.: DE 10 2004 060 068

[P37] B. Schultrich, D. Schneider

"Identifikationselement"

Erteilungs-Nr.: DE 10 2006 017 155 B4

[P38] F. Sonntag

"Mikrofluidische Anordnung zur Detektion von in Proben enthaltenen chemischen, biochemischen Molekülen und/oder Partikeln"

Erteilungs-Nr.: DE 10 2006 024 355 B4

[P39] A. Uelze, T. Himmer

"Bauteil mit miteinander verbundenen plattenförmigen Elementen sowie ein Verfahren zu deren Herstellung"

Erteilungs-Nr.: DE 102 14 055 B4

rp = reviewed paper

[L01] H. Althues, S. Kaskel
"Kleine Helfer sparen intelligent Energie"
Kunststoffe 98 (2008) 9, S. 134-137

[L02] H. Althues, P. Pötschke, G.-M. Kim, S. Kaskel
"Structure and Mechanical Properties of Transparent ZnO/PBDMA Nanocomposites"
J. Nanosci. Nanotechnol. (accepted)

[L03] J. Asmussen, T.A. Grotjohn, T. Schuelke, M.F. Becker, M.K. Yaran, D.J. King, S. Wicklein, D.K. Reinhard
"Multiple Substrate Microwave Plasma-assisted Chemical Vapor Deposition Single Crystal Diamond Synthesis"
Applied Physics Letters 93 (2008) 3, Art. 031502, S. 3

[L04] A. Ay, V.M. Swope, G.M. Swain
"The Physicochemical and Electrochemical Properties of 100 and 500 nm Diameter Diamond Powders Coated with Boron-doped Nanocrystalline Diamond"
Journal of the Electrochemical Society 155 (2008) 10, S. B1013-B1022

[L05] R. Banndorf, W. Diehl, U. Heckmann, H. Holescek, U. Klotzbach, S. Kondruweit-Reinema, A. Leson, M. Metzner, A. Pflug, O. Zimmer
"Thesen und Trends - Mit funktionalen Oberflächen in die Zukunft"
Vakuum in Forschung und Praxis 20 (2008) 4, S. 14

[L06] H. Beese, W. Grählert, R. Grübler, P. Kaspersen, A. Bohman
"Optisch-spektroskopische Bestimmung der Permeabilität von Ultrabarrierematerialien"
Fachtagung "Optische Analysenmesstechnik in Industrie und Umwelt" (2008), (VDI-Berichte 2047), 2008 S. 113-120

[L07] H. Beese, S. Kaskel
"Prozessgasanalytik mittels Laserdioden-spektroskopie"
CHEManager 22 (2008) S. 17

[L08] L.-M. Berger, K. Lipp, C. Jordan, U. May, T. Naumann
"Rolling Contact Fatigue of HVOF-Sprayed WC-Based Hardmetal Coatings "
Euro PM2008, International Powder Metallurgy Congress & Exhibition, Proceedings, (2008), Mannheim, Germany, Shrewsbury, U.K.: European Powder Metallurgy Association, 1 (2008) S. 205-212, ISBN 978 1 899072 03 3

[L09] L.-M. Berger, S. Saaro, C. Jordan, T. Naumann, M. Kašparova, F. Zahálka
"HVOF-Sprayed WC-(W,Cr)$_2$C-Ni Coatings and Their Properties"
International Thermal Spray Conference & Exhibition (ITSC 2008), Conference Proceedings, June 2008, Maastricht, Netherlands, Düsseldorf: DVS-Verlag GmbH, (2008) (CD-ROM), ISBN 978-3-87155-979-2, S. 229-234

[L10] L.-M. Berger, S. Saaro, T. Naumann, M. Kašparova, F. Zahálka
"Microstructure and Properties of HVOF-sprayed WC-(W,Cr)$_2$C-Ni Coatings"
Journal of Thermal Spray Technology 17 (2008) 3, S. 395-403

[L11] L.-M. Berger, S. Saaro, T. Naumann, M. Wiener, V. Weihnacht, S. Thiele, J. Suchánek
"Microstructure and Properties of HVOF-sprayed Chromium Alloyed WC-Co and WC-Ni Coatings"
Surface and Coatings Technology 202 (2008) 18, S. 4417-4421

[L12] L.-M. Berger, S. Saaro, M. Woydt
"WC-(W,Cr)$_2$C-Ni – die "unbekannte" Hartmetallschicht"
Thermal Spray Bulletin, 1 (2008) S. 39-42, ISSN 1866-6248

[L13] L.-M. Berger, C. C. Stahr
"State and Perspectives of Thermally Sprayed Ceramic Coatings in the Al_2O_3-Cr_2O_3-TiO_2 System"
Proceedings of the 21st International Conference on Surface Modification Technologies, September, 2007, Paris, France, Eds.: T.S. Sudarshan, M. Jeandin. (2008), Valar Docs, S. 469-478 ISBN 978-0-9817065-0-4

[L14] L.-M. Berger, C.C. Stahr, S. Saaro, S. Thiele, M. Woydt
"Dry Sliding Wear Properties of Thermal Spray Coatings in the TiO_2-Cr_2O_3 System"
Proc. Friction, Wear and Wear Protection, April, 2008, Aachen, Tagungsband

[L15] L.-M. Berger, C. C. Stahr, S. Saaro, S. Thiele, M. Woydt, N. Kelling
"High Temperature Tribology up to 7.5 m/s of Thermally Sprayed Coatings of the TiO_2-Cr_2O_3 System and (Ti,Mo)(C,N)-Ni(Co)"
49. Tribologie-Fachtagung, September (2008), Göttingen, Aachen: Gesellschaft für Tribologie (GfT), (2008) Band I, S. 22/1-22/12, ISBN-10: 3-00-019670-6, ISBN-13: 978-3-00-019670-6

[L16] L.-M. Berger, F.-L. Toma, C.C. Stahr
"Thermally Sprayed Titanium Oxide Coatings – A Truly Multifunctional Coating Solution"
Proc. APNFM, Januar 2008, Dresden,

[L17] E. Beyer
"High Power Laser Materials Processing - New Developments and Trends"
3rd Pacific International Conference on Applications of Lasers and Optics (PICALO) 2008, Proceedings (CD-ROM), ISBN-Nummer: 978-0-912035-89-5

[L18] E. Beyer, T. Himmer, M. Lütke, F. Bartels, A. Mahrle
"Cutting with High Brightness Lasers"
Stuttgarter Lasertage (SLT'08), Tagungsband inkl. CD-ROM, S. 29

[L19] E. Beyer, M. Lütke, T. Himmer
"Remote-Schneiden mit brillanten Strahlquellen"
Münchener Kolloquium, Innovationen für die Produktion,Tagungsband S. 361–370, ISBN-10: 3-8316-0844-X, ISBN-13: 978-3-8316-0844-7

[L20] S. Bonß
"Laserstrahlhärten – Integration in die Fertigung ermöglicht schlanke Prozesse"
HTM Z. Werkst. Wärmebeh. Fertigung 63 (2008) 3, S. 147-153

[L21] S. Bonß, J. Hannweber, U. Karsunke, M. Seifert, B. Brenner, E. Beyer
"Integrated Heat Treatment – Comparison of Different Machine Concepts"
3rd Pacific International Conference on Applications of Lasers and Optics Peking (PICALO) 2008, VR China, Tagungs-CD

[L22] B. Brenner
"Development of New Laser Welding Technologies and Their Industrial Use in Germany"
Keynote presentation, AILU Technology Workshop "Welding and Cutting with Fibre-Delivered Laser Beams", TWI Cambridge (UK), 2008, Workshop-CD

[L23] B. Brenner, S. Bonß

"Hochleistungsdiodenlaser als Werkzeug"

7. Workshop "Industrielle Anwendungen von Hochleistungsdiodenlasern", IWS Dresden, 2008, Workshop-CD, ISBN 978-3-8167-7663-5

[L24] B. Brenner, D. Dittrich, J. Standfuß, B. Winderlich, J. Liebscher, J. Hackius

"Laserstrahlschweißtechnologien für innovative integrale Rumpfschalen ziviler Großraumflugzeuge"

DVS-Berichte, DVS Media GmbH Düsseldorf, Band 250, S. 49-54

[L25] B. Brenner, J. Hackius, J. Standfuß, D. Dittrich, B. Winderlich, J. Liebscher

"Laser Beam Welding of Aircraft Fuselage Structures"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), Proceedings paper # 1801, S. 838-845

[L26] B. Brenner, A. Jahn, J. Standfuß

"Improved Formability and Crash Performance of Laser-Welded Structures Made of High Strength Multiphase-Steels"

9th European Automotive Laser Application Conference (EALA 2008), Bad Nauheim, Tagungsband

[L27] B. Brenner, J. Standfuß, U. Stamm, D. Dittrich, A. Jahn, B. Winderlich

"Perspektiven für den Metallleichtbau in der Fahrzeug- und Luftfahrtindustrie durch fortgeschrittene Laserstrahlschweißverfahren"

12. Dresdner Leichtbausymposium „Innovationsquelle Leichtbau", Tagungsband

[L28] P. Bringmann, O. Rohr, J. Wehr, I. Jansen

"Cr^{+6}-free Hybrid Coatings as Potential Pre-Treatment for Structural Adhesive Bonding"

Euradh 2008 / Adhesion ´08, 10th Internat. Conf. Sci. & Techn. Adh. (2008) Oxford, UK, S. 105-109

[L29] F. Brückner, D. Lepski, E. Beyer

"Numerical and Experimental Investigation of Thermal Stresses and Distortions in the Induction Assisted Laser Cladding"

Proceedings of the 3rd Pacific International Conference on Application of Lasers and Optics (PICALO 2008), Paper 206, S. 88-93

[L30] F. Brückner, D. Lepski, E. Beyer

"Reduction of Thermally Induced Distortion in Laser Cladding"

Proceedings of the 2nd International Workshop on Thermal Forming and Welding Distortion, Bremen (2008)

[L31] R. Dietsch, A. König, J. Ziemer

"Multischicht-Röntgenoptiken: Präzision im Nanometerbereich"

Fokus Technologie: Chancen erkennen - Leistungen entwickeln (2008) S. 349-364, Hrg.: H.-J. Bullinger, ISBN 978-3-446-41739-9

[L32] D. Dittrich, E. Beyer, B. Brenner, J. Standfuß, B. Winderlich, J. Hackius

"Progress in Laser Beam Welding of Aircraft Fuselage Panels / Skin-Skin-Connections"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, Proceedings paper # 1804, S. 863-871

[L33] D. Dittrich, B. Brenner, B. Winderlich, G. Kirchhoff, J. Hackius

"New Weld Seam Design for Advanced Joining Techniques to Improve Safety and to Reduce Structural Weight"

Aircraft Structural Design Conference, Liverpool (UK) (2008) Proceedings

[L34] J. Drechsel, S. Weinhold, J. Bachale, R. Ebert, H. Exner, S. Bonß, C. Zellbeck

"Initiative LiFt - Lasertechnologieintegration in die Fertigungstechnik"

Laser Magazin 6 (2008) S. 40-41

[L35] J. Dubský, P. Chráska, B. Kolman, C. C. Stahr, L.-M. Berger

"Formation of Corundum Phase in Plasma Sprayed Alumina Coatings"

Proceedings edited by Materials Australia, Thermal Processing and Surface Engineering: Key Activities in the Global Knowledge Economy, The 16th International Federation for Heat Treatment and Surface Engineering (IFHTSE) Congress, Brisbane, Australien 2007, S. 62. ISBN 978 1 876855 31 2

[L36] J. Dubský, P. Chráska, B. Kolman, C. C. Stahr, L.-M. Berger

"Formation of Corundum Phase in Plasma Sprayed Alumina"

Journal "Materials Technology: Advanced Performance Materials", Maney Publishing, London, UK

[L37] S. Eckert, S. Nowotny, A. Mehlhorn, A. Klöden, D. Kochan

"Laserauftragsschweißen im Werkzeugbau"

Der Stahlformenbauer 25 (2008) 5, S. 96-104

[L38] H.-J. Fecht, A. Leson, B. Michel, M. Werner

"Advanced Adhesives Based on Carbon Nanotube Technology"

mst-news No. 3/08, Juni 2008, S. 28-29

[L39] V. Fux, K. Merz, B. Brenner

"Laser-Walzplattieren erzeugt attraktive Werkstoffpaarungen"

Maschinenmarkt (2009) 5, S. 42-45

[L40] P. Gawlitza, S. Braun, G. Dietrich, M. Menzel, S. Schädlich, A. Leson

"Ion Beam Sputtering of Multilayer X-Ray Optics"

Annual meeting of Spie Optics & Photonics, San Diego, USA, (2008), proceedings of SPIE 7077-2

[L41] L. Girdauskaite, S. Krzywinski, H. Rödel, R. Böhme, I. Jansen

"Complex Shaped Dry Textile Preforms for High Quality Composites"

2nd Aachen-Dresden International Textile Conference, (2008) Dresden

[L42] L. Girdauskaite, S. Krzywinski, H. Rödel, R. Böhme, I. Jansen

"Possibilities for the Production of Complex Shaped Dry Textile Performs for High Quality Composites"

8th AUTEC conference, (2008) Biella, Italien, Vorträge mit Proceedings

[L43] G. Göbel

"Erweiterung der Prozessgrenzen beim Laserstrahlschweißen heißrissgefährdeter Werkstoffe"

Stuttgart, Fraunhofer IRB Verlag, 2008, Zugl.: Dresden, TU, Diss., 2007, ISBN 3-8167-7671-X ISBN 978-3-8167-7671-0

[L44] G. Göbel, J. Standfuß, B. Brenner

"Engspaltschweißen mit hohem Aspektverhältnis"

Laser und Produktion, Spezial: Faserlaser, Sonderheft 2008, S. 20-22

[L45] W. Grählert

"Laserdiodenspektroskopie: ein selektives hoch empfindliches Werkzeug zur Spurengasanalytik"

Ingenieurnachrichten 5 (2008) S. 6

[L46] W. Grimm, V. Weihnacht

"Super Hard Carbon Coatings Deposited by Pulsed DC-Arc-Process"

11th International Conference on Plasma Surface Engineering (PSE 2008) Garmisch-Partenkirchen, Tagungsband PSE 2008, S. 94

[L47] U. Heckmann, R. Bandorf, W. Diehl, H. Holeczek, U. Klotzbach, S. Kondruweit-Reinema, A. Leson, M. Metzner, A. Pflug, O. Zimmer

"Produktionstechnik für funktionale Oberflächen: Perspektiven, Forschungs- und Handlungsbedarf"

wt Werkstattstechnik online 98 (2008) 6, S. 481-485

[L48] P. Herwig

"Materialbearbeitung hoch reflektiver Werkstoffe"

Laser-Magazin (2008) 5, S. 9-11

[L49] S. Houdková, F. Zahálka, M. Kašparová, L.-M. Berger

"Tribological Behaviour of Thermally Sprayed Coatings at Elevated Temperatures"

International Thermal Spray Conference & Exhibition (ITSC 2008), Conference Proceedings, Düsseldorf: DVS-Verlag GmbH, (2008), CD, S. 1497-1502, ISBN 978-3-87155-979-2

[L50] D. Hrunski, A. Gordijn, U. Stickelmann, T. Kilper, W. Appenzeller, W. Grählert, H. Beese

"Analysis and Minimization of Plasma Process Instabilities During Thin Silicon Films Deposition"

Photovoltaics International, 4 (2008)

[L51] A. Jahn, M. Krätzsch, B. Brenner

"Laserstrahlschweißen hochfester Feinkornbaustähle mit werkstoffangepasster Temperaturführung"

DVS-Bericht, DVS Media GmbH Düsseldorf, Band 250, S. 215-220

[L52] A. Jahn, M. Krätzsch, B. Brenner

"Induction Assisted Laser Beam Welding of HSLA Steel Sheets"

International Scientific Colloquium “Modelling for Electromagnetic Processing”, (2008), Proceedings S. 195-200

[L53] I. Jansen, J.-S. Pap, R. Rechner

"8. Kolloquium Gemeinsame Forschung in der Klebtechnik"

8. Kolloquium Gemeinsame Forschung in der Klebtechnik, (2008), Frankfurt, Vorträge mit Proceedings, S. 38-41

[L54] I. Jansen, P. Pötschke, F. Wehnert

"Integration of Carbon Nanotubes into Adhesives"

Euradh 2008 / Adhesion ´08, 10th Internat. Conf. Sci. & Techn. Adh. 2008, Oxford, UK, S. 355-359

[L55] I. Jansen, R. Rechner

"Einsatz des Diodenlasers zur Kantenleimung"

7. Workshop "Industrielle Anwendung von Hochleistungsdiodenlasern" (2008) IWS Dresden, Vorträge mit Proceedings

[L56] **rp** I. Jansen, D. Schneider, R. Haßler

"Laser-Acoustic, Thermal and Mechanical Methods for Investigations of Bond Lines"

International Journal of Adhesion & Adhesives 29 (2009) S. 210–216

[L57] J. Kaspar, J. Bretschneider, S. Bonß, B. Winderlich, B. Brenner

"Laser Nitriding: A Promising Way to Improve the Cavitation Erosion Resistance of Components Made of Titanium Alloys"

Symp. On Friction, Wear and Wear Protection, Aachen, (2008), (im Druck)

[L58] D. King, M. K. Yaran, T. Schuelke, T.A. Grotjohn, D. K. Reinhard, J. Asmussen

"Scaling the Microwave Plasma-Assisted Chemical Vapor Diamond Deposition Process to 150-200 mm Substrates"

International Conference on New Diamond and Nano Carbons (NDNC 2007) Proceedings : Amsterdam : Elsevier, 2008, S. 520-524 (Diamond and related materials 17. 2008, Nr. 4-5)

[L59] U. Klotzbach

"Schnelligkeit und Präzision"

Mikroproduktion (2008) 2, S. 26-29

[L60] U. Klotzbach, M. Panzner, G. Wiedemann

"Potential and Limitations of Laser Technology in Restoration of Metallic Objects of Art and Cultural Heritage"

Materials and corrosion 59 (2008) 3, S. 220-227

[L61] S. Kühn

"Neue aktive Laserschutzwand für Laser höchster Brillianz"

Laser-Magazin (2008) 2, S. 28-29

[L62] S. Kühn

"Aktiver Laserschutz mit Heißleiter"

Photonik No. 4 (2008), S. 13

[L63] S. Kühn, J. Hannweber, B. Brenner, E. Beyer

"A Novel Active Laser Safety Shield"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Proceedings paper # 208, S. 113-116

[L64] D. Lepski, F. Brückner

"Laser Cladding"

Chapter 8 of the book by J.M. Dowden (Ed.) „The Theory of Laser Materials Processing“, Canopus Publishing Limited, Bristol, (im Druck)

[L65] A. Leson

"Neue-Nano-Ideen für die Industrie"

Konstruktion, 3 (2008) IW12

[L66] A. Leson

"Nanotechnologie - Von der Vision zur Wirklichkeit"

Forschung / Karriere / Kompetenz Nanotechnologie aktuell, IWV, 1 (2008) S. 50-53

[L67] A. Leson

"Zukunftsthema Nanotechnologie"

Ingenieure in Sachsen 01 (2008) S. 10-11

[L68] D. Linaschke, M. Leistner, G. Mäder, W. Grählert, I. Dani, S. Kaskel

"In-line Plasma-chemical Etching of Crystalline Silicon Solar Wafers at Atmospheric Pressure"

Eingereicht in IEEE

[L69] D. Linaschke, M. Leistner, G. Mäder, W. Grählert, I. Dani, S. Kaskel

"In-line Plasma-chemical Etching of Crystalline Silicon Solar Wafers at Atmospheric Pressure and FT-IR Spectroscopic Process Control"

Photovoltaics International, 4 (2008) S. 47 - 53

[L70] S. Lipfert, S. Braun, P. Gawlitza, J. Schmidt, A. Leson

"Inner Coating of EUV Collector Shells"

11th International Conference on Plasma Surface Engineering (PSE20008) Tagungsband PSE 2008, S. 332

[L71] S. Lipfert, P. Gawlitza, S. Braun, A. Leson

"Application of Large Ion Beam Technology for Optical Coatings"

11th International Conference on Plasma Surface Engineering (PSE2008) Tagungsband PSE 2008, S. 157

[L72] M. Lütke

"Aus der Faser in die Ferne: Laser-Remote-Schneiden mit dem Faserlaser"

Photonik 40 (2008) 1, S. 12

[L73] M. Lütke, T. Himmer

"Fein- und Dickbleche Schneiden mit dem Faserlaser"

Laser und Produktion, Spezial: Faserlaser, Sonderheft 2008, S. 18-19

[L74] M. Lütke, T. Himmer

"Remote-Schneiden mit dem Faserlaser ermöglicht hohe Konturgeschwindigkeiten"

Maschinenmarkt, Ausgabe 41 (2008), S. 100-102

[L75] M. Lütke, A. Mahrle, T. Himmer, L. Morgenthal, E. Beyer

"Remote-Cutting – A Smart Solution Using the Advantages of High Brightness Lasers"

27th ICALEO 2008, Tagungsband, Paper 2005

[L76] G. Mäder

"Atmosphärendruck-Plasma-Beschichtungsreaktoren"

Stuttgart : Fraunhofer IRB Verlag, 2008 Zugl.: Dresden, Univ., Diss., 2008 ISBN 3-8167-7656-6 ISBN 978-3-8167-7656-7

[L77] A. Mahrle, F. Bartels, E. Beyer

"Theoretical Aspects of the Process Efficiency in Laser Beam Cutting with Fibre Lasers"

Proceedings of the 27th International Congress on Applications of Lasers & Electro-Optics (ICALEO), 2008, Paper 2006

[L78] A. Mahrle, E. Beyer

"Derivation of Optimal Processing Parameters for Conduction Mode Laser Beam Welds by Simulation"

Proceedings of the 3rd Pacific International Conference on Applications of Lasers and Optics, Paper P223, S. 936-941

[L79] P. Marsik, P. Verdonck, D. Schneider, D. de Roest, S. Kaneko, M. R. Baklanov

"Spectroscopic Ellipsometry and Ellipsometric Porosimetry Studies of CVD Low-k Dielectric Films"

In: Arwin, H.: Papers presented at the 4th International Conference on Spectroscopic Ellipsometry, (ICSE4), Stockholm, Sweden, 2007, Weinheim: Wiley-VCH, 2008, S.1253-1256, (Physica status solidi. (c), Current topics in solid state physics, (2008), Nr.5)

[L80] J.J. Narendra, T.A. Grotjohn, J. Asmussen

"Microstripline Applicators for Creating Microplasma Discharges with Microwave Energy"

Plasma sources science & technology 17 (2008) 3, Art. 035027, S. 11

[L81] S. Nowotny, S. Scharek, S. Thieme, R.A. Gnann

"FLEXILAS – Laser-Präzisionstechnologie zum Auftragschweißen mit zentrischer Werkstoffzufuhr"

DVS-Berichte Band 250, S. 318-322, DVS Media GmbH, Düsseldorf, 2008

[L82] B. van Pham, H.-A. Bahr, U. Bahr, H. Balke, H.-J. Weiß

"Global Bifurcation Criterion for Oscillatory Crack Path Instability"

Physical Review. E 77 (2008) 6, Art. 066114, S. 10

[L83] B. Pollakowski, B. Beckhoff, B. F. Reinhardt, S. Braun, P. Gawlitza

"Speciation of Deeply Buried TiOx Nanolayers with Grazing-Incidence X-Ray Fluorescence Combined With a Near-Edge X-Ray Absorption Fine-Structure Investigation"

Physical Review B 77 (2008) 23, Art. 235408, S. 11

[L84] L. Prager, P. Marsik, L. Wennrich, M. R. Baklanov, S. Naumov, L. Pistol, D. Schneider, J. W. Gerlach, P. Verdonck, M. R. Buchmeiser

"Effect of Pressure on Efficiency of UV Curing of CVD-Derived Low-K Material at Different Wavelengths"

European Workshop on Materials for Advanced Metallization (MAM 2008), In: Schulz, S.E.: Proceedings of the Workshop: A single-session workshop devoted to materials research, materials properties and interactions, 2008, Dresden
Amsterdam : Elsevier, 2008, S. 2094-2097, (Microelectronic engineering 85.2008, Nr.10)

[L85] M. Raaif, F.M. El-Hossary, N.Z. Negm, S. M. Khalil, A. Kolitsch, D. Höche, J. Kaspar, S. Mändl, P. Schaaf

"CO_2 Laser Nitriding of Titanium"

Journal of Physics. D. Applied Physics 41 (2008) 8, S. 8

[L86] R. Rechner, I. Jansen

"Laservorbehandlung von Leichtmetallen vor dem Kleben"

6. Praxisseminar Kleben, (2008) Jena, Vorträge mit Proceedings

[L87] M. Reichmann, O. Throl, J. Rank, V. Uhlig, E. Beyer, G. Walter

"Kontrolliertes Entbindern in mikrowellen-unterstützten Thermoprozessanlagen"

Elektrowärme International 3 (2008), S. 203-209

[L88] R. Schedewy, E. Beyer, B. Brenner, A. Grimm, D. Dittrich, J. Standfuß

"Laser Beam Welding of High Stiffness Light Weight Structures Generated by Scanned Fiber Laser"

27th International Congress on Applications of Lasers and Electro Optics, (ICALEO) Temecula (CA), USA, 2008, Proceedings paper # 609, S. 332-339

[L89] H.-J. Scheibe, M. Leonhard, A. Leson, C.-F. Meyer, T. Stucky, V. Weihnacht

"Abscheidung superharter Kohlenstoffschichten mittels Laser-Arco® auf dem Weg vom Labor in die industrielle Serienfertigung"

Vakuum in Forschung und Praxis 20 (2008) 6, S. 26-31

[L90] H.-J. Scheibe, V. Weihnacht, T. Stucky

"Verschleissschutz - Extrem harte Kohlenstoffschichten unter Fertigungsbedingungen abscheidbar"

Maschinenmarkt. MM, das Industriemagazin (2008) 25, S. 22-24

[L91] D. Schneider, E. Hensel, A. Leson

"Testing Thin Films and Surfaces"

NanoS Guide 2008, Wiley-VCH Verlag, S. 20-26

[L92] D. Schneider, A. Leson

"Evaluating Thin Films and Material Surfaces by the Surface Acoustic Wave Technique LAwave"

MicroCar 2008, Micromaterials and Nanomaterials, 8 (2008)

[L93] B. Schultrich, V. Weihnacht

"Tribologisches Verhalten von harten und superharten Kohlenstoffschichten"

Vakuum in Forschung und Praxis 20 (2008) 1, S. 12-17

[L94] C. C. Stahr, L.-M. Berger, M. Herrmann, D. Deska

"Corrosion of Alumina-Based Coatings"

International Thermal Spray Conference & Exhibition (ITSC 2008), Conference Proceedings, Düsseldorf: DVS-Verlag GmbH, (2008), CD, S. 374-377, ISBN 978-3-87155-979-2

[L95] C. C. Stahr, L.-M. Berger, M. Herrmann, D. Deska

"Korrosion thermisch gespritzter Schichten auf der Basis von Aluminiumoxid"

Tagungsband zum 11. Werkstofftechnischen Kolloquium in Chemnitz, (2008) Schriftenreihe "Werkstoffe und werkstofftechnische Anwendungen", Band 31, Herausgeber: B. Wielage, Chemnitz: TU Chemnitz, (2008) S. 115-122, ISBN: 978-3-00-025648-6, ISSN: 1439-1597

[L96] C. C. Stahr, L.-M. Berger, S. Thiele

"Mikrostruktur und Eigenschaften HVOF-gespritzter Schichten im System TiO_2 - Cr_2O_3"

Materialwissenschaft und Werkstofftechnik 39 (2008) 1, S. 24-28

[L97] C. C. Stahr, L.-M. Berger, S. Thiele, S. Saaro

"Thermally Sprayed TiO_2-Cr_2O_3 Coatings with Multifunctional Properties"

International Thermal Spray Conference & Exhibition ITSC 2008, Conference Proceedings, Düsseldorf: DVS-Verlag GmbH, (2008), CD, S. 1114-1119, ISBN 978-3-87155-979-2

[L98] C. C. Stahr, L.-M. Berger, F.-L. Toma

"Keramische Schichten im System Al_2O_3-Cr_2O_3-TiO_2 – ausgewählte Entwicklungstendenzen"

Tagungsband zum 4. GTV Kolloquium Thermisches Spritzen (2008), Luckenbach, Hrg.: A. Schwenk, Luckenbach: GTV-Verschleiss-Schutz GmbH, (2008) S. 56-63, ISSN 1610-0530

[L99] C. C. Stahr, L.-M. Berger, F.-L. Toma, M. Herrmann, D. Deska, G. Michael

"Korrosion thermisch gespritzter Schichten auf der Basis von Aluminiumoxid"

Materialwissenschaft und Werkstofftechnik, 39 (2008) 12, S. 892-896

[L100] J. Standfuß, U. Stamm, G. Göbel, S. Schrauber, B. Brenner

"Future Powertrain Welding Applications Driven by Fiber Lasers"

ALAW 2008, Automotive Laser Application Workshop 2008, Plymouth (MI), USA, Tagungsband

[L101] O. Stelling, N. Ellendt, V. Uhlenwinkel, P. Krug, O. Keßler, H.-W. Zoch, B. Commandeur

"Einfluss des primär ausgeschiedenen Mg_2Si-Anteils sowie dessen Verteilung auf die Eigenschaften von sprühkompaktierten AlMgSiCu-Legierungen"

Härterei-Technische Mitteilungen: HTM 63 (2008) 5, S. 276-283

[L102] T. Stucky, V. Weihnacht, S. Bräunling

"Potenzial von ta-C-Schichten für die Trockenumformung"

Europäische Forschungsgesellschaft Dünne Schichten e.V. -EFDS- ; Fraunhofer-Institut für Schicht- und Oberflächentechnik -IST-, Braunschweig ; Fraunhofer-Institut für Werkstoff- und Strahltechnik -IWS-, Dresden: Kohlenstoffschichten- Tribologische Eigenschaften und Verfahren zu ihrer Herstellung. 3. EFDS Workshop 2008, Dortmund, S. 10

[L103] A. Techel

"Mit dem Laser Energie sparen"

Laser + Produktion 2008, S. 12-14

[L104] A. Techel, L.-M. Berger, V. Weihnacht

"Hart im Nehmen"

Metalloberfläche (mo), 62 (2008) 9, S. 30-32, ISSN 0026-0797

[L105] A. Techel, C. Zellbeck

"Im Blickpunkt – Deutschlands Elite-Institute – Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS Dresden"

ISSN 1614-8185

[L106] F.-L. Toma, L.-M. Berger, D. Jacquet, D. Wicky , I. Villaluenga, Y. R. de Miguel, J. S. Lindeløv

"Vergleichende Untersuchungen zu den photokatalytischen Eigenschaften von thermisch gespritzten Titanoxidschichten aus Pulvern und Suspensionen"

Tagungsband zum 11. Werkstofftechnischen Kolloquium in Chemnitz, Schriftenreihe "Werkstoffe und werkstofftechnische Anwendungen", Band 31, Hrg.: B. Wielage, Chemnitz: TU Chemnitz (2008) S. 107-114, ISBN: 978-3-00-025648-6, ISSN: 1439-1597

[L107] F.-L. Toma, L.-M. Berger, T. Naumann, S. Langner

"Microstructures of Nanostructured Ceramic Coatings Obtained by Suspension Thermal Spraying"

Surface and Coatings Technology 202 (2008) 18, S. 4343-4348

[L108] F.-L. Toma, L.-M. Berger, T. Naumann, S. Langner

"Characterisation of Ceramic Nanostructured Coatings Prepared by Thermal Spraying of Suspensions"

International Thermal Spray Conference & Exhibition (ITSC 2008), Conference Proceedings, Düsseldorf: DVS-Verlag GmbH, (2008), CD, S. 429-434, ISBN 978-3-87155-979-2

[L109] F.-L. Toma, G. Bertrand, D. Klein, C. Meunier, S. Begin

"Development of Photocatalytic Active TiO_2 Surfaces by Thermal Spraying of Nanopowders"

Journal of Nanomaterials. Online unter http://www.hindawi.com/journals/jnm/index.html 2008 (2008), Art. 384171, S. 8

[L110] A.M. Urbanowicz, B. Meshman, D. Schneider, M. R. Baklanov

"Stiffening and Hydrophilisation of SOG Low-K Material Studied by Ellipsometric Porosimetry, UV Ellipsometry and Laser-Induced Surface Acoustic Waves"

Physica status solidi. A, 205 (2008) 4, S. 829-832

[L111] V. Weihnacht

"Mechanisch-tribologisch angepasste ta-C-basierte-Schichtsysteme"

In: Europäische Forschungsgesellschaft Dünne Schichten e.V. -EFDS- ; Fraunhofer-Institut für Schicht- und Oberflächentechnik -IST-, Braunschweig ; Fraunhofer-Institut für Werkstoff- und Strahltechnik -IWS-, Dresden: Kohlenstoffschichten- Tribologische Eigenschaften und Verfahren zu ihrer Herstellung. 3. EFDS Workshop 2008, Dortmund, S. 9

[L112] V. Weihnacht, A. Brückner

"Optimized ta-C-Based Coating Systems for Lubricated Conditions"

Seminar HANSER-Verlag "Funktionale Schichten", Fellbach, März, 2008, Tagungsband

[L113] V. Weihnacht, A. Brückner

"Optimized ta-C-Based Coating Systems for Lubricated Conditions"

Workshop "Friction, Wear and Wear protection", Aachen, 2008, Tagungsband

[L114] V. Weihnacht, A. Brückner, S. Bräunling

"ta-C beschichtete Werkzeuge für die Trockenumformung von Aluminiumblechen"

Vakuum in Forschung und Praxis 20 (2008) 3, S. 6-10

[L115] V. Weihnacht, A. Brückner, S. Bräunling

"Diamantartige Kohlenstoffschichten mit Potenzial zur Trockenumformung"

Europäische Forschungsgesellschaft für Blechverarbeitung (Kolloquium)
In: Europäische Forschungsgesellschaft für Blechverarbeitung e.V., EFB: Intermezzo der Werkstoffe. Die Chance der Wahl für Konstrukteure und Planer, EFB, 2008, S. 47-52

[L116] V. Weihnacht, H.-J. Scheibe

"Friction and Wear Behaviour of Modified Diamondlike Carbon Films"

16th International Colloquium Tribology Stuttgart, Januar, 2008, Tagungsband

[L117] V. Weihnacht, H.-J. Scheibe, A. Leson

"ta-C and Modified ta-C:X Films for Demanding Tribological Applications"

11th International Conference on Plasma Surface Engineering (PSE2008) Garmisch-Partenkirchen, September 2008, Tagungsband PSE 2008, S. 90

[L118] B. Weller, I. Jansen, S. Tasche

"Adhesive Joints with Acrylates in Glass Structures"

Euradh 2008 / Adhesion ´08, 10th Internat. Conf. Sci. & Techn. Adh., September 2008, Oxford, UK, S. 309-312

[L119] S. Winkler, S. Braun, P. Gawlitza, D. C. Meyerl

"Fabrication and Characterization of Multilayered Thermal Barrier Coatings"

11th International Conference on Plasma Surface Engineering (PSE2008) Garmisch-Partenkirchen, Tagungsband PSE 2008, S. 310

[L120] W. L. Xu, J.-S. Pap, J. Bronlund

"Design of a Biologically Inspired Parallel Robot for Foods Chewing"

IEEE transactions on industrial electronics 55 (2008) 2, S. 832-841

[L121] W.L. Xu, D.J. Torrance, B.Q. Chen, J. Potgieter, J.E. Bronlund, J.-S. Pap

"Kinematics and Experiments of a Life-Sized Masticatory Robot for Characterizing Food Texture"

IEEE transactions on industrial electronics 55 (2008) 5, S. 2121-2132

[L122] O. Zimmer, F. Kaulfuß

"Hard Coatings with Elevated Film Thickness Prepared by PVD"

11th International Conference on Plasma Surface Engineering (PSE2008), Tagungsband PSE 2008, S. 537

[L123] Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS, Dresden

"4. Internationaler Workshop "Faserlaser" 2008, CD-ROM, 5.-6. November 2008, Fraunhofer IWS Dresden"

Stuttgart: Fraunhofer IRB Verlag, 2008
ISBN 978-3-8167-7853-0

[L125] Fraunhofer-Institut für Werkstoff- und Strahltechnik -IWS-, Dresden

"7. Workshop "Industrielle Anwendungen von Hochleistungs-Diodenlasern" 2008, CD-ROM, 24. bis 25. Juni 2008 in Dresden"

Stuttgart : Fraunhofer IRB Verlag, 2008
ISBN 978-3-8167-7663-5

is = invited speakers

[T01] T. Abendroth, H. Althues, S. Kaskel

"Abscheidung von photokatalytisch aktiven Titandioxidschichten bei niedrigen Temperaturen mittels Atmosphärendruck CVD"

4. Thüringer Grenz- und Oberflächentage, Jena, September 2008

[T02] T. Abendroth, H. Althues, S. Kaskel

"Chemische Dampfphasenabscheidung (CVD) von funktionellen Oxidschichten auf Polymeroberflächen bei Atmosphärendruck"

16. Neues Dresdner Vakuumtechnisches Kolloquium, Dresden, Oktober 2008

[T03] H. Althues, T. Abendroth, I. Dani, S. Kaskel

"Atmospheric Pressure PECVD for Cost-Saving, Continuous Deposition of Thin Films"

7th International Conference on Coatings on Glass & Plastics, Eindhoven/Veldhoven, Niederlande, Juni 2008

[T04] H. Beese, W. Grählert, J. Grübler, P. Kaspersen, A. Bohman

"Optisch-spektroskopische Bestimmung der Permeabilität von Ultrabarrierematerialien"

6th Conference on Optical Analysis Technology (OPTAM), Leverkusen, September 2008

[T05] H. Beese, E. Lopez, W. Grählert, I. Dani, V. Hopfe

"Characterisation of Photovoltaic Production Processes by Infrared Spectroscopy"

1st European Conference on Process Analytics and Control Technology (EUROPACT), Frankfurt/M., 22.–25. April 2008

[T06] **is** L.-M. Berger

"Thermisch gespritzte Beschichtungslösungen für die Antriebstechnik"

Forschungsvereinigung Antriebstechnik des VDMA, Frankfurt/M.
17. Januar 2008

[T07] **is** L.-M. Berger

"Neue Möglichkeiten für thermisch gespritzte Hartmetallschichten"

Thermisches Spritzen 3-Ländereck des Schweizer Verbandes für Schweisstechnik, Basel, 28. Oktober 2008

[T08] L.-M. Berger, K. Lipp, C. Jordan, U. May, T. Naumann

"Rolling Contact Fatigue of HVOF-Sprayed WC-based Hardmetal Coatings"

International Powder Metallurgy Congress & Exhibition, Mannheim, 29. September - 1. Oktober 2008,

[T09] L.-M. Berger, S. Saaro

"Oxidation of (Ti,Mo)(C,N)-Based HVOF-Sprayed Hardmetal Coatings"

International Conference on the Science of Hard Materials, Montego Bay, Jamaica, 10.-14. März 2008,

[T10] L.-M. Berger, S. Saaro, C. Jordan, T. Naumann, M. Kašparova, F. Zahálka

"HVOF-Sprayed WC-(W,Cr)$_2$C-Ni Coatings and Their Properties"

International Thermal Spray Conference & Exhibition, Maastricht, Niederlande 2.-4. Juni 2008

[T11] L.-M. Berger, C.C. Stahr, S. Saaro, S. Thiele, M. Woydt

"Dry Sliding Wear Properties of Thermal Spray Coatings in the TiO_2-Cr_2O_3 System"

Friction, Wear and Wear Protection, Aachen, 9.-11. April, 2008

[T12] L.-M. Berger, C.C. Stahr, S. Saaro, S. Thiele, M. Woydt, N. Kelling

"High Temperature Tribology up to 7.5 m/s of Thermally Sprayed Coatings of the TiO_2-Cr_2O_3 System and (Ti,Mo)(C,N)-Ni(Co)"

49. Tribologie-Fachtagung, Göttingen, 22.-24. September 2008

[T13] L.-M. Berger, V. Weihnacht, S. Saaro, R. Schwetzke

"Microstructure and Dry Sliding Wear Properties of HVOF-Sprayed Hardmetal Coatings with Thin Film Topcoats"

Nordtrib 2008, 13th Nordic Symposium on Tribology, Tampere, 10.-13. Juni 2008

[T14] E. Beyer

"High Power Laser Materials Processing - New Developments and Trends"

3rd Pacific International Conference on Applications of Lasers and Optics (PICALO 2008), Peking, China, 16.–18. April 2008

[T15] E. Beyer, T. Himmer, M. Lütke, F. Bartels, A. Mahrle

"Cutting with High Brightness Lasers"

Stuttgarter Lasertage (SLT'08), Stuttgart, 4.-6. März 2008

[T16] E. Beyer, M. Lütke, T. Himmer

"Remote-Schneiden mit brillanten Strahlquellen"

Münchener Kolloquium, Innovationen für die Produktion, München, 9. Oktober 2008

[T17] S. Bonß

"LiFt - Laserintegration in die Fertigungstechnik"

SIT – Ingenieurtag, Chemnitz, 27. Juni 2008

[T18] S. Bonß

"LiFt - Prozesseffizienz durch Laserintegration"

Innovationabend der Firma euro-engineering, Chemnitz, 25. September 2008

[T19] S. Bonß, J. Hannweber, U. Karsunke, S. Kühn, M. Seifert, E. Beyer, G. Drollinger

"Prozesskettenverkürzung durch integriertes Laserstrahlhärten in Drehmaschinen"

Härterei-Kolloquium 2008, Wiesbaden, 8.-10. Oktober 2008

[T20] S. Bonß, J. Hannweber, U. Karsunke, S. Kühn, M. Seifert, E. Beyer, G. Drollinger

"Integrated Laser Beam Hardening in Turning Machines for Process Chain Reduction"

27th International Congress on Applications of Lasers & Electro-Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T21] S. Bonß, J. Hannweber, U. Karsunke, M. Seifert, B. Brenner, E. Beyer

"Integrated Heat Treatment - Comparison of Different Machine Concepts"

3rd Pacific International Conference on Applications of Lasers and Optics (PICALO 2008), Peking, China, 16.-18. April 2008

[T22] S. Braun

"Application of Nanometer Precision Coatings for EUV Lithography and X-Ray Analytics"

NanoTech 2008, Tokyo, Japan, 13.-15. Februar 2008

[T23] S. Braun

"High Precision Nanoscaled Coatings for Optics"

Seminars and Lab tours "Nanotechnologies for Energy and Energy Efficiency" Dresden, 13. März 2008

[T24] S. Braun, P. Gawlitza, M. Menzel, S. Schädlich, A. Leson

"Figuring of Superpolished Substrates by High-Precision Coatings"

9th International Conference on the Physics of X-ray Multilayer Structures (PXRMS), Montana, USA, 3.-7. Februar 2008

[T25] S. Braun, S. Schädlich, A. Leson

"Multilayer Laue Lenses: A New Approach for Nanometer Focusing and X-Ray Microscopy"

4th Workshop on "Advanced Nanomaterials", Wroclaw, Polen, 27.-28. Oktober 2008

[T26] S. Braun, E. Zschech, W. Yun

"Nano-Röntgentomographie für Prozesskontrolle und Fehleranalyse in der Halbleiterindustrie"

Industrielle Computertomographie Tagung, Wels, Österreich, 27.-28. Februar 2008

[T27] B. Brenner

"Neue Laserstrahlschweißverfahren in Forschung und Industrie"

BIC-Fachforum „Trends und Entwicklungen in der Laserbearbeitung – Neue Möglichkeiten für Unternehmen der Region", Zwickau,19. Januar 2008

[T28] B. Brenner

"Development of New Laser Welding Technologies and Their Industrial Use in Germany"

Keynote presentation, AILU Technology Workshop "Welding and Cutting with Fibre-Delivered Laser Beams", TWI Cambridge, UK, 20. Februar 2008

[T29] B. Brenner

"Neueste laserbasierte Fügeverfahren in Forschung und Industrie"

Materialforschungstag des Materialforschungsverbundes Dresden, „Effizienter Leichtbau durch einsatzgerechte Werkstoffauswahl"(Intec 2008), Leipzig, 29. Februar 2008

[T30] B. Brenner

"Aktuelle Entwicklungen zum Laserstrahlschweißen schwer schweißbarer Werkstoffe"

Studentenkongress im Rahmen der Großen Schweißtechnischen Tagung, Dresden, 17. November 2008

[T31] B. Brenner, S. Bonß

"Hochleistungsdiodenlaser als Werkzeug"

7. Workshop „Industrielle Anwendungen von Hochleistungsdiodenlasern",IWS Dresden, 24.-25. Juni 2008

[T32] B. Brenner, J. Hackius, J. Standfuß, D. Dittrich, B. Winderlich, J. Liebscher

"Laser Beam Welding of Aircraft Fuselage Structures"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T33] B. Brenner, A. Jahn, J. Standfuß

"Improved Formability and Crash Performance of Laser-Welded Structures Made of High Strength Multiphase-Steels"

9th European Automotive Laser Application Conference (EALA 2008), Bad Nauheim, 31. Januar - 1. Februar 2008

[T34] B. Brenner, J. Standfuß, U. Stamm, D. Dittrich, A. Jahn, B. Winderlich

"Perspektiven für den Metallleichtbau in der Fahrzeug- und Luftfahrtindustrie durch fortgeschrittene Laserstrahlschweißverfahren"

12. Dresdner Leichtbausymposium „Innovationsquelle Leichtbau", Dresden, 12.-14. Juni 2008

[T35] P. Bringmann, O. Rohr, J. Wehr, I. Jansen

"Cr^{+6}-free Hybrid Coatings as Potential Pre-Treatment for Structural Adhesive Bonding"

Euradh 2008 / Adhesion ´08, 10th Internat. Conf. Sci. & Techn. Adh. Adh., Oxford, UK, 3.-5. September 2008

[T36] F. Brückner, D. Lepski, E. Beyer

"Simulation of Induction Assisted Laser Cladding and Experimental Validation"

21th Meeting on Mathematical Modelling of Materials Processing with Lasers, Igls, Österreich, 16.-18. Januar 2008

[T37] F. Brückner, D. Lepski, E. Beyer

"Induktiv unterstütztes Laser-Pulver-Auftragsschweißen - Simulation und Experimente"

WLT Summer School 2008, Stuttgart, 3. März 2008

[T38] F. Brückner, D. Lepski, E. Beyer

"Numerical and Experimental Investigation of Thermal Stresses and Distortions in the Induction Assisted Laser Cladding"

3rd Pacific International Conference on Application of Lasers and Optics (PICALO 2008), Peking, China, 16.-18. April 2008

[T39] F. Brückner, D. Lepski, E. Beyer

"Reduction of Thermally Induced Distortion in Laser Cladding"

2nd International Workshop on Thermal Forming and Welding Distortion, Bremen, 22.-23. April 2008

[T40] J. Chen, E. Louis, F. Bijkerk, C. J. Lee, R. Kunze, H. Schmidt, D. Schneider, R. Moors

"Characterization of EUV Induced Carbon Films Using Laser-Generated Surface Acoustic Waves"

Diamond 2008, Sitges, Spain, 2008, 7.-11. September 2008

[T41] **is** I. Dani

"Atmospheric Pressure Plasmas for the Manufacturing of Solar Cells"

New Technologies and Processes for the Photovoltaic Industry Conference, Turin, November 2008

[T42] I. Dani, E. López, B. Dresler, D. Linaschke, H. Beese, V. Hopfe, S. Kaskel

"Atmospheric Pressure Plasma Processes for Photovoltaics"

Nanofair 2008, Workshop energy, Dresden

[T43] I. Dani, E. Lopez, B. Dresler, J. Roch, G. Mäder, P. Grabau, V. Hopfe

"Kontinuierliche Prozessierung von kristallinen Si-Solarwafern durch plasmachemisches Ätzen und Beschichten bei Atmosphärendruck"

XV. Erfahrungsaustausch "Oberflächentechnologie mit Plasma- und Ionenstrahlprozessen", Mühlleithen, 4.-6. März 2008

[T44] I. Dani, G. Mäder, J. Roch, P. Grabau, B. Dresler, D. Linaschke, S. Tschöcke, E. López, V. Hopfe

"Equipment for Atmospheric Pressure Plasma Processing"

Eleventh International Conference on Plasma Surface Engineering, Garmisch, September 2008

[T45] C. Demuth, A. Mahrle, E. Beyer

"Partikelbasierte numerische Verfahren zur Prozesssimulation in der Lasermaterialbearbeitung – Potenzial, Methodik und Implementierung"

WLT-Summerschool, Stuttgart, 3. März 2008

[T46] G. Dietrich, P. Gawlitza, S. Braun, A. Leson

"Ionenstrahlsputtern von Kohlenstoff - Möglichkeiten und Grenzen bei der Herstellung hochpräziser (Multi-) Schichten"

Erfahrungsaustausch "Oberflächentechnologien mit Plasma- und Ionstrahlprozessen", Mühlleiten, 4.-6. März 2008

[T47] G. Dietrich, P. Gawlitza, S. Braun, A. Leson

"Reactive Nanometer Multilayers as Tailored Heat Sources for Joining Techniques"

4th Workshop on "Advanced Nanomaterials", Wroclaw, Polen, 27.-28. Oktober 2008

[T48] D. Dittrich, E. Beyer, B. Brenner, J. Standfuß, B. Winderlich, J. Hackius

"Progress in Laser Beam Welding of Aircraft Fuselage Panels / Skin-Skin-Connections"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T49] D. Dittrich, B. Brenner, B. Winderlich, G. Kirchhoff, J. Hackius

"New Weld Seam Design for Advanced Joining Techniques to Improve Safety and to Reduce Structural Weight"

Aircraft Structural Design Conference, Liverpool, UK, 14.-16. Oktober 2008

[T50] D. Dittrich, B. Brenner, B. Winderlich, J. Standfuß, J. Liebscher, J. Hackius

"Laserstrahlschweißtechnologien für innovative integrale Rumpfschalen ziviler Großraumflugzeuge"

Große Schweißtechnische Tagung, Dresden, 17.-19. September 2008

[T51] B. Dresler, J. Roch, I. Dani, V. Hopfe, M. Heintze, R. Möller, M. Kirschmannn, J. Frenck, R. Dahl

"Silicon Nitride Produced by Atmospheric Pressure Microwave PECVD"

23th European Photovoltaic Solar Energy Conference and Exhibition, Valencia, Spanien, September 2008

[T52] B. Dresler, J. Roch, I. Dani, V. Hopfe, B. Leupolt, A. Poruba, R. Barinka, M. Kirschmannn, J. Frenck

"Atmospheric Pressure Microwave PECVD of Silicon Nitride Layers for Passivation of Solar Wafers"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T53] P. Gawlitza, S. Braun, G. Dietrich, M. Menzel, S. Schädlich, A. Leson

"Ion Beam Sputtering of Multilayer X-Ray Optics"

Annual Meeting of Spie Optics & Photonics, San Diego, USA, 10.-14. August 2008

[T54] P. Gawlitza, G. Dietrich, S. Braun, A. Leson

"Smoothing of Surface Roughness by Ion Beam Deposition and Etching"

9th International Conference on the Physics of X-ray Multilayer Structures Montana, USA, 3.-7. Februar 2008

[T55] L. Girdauskaite, S. Krzywinski, H. Rödel, R. Böhme, I. Jansen

"Possibilities for the Production of Complex Shaped Dry Textile Performs for High Quality Composites"

8th AUTEC Conference, Biella, Italien, 24.-26. Juni 2008

[T56] L. Girdauskaite, S. Krzywinski, H. Rödel, R. Böhme, I. Jansen

"Complex Shaped Dry Textile Preforms for High Quality Composites"

2nd Aachen-Dresden International Textile Conference, Dresden, 4.-5. Dezember 2008

[T57] P. Grabau, G. Mäder, I. Dani, V. Hopfe

"Electrical Characterisation of a Linearly extended Arc Discharge at Atmospheric Pressure"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T58] W. Grählert, H. Beese, P. Kaspersen, A. Bohman

"TraceScout - an Advanced Sensor System for In-line Monitoring of Special Gases in Semiconductor Industry"

1st European Conference on Process Analytics and Control Technology, Frankfurt / M., 22.–25. April 2008

[T59] W. Grählert, M. Leistner, D. Linaschke, I. Dani

"Infrarotspektroskopische Charakterisierung photovoltaischer Produktionsprozesse"

9. Wörlitzer Workshop Diagnostik & Prozesskontrolle bei der Herstellung von Solarzellen, Wörlitz, 17. Juni 2008

[T60] W. Grählert, M. Leistner, M. Märcz, O. Jost, V. Hopfe, S. Kaskel

"In-situ Monitoring of the Synthesis of Single-wall Carbon Nanotubes (SWCNT) Using FT-NIR Spectroscopy"

Nanofair, Dresden, 11.-12.März 2008

[T61] W. Grimm, V. Weihnacht

"Super Hard Carbon Coatings Deposited by Pulsed DC-Arc-Process"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T62] L. Haubold, M. Becker, T. Schuelke, C. Kleemann, H. Scheibe, C. Hinüber, R. Friedrichs, E. Hoeffing, M. Baumann

"JB-4-ta-C:X for Biomedical Implants"

SVC 2008, Chicago, USA, 19.-24. April 2008

[T63] **is** T. Himmer, M. Lütke, L. Morgenthal

"Cutting Applications for High Brightness Lasers"

XIII International Conference on Laser Optics 2008, St. Petersburg, Russland, Juni 2008,

[T64] T. Himmer, M. Lütke, L. Morgenthal

"Potential des Remote-Laserstrahlschneidens in der Fertigungstechnik"

DPS Kundentage 2008 – Faszination 4D, Dresden, Oktober 2008,

[T65] **is** T. Himmer, M. Lütke, L. Morgenthal, E. Beyer, C. Bratt

"Remote Cutting with High Brightness Lasers"

XXXII Conference on Production Engineering 2008, Novi Sad, Serbien September 2008

[T66] V. Hopfe, I. Dani, E. López, B. Dresler, M. Heintze, R. Möller, H. Wanka, A. Poruba, R. Barinka, M. Kirschmannn, J. Frenck

"Atmospheric Pressure Plasmas for Coating and Etching of Solar Wafers"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen,15.-19. September 2008

[T67] **is** V. Hopfe, D. W. Sheel

"Atmospheric Pressure Plasmas for Crystalline Silicon Photovoltaics"

51st SVC Annual Technical Conference, Chicago, 19.-24. April 2008

[T68] **is** V. Hopfe, D. W. Sheel, R. Moeller

"Nanostructured c-Si Photovoltaic Cells by Atmospheric Pressure Plasma Processing"

International Conference on Functional Nanocoatings, Budapest, 30. März - 2. April 2008

[T69] Š. Houdková, F. Zahálka, M. Kašparová, L.-M. Berger

"Tribological Behaviour of Thermally Sprayed Coatings at Elevated Temperatures"

International Thermal Spray Conference & Exhibition, Maastricht, Niederlande, 2.-4. Juni 2008,

[T70] A. Jahn, M. Krätzsch, B. Brenner

"Laserstrahlschweißen hochfester Feinkornbaustähle mit werkstoffangepasster Temperaturführung"

Große Schweißtechnische Tagung, Dresden, 17.-19. September 2008

[T71] A. Jahn, M. Krätzsch, B. Brenner

"Induction Assisted Laser Beam Welding of HSLA Steel Sheets"

International Scientific Colloquium "Modelling for Electromagnetic Processing", Hannover, 27.-29. Oktober 2008

[T72] I. Jansen, J.-S. Pap, R. Rechner

"8. Kolloquium Gemeinsame Forschung in der Klebtechnik"

Frankfurt, 26.-27. Februar 2008

[T73] I. Jansen, R. Rechner

"Einsatz des Diodenlasers zur Kantenleimung"

7. Workshop "Industrielle Anwendung von Hochleistungsdiodenlasern", IWS Dresden, 24.-25. Juni 2008,

[T74] J. Kaspar, J. Bretschneider, S. Bonß, B. Winderlich, B. Brenner

"Laser Nitriding: A Promising Way to Improve the Cavitation Erosion Resistance of Components Made of Titanium Alloys"

Symp. On Friction, Wear and Wear Protection, Aachen, 9.-11. April 2008

[T75] A. Klotzbach

"Introduction to Remote Welding / Cutting Systems"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T76] A. Klotzbach, M. Leminski, J. Standfuß, R. Schedewy, A. Mahrle, F. Brückner

"Zukünftige Industrieanwendungen für brillante Laserquellen und deren Qualifizierung unter Nutzung der Strahldiagnostik"

3. Primes Workshop, Pfungstadt, 9.-10. September 2008

[T77] S. Kühn, J. Hannweber, B. Brenner, E. Beyer

"A Novel Active Laser Safety Shield"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T78] M. Leistner, M. Märcz, W. Grählert, V. Hopfe, O. Jost, S. Kaskel

"In-situ Monitoring of Single-Wall Carbon Nanotubes (SWCNT) Synthesis Using FT-NIR Spectroscopy"

1st European Conference on Process Analytics and Control Technology (EUROPACT), Frankfurt / M., 22.–25. April 2008

[T79] D. Lepski, F. Brückner

"The Physics of Laser Cladding"

21. Meeting on Mathematical Modeling of Materials Processing with Lasers, Igls, Österreich, Januar 2008

[T80] **is** A. Leson

"Current Research and Technology Transfer at the Fraunhofer Institute for Material and Beam Technology"

Center of Condensed Matter of the Mexican Autonomous National University, Ensenada, Mexiko, 30. April 2008

[T81] **is** A. Leson

"More Moore"

Gastvorlesung Universität Osaka Osaka, Japan, 23. Juli 2008

[T82] A. Leson

"Dünnschichttechnologie - Verfahren, Anwendungen, Perspektiven"

Fraunhofer Technologiezirkel: "Wirtschaftliches Potential der Nanotechnologien", Würzburg, 15.-16. Oktober 2008

[T83] A. Leson

"Nanostructured Carbon Layers for Wear Resistance and Friction Reduction"

2nd British-German Nanotech Forum "Commercialising Future Technologies for Energy and Automotive Applications", London, GB, 27. Oktober 2008

[T84] A. Leson, M. Leonhardt, C.-F. Meyer, H.-J. Scheibe, V. Weihnacht

"Deposition of Super Hard and Smooth ta-C Films by Filtered Laser-Arc"

European Vacuum Coaters Symposium Anzio, Italien, 29. September - 2. Oktober 2008

[T85] **is** A. Leson, M. Leonhardt, C.-F. Meyer, H.-J. Scheibe, V. Weihnacht

"Hard Nanostructured Carbon Coatings - Technology and Applications"

RusNanoTech'2008 Nanotechnology International Forum, Moskau, Russland, 3.-5. Dezember 2008

[T86] A. Leson, H.-J. Scheibe, V. Weihnacht

"Nanostructured Carbon Coatings - Technology and Applications"

MiNaT2008, Stuttgart, 8. Oktober 2008

[T87] S. Lipfert, S. Braun, P. Gawlitza, J. Schmidt, A. Leson

"Inner Coating of EUV Collector Shells"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T88] S. Lipfert, P. Gawlitza, S. Braun, A. Leson

"Application of Large Ion Beam Technology for Optical Coatings"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T89] E. López, I. Dani, V. Hopfe, M. Heintze, R. Möller, H. Wanka, H. Nußbaumer, R. Dahl, A. Poruba, R. Barinka, M. Kirschmann, J. Frenck

"Plasma Enhanced Chemical Etching at Atmospheric Pressure for Crystalline Silicon Wafer Processing"

23th European Photovoltaic Solar Energy Conference and Exhibition, Valencia, Spanien, September 2008

[T90] E. López, B. Dresler, G. Mäder, S. Krause, I. Dani, V. Hopfe, M. Heintze, R. Möller, H. Wanka, M. Kirschmann, J. Frenck, A. Poruba, R. Barinka, R. Dahl, H. Nussbaumer

"Plasma Enhanced CVD and Plasma Chemical Etching at Atmospheric Pressure for Continuous Processing of Crystalline Silicon Solar Wafers"

51st SVC Annual Technical Conference, Chicago, USA, 19.-24. April 2008

[T91] E. López, D. Linaschke, H. Beese, G. Mäder, I. Dani, V. Hopfe, M. Kirschmann, J. Frenck

"Plasma Chemical Etching for In-line c-Si Solar Cell Processing at Atmospheric Pressure"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T92] M. Lütke, A. Mahrle, T. Himmer, L. Morgenthal, E. Beyer

"Remote-Cutting – A Smart Solution Using the Advantages of High Brightness Lasers"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T93] A. Mahrle, F. Bartels, E. Beyer

"Theoretical Aspects of the Process Efficiency in Laser Beam Cutting with Fibre Lasers"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T94] A. Mahrle, E. Beyer

"Derivation of Optimal Processing Parameters for Conduction Mode Laser beam Welds by Simulation"

3rd Pacific International Conference on Applications of Lasers and Optics, Peking, China, 16.-18., April 2008 (Postervortrag)

[T95] C.-F. Meyer, H.-J. Scheibe

"Filtered Laser-Arc: A New Technology for Deposition of Smooth ta-C Films"

ICMCTF 2008, San Diego, USA, 28. April – 2. Mai 2008

[T96] S. Nowotny

"Industrielle Lösungen für das Laserstrahl-Auftragschweißen"

TAW-Symposium Thermisches Beschichten mit laserbasierten Fertigungsverfahren, IWS Dresden, 12.-13. Februar 2008

[T97] S. Nowotny, S. Scharek, A. Schmidt, F. Kempe

"Systemtechnische Lösungen für die Praxis des Auftragschweißens mit Diodenlasern"

7. Workshop "Industrielle Anwendungen von Hochleistungsdiodenlasern“, IWS Dresden, 24.-25. Juni 2008

[T98] S. Nowotny, S. Scharek, S. Thieme, R.A. Gnann

"Flexilas - eine neue Dimension der Laser-Materialbearbeitung mit Zusatzwerkstoffen"

Karlsruher Arbeitsgespräche Produktionsforschung 2008, Karlsruhe, 11.-12. März 2008

[T99] S. Nowotny, S. Scharek, S. Thieme, R.A. Gnann

"Flexilas: Laser-Auftragschweißen mit zentrischer Drahtzufuhr"

Die Verbindungs Spezialisten, Große Schweißtechnische Tagung, Dresden, 17.-19. September 2008

[T100] L. Prager , P. Marsik, J. W. Gerlach, M. R. Baklanov, S. Naumov, L. Pistol, D. Schneider, L. Wennrich, P. Verdonck, M. R. Buchmeise

"Effect of Pressure on Efficiency of UV Curing of CVD-Derived Low-K Material at Different Wavelengths"

European Workshop on Materials for Advanced Metallization (MAM 2008), Dresden, 2.-5. März 2008

[T101] R. Rechner, I. Jansen

"Laservorbehandlung von Leichtmetallen vor dem Kleben"

6. Praxisseminar Kleben, Jena, 12. Februar 2008

[T102] R. Schedewy, E. Beyer, B. Brenner, A. Grimm, D. Dittrich, J. Standfuß

"Laser Beam Welding of High Stiffness Light Weight Structures Generated by Scanned Fiber Laser"

27th International Congress on Applications of Lasers and Electro Optics (ICALEO 2008), Temecula (CA), USA, 20.-23. Oktober 2008

[T103] H.-J. Scheibe, A. Leson, V. Weihnacht

"Pulsed Arc Deposition of Modified ta-C Films, Tribological Properties and Applications"

HIPIMS Days, Venlo, Niederlande, 7.-8. Juli 2008

[T104] H.-J. Scheibe, V. Weihnacht, A. Leson

"Friction and Wear Behaviour of Modified ta-C Films"

ICMCTF 2008, San Diego, USA, 28. April - 2. Mai 2008

[T105] D. Schneider, A. Leson

"Evaluating Thin Films and Material Surfaces by the Surface Acoustic Wave Technique LAwave"

MicroCar 2008, Leipzig, 27. Februar 2008

[T106] C. C. Stahr, L.-M. Berger, M. Herrmann, D. Deska

"Corrosion of Alumina-Based Coatings"

International Thermal Spray Conference & Exhibition, 2.-4. Juni 2008, Maastricht, Niederlande

[T107] C. C. Stahr, L.-M. Berger, M. Herrmann, D. Deska, F.-L. Toma

"Korrosion thermisch gespritzter Schichten auf der Basis von Aluminiumoxid"

11. Werkstofftechnischen Kolloquium in Chemnitz, 1.-2. Oktober 2008

[T108] C. C. Stahr, L.-M. Berger, S. Thiele, S. Saaro

"Thermally Sprayed TiO_2-Cr_2O_3 Coatings with Multifunctional Properties"

International Thermal Spray Conference & Exhibition, 2.-4. Juni 2008, Maastricht, Niederlande

[T109] **is** C. C. Stahr, L.-M. Berger, F.-L. Toma

"Keramische Schichten im System Al_2O_3-Cr_2O_3-TiO_2 – ausgewählte Entwicklungstendenzen"

4. GTV Kolloquium Thermisches Spritzen, Luckenbach, 5. September 2008,

[T110] J. Standfuß, U. Stamm, G. Göbel, S. Schrauber, B. Brenner

"Future Powertrain Welding Applications Driven by Fiber Lasers"

Automotive Laser Application Workshop 2008 (ALAW 2008), Plymouth (MI), USA, 13.-15. Mai 2008

[T111] T. Stucky, V. Weihnacht, S. Bräunling

"Potential von ta-C-Schichten für die Trockenumformung"

3. Workshop "Kohlenstoffschichten - tribologische Eigenschaften und Verfahren zu ihrer Herstellung", Dortmund, 4. Juni 2008

[T112] A. Techel

"Lasersysteme und Photovoltaik – eine Einführung"

Lasersysteme und Photovoltaik, Fellbach/Stuttgart, 22.-23. April 2008

[T113] A. Techel

"Technologievorsprung durch Laser- und Oberflächentechnik"

Fokus Technologie, Stuttgart, 30.-31. Oktober 2008

[T114] F.-L. Toma, L.-M. Berger, D. Jacquet, D. Wicky, I. Villaluenga, Y.R. de Miguel, J.S. Lindeløv

"Comparative Study on the Photocatalytic Behaviour of Titanium Oxide Thermal Sprayed Coatings from Powders and Suspensions"

2nd International Workshop on Suspension and Solution Thermaly Spraying, Tours, 5.-7. Juni 2008

[T115] F.-L. Toma, L.-M. Berger, D. Jacquet, D. Wicky , I. Villaluenga, Y. R. de Miguel, J. S. Lindeløv

"Vergleichende Untersuchungen zu den photokatalytischen Eigenschaften von thermisch gespritzten Titanoxidschichten aus Pulvern und Suspensionen"

11. Werkstofftechnischen Kolloquium, Chemnitz, 1.-2. Oktober 2008

[T116] F.-L. Toma, L.-M. Berger, T. Naumann, S. Langner

"Characterisation of Ceramic Nanostructured Coatings Prepared by Thermal Spraying of Suspensions"

International Thermal Spray Conference & Exhibition, 2.-4. Juni 2008, Maastricht, Niederlande

[T117] S. Tschöcke, I. Dani, V. Hopfe

"Kontinuierliche Großflächenbeschichtung von transparenten, kratzbeständigen SiO_2-Schichten mittels DC-Arc-PECVD bei Atmosphärendruck"

4. Thüringer Grenz- und Oberflächentage, Jena, September 2008

[T118] V. Weihnacht

"Nanostructured Carbon Coatings for Wear Resistance and Friction Reduction"

Seminars and Lab tours "Nanotechnologies for Energy and Energy Efficiency" Dresden, 13. März 2008

[T119] V. Weihnacht

"Mechanisch-tribologische Anpassung durch ta-S-basierende Schichtsysteme"

3. Workshop "Kohlenstoffschichten - tribologische Eigenschaften und Verfahren zu ihrer Herstellung", Dortmund, 4. Juni 2008

[T120] V. Weihnacht

"Amorphe Kohlenstoffschichten und deren tribologische Eigenschaften"

Institutskolloquium MPA TU Darmstadt Darmstadt, 19. Juni 2008

[T121] V. Weihnacht

"Diamantartige Kohlenstoffschichten mit Potenzial zur Trocken-Blechumformung"

1. Workshop "Oberflächen für die Produktion - dünne Schichten in geschmierten und ungeschmierten Systemen", Dresden, 17. Oktober 2008

[T122] V. Weihnacht, A. Brückner

"Optimized ta-C-Based Coating Systems for Lubricated Conditions"

Seminar Hanser-Verlag "Funktionale Schichten", Fellbach, 11.-12. März 2008

[T123] V. Weihnacht, A. Brückner

"Optimized ta-C-Based Coating Systems for Lubricated Conditions"

Workshop "Friction, Wear and Wear protection", Aachen, 9.-11. April 2008

[T124] V. Weihnacht, A. Brückner, S. Bräunling

"Diamantartige Kohlenstoffschichten mit Potenzial zur Trockenumformung"

EFB-Kolloquium, Dresden, 3.-4. April 2008

[T125] V. Weihnacht, H.-J. Scheibe

"Friction and Wear Behaviour of Modified Diamondlike Carbon Films"

16th International Colloquium Tribology, Stuttgart, 15.-17. Januar 2008

[T126] V. Weihnacht, H.-J. Scheibe, A. Leson

"ta-C and Modified ta-C:X Films for Demanding Tribological Applications"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T127] B. Weller, I. Jansen, S. Tasche

"Adhesive Joints With Acrylates in Glass Structures"

Euradh 2008 / Adhesion ´08, 10th Internat. Conf. Sci. & Techn. Adh., Oxford, UK, 3.-5. September 2008

[T128] S. Winkler, S. Braun, P. Gawlitza, D. C. Meyer

"Fabrication and Characterization of Multilayered Thermal Barrier Coatings"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

[T129] O. Zimmer

"Hard Coatings Thicker Than 20 Microns - an Experimental Study"

HIPIMS Days, Venlo, Niederlande, 7.-8. Juli 2008

[T130] O. Zimmer; F. Kaulfuß

"Hard Coatings with Elevated Film Thickness Prepared by PVD"

11th International Conference on Plasma Surface Engineering, Garmisch-Partenkirchen, 15.-19. September 2008

If you would like to receive more information, please tick corresponding items below and send a copy of the page by mail or fax to the IWS.

I am interested in:

- The brochure "Germany's Elite-Institutes - Fraunhofer IWS Dresden" (in German)
- The brochure "Germany's Elite-Institutes - Fraunhofer IWS Dresden" (in English)
- The brochure "One-Stop Solutions" (in German)
- The brochure "One-Stop Solutions" (in English)

- Annual Report 2006 (in English)
- Annual Report 2007 (in English)
- Additional copy of the 2008 Annual Report

Address:

Fraunhofer Institute for
Material and Beam Technology IWS
(Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS)

Contact: Dr. Ralf Jäckel

Winterbergstraße 28
01277 Dresden

phone: +49 (0) 351 2583 444
fax: +49 (0) 351 2583 300
e-mail: ralf.jaeckel@iws.fraunhofer.de

website: www.iws.fraunhofer.de

Please send me material about the following processes and methods:

Area PVD- and nanotechnology

- Multilayers for x-ray optical applications
- Diamor® - Superhard amorphous carbon films on tools for machining and forming of metals and polymers
- Diamor® - Superhard amorphous carbon films for components of packaging and food processing machines
- Laser-acoustic technique for testing coatings and material surfaces LAwave®
- Laser-Arc module for the deposition of super hard amorphous carbon coatings

Area CVD thin film technology

- FTIR spectroscopy for CVD diagnostics
- Optical spectroscopy of surfaces and films

Area thermal coating

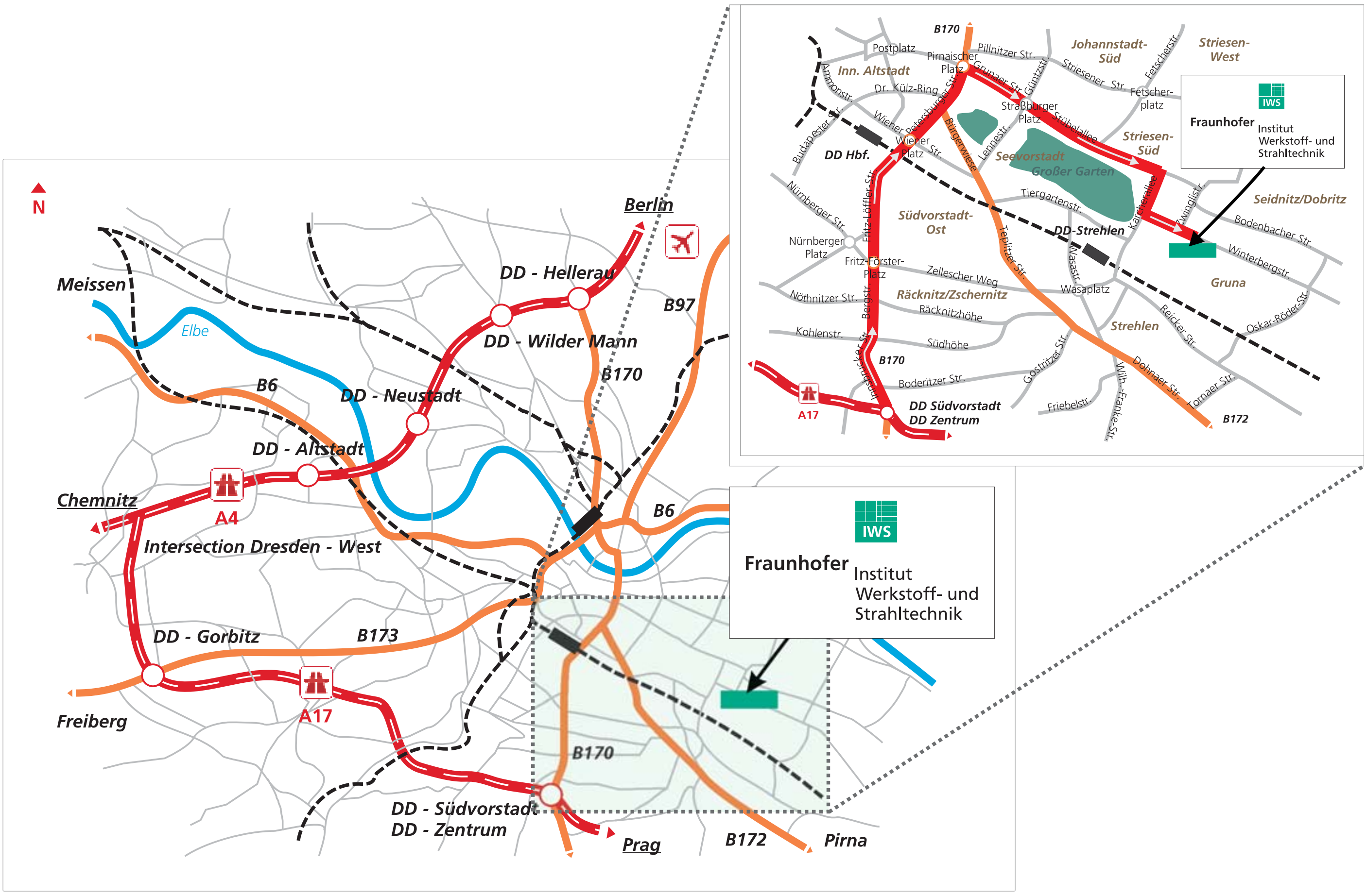
- COAXn: powder nozzles for laser precision built-up welding
- Laser rapid prototyping - a process for the fast manufacturing of functional samples
- Rapid prototyping of metallic parts through laser liquid phase sintering of composite powders
- Advanced coating solutions: Thermal Spray

Area joining and surface treatment

- Laser beam welding and hybrid welding processes
- Laser beam welding with high power diode lasers
- Inductively supported laser materials processing
- Technological developments for the aerospace industry
- Materials characterization for new processes and products
- GEOPT - Software for laser beam hardening

Area system engineering / laser ablation and cutting

- lasertronic® - Systems made by Fraunhofer IWS Dresden
- lasertronic® - High-speed beam scanning for laser beam welding
- Shape precision high-speed laser cutting
- Laser beam ablation of thin surface layers
- Patina excavating with laser beam
- Micro cutting and drilling with ultraviolet light
- Microstructuring of ceramics with excimer lasers
- Slip-free modification of natural stone surfaces



Directions:

by car (from Autobahn / Highway)

- take Autobahn A4 or A13 to intersection Dresden-West, follow new Autobahn A17 to exit Südvorstadt / Zentrum
- follow road B170 in direction Stadtzentrum (city center) to Pirnaischer Platz (about 6 km)
- at Pirnaischer Platz turn right towards "Gruna / VW-Manufaktur"
- continue straight until the end of the "Großer Garten" (Great Garden) and then turn right onto Karcherallee
- at the next traffic light turn left onto Winterbergstraße and continue straight until IWS

by railway and tram

- from Dresden main railway station take line #10 to Straßburger Platz
- change to line #1 or #2 heading out from the city (toward Kleinzschachwitz or Prohlis); exit at Zwinglistraße stop
- 10 minutes to walk from there (in the direction of Grunaer Weg) or one station by bus # 61 (in the direction Löbtau)

by air plane

- from Airport Dresden-Klotzsche with a taxi to Winterbergstraße 28 (distance is approximately 7 miles or 10 km)
- or with public transportation (shuttle train) to the main railway station (Hauptbahnhof), and continue with the tram

Institute address:

Fraunhofer-Institut
für Werkstoff- und Strahltechnik
(Fraunhofer Institute
for Material and Beam Technology)

Winterbergstr. 28
01277 Dresden, Germany

phone: +49 (0) 351-2583-324
fax: +49 (0) 351-2583-300
info@iws.fraunhofer.de
www.iws.fraunhofer.de

Editorial notes

Editorial staff:	Dr. Ralf Jäckel Karin Juch Dr. Anja Techel	
Coordination / editing:	Karin Juch Dr. Ralf Jäckel	
Photos:	page 6 (top l. pic.):	Fraunhofer IWS / TU Wrocław
	page 7 (top m. pic):	teamtechnik Maschinen und Anlagen GmbH Freiberg
	page 28 (top):	EMAG Lasertech GmbH Salach / Heubach
	all other pictures:	Fraunhofer IWS Dresden
Quotations:	The quotations are translated faithfully to their meanings.	