Fraunhofer Institut
Werkstoff- und
Strahltechnik

Annual Report 2003

Internet: www.iws.fraunhofer.de

Fraunhofer Institut Werkstoff- und Strahltechnik

Annual Report 2003

Prologue

Editor: The year 2003 was very difficult for the German economy and the Fraunhofer Society. How did the IWS do?

Prof. Beyer: Against the odds we achieved a double-digit growth in 2003. Our industrial revenues increased by more than twenty percent.

Editor: That is really remarkable. And how did you achieve these excellent results?

Prof. Beyer: It was clear to us from the beginning that we would receive less funding from public sources. Therefore we increased our investment in public relations by heavily participating in trade shows, workshops, and conferences. We took a high risk but remained successful due to the great efforts of all employees.

Editor: Are there some outstanding projects you could mention?

Prof. Beyer: It is always a special achievement if we manage to transfer an IWS development into production. During the last years we were very proud when we had two or even three such transfers. In 2003 we had a total of thirteen development transfers to industry. This is an incredibly high number. While some of these are still confidential, we will introduce others on the following pages.

Editor: Research Funding through state and federal governments will further decrease in 2004. How will the IWS position itself towards these continuously more difficult research and development conditions?

Prof. Beyer: Year 2003 was an extraordinarily successful year for the IWS. In order to keep up with this success while facing continuously decreasing financial support from the government, we have to again clearly increase our industrial revenues. In addition, in 2004 we will be facing downtime as a result of the planned move of different groups and laboratories into the new extension of our facility. 2004 will be by all means a very interesting year. "We will see how it develops…"

Editor: Thanks you very much for the interview.

To judge the past
to organize the present
to lead into the future

Fraunhofer-Institut für
Werkstoff- und Strahltechnik IWS

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Contents

IWS Organizes Nanofair 2003 - An International Nanotechnology Symposium in Dresden

The second international nanotechnology symposium was held in Dresden from November 20 - 21, 2003, with the motto "New ideas for industry". The event is a joint effort between the cities of Dresden, Karlsruhe, and Strasbourg, and is supported by the Association of German Engineers (VDI). The IWS was in charge of the scientific administration and program of the fair. The plenar hall of Saxony's parliament in the heart of Dresden's Old Town offered an attractive site for the event. The symposium focused on nanotechnology research results and applications in the areas of electronics, automotive, materials, optics, and life sciences. The presence of more than 300 participants from 14 countries including 100 industrial representatives guaranteed lively discussion during the conference, which was complemented by an industry exhibition.

Edelgard Bulmahn, Federal Minster of Education and Research, during the opening ceremony of the Nanofair 2003

Opening ceremony of the Nanofair 2003 in the Saxony parliament

Press conference on the opening of the Nanofair 2003

View of the plenar hall of the Saxony parliament during the opening ceremony of the Nanofair 2003

New EUV Reflectometer - Developed and Assembled at the IWS

For the first time in Europe, a compact reflectometer operating at extreme ultraviolet (EUV) wavelengths from 10 - 16 nm has been developed and assembled. This EUV reflectometer is the result of a project that has been funded by the Federal Ministry of Education and Research (BMBF). The IWS as the program managing institution cooperated with Carl Zeiss SMT AG Oberkochen, the Physikalisch-Technische Bundesanstalt (PTB is the national metrology institute in Germany) Berlin, the Max Born Institute Berlin, the Bestec GmbH Berlin, and the AIS Automation Dresden GmbH. This reflectometer enables a more effective development of EUV optics.

Sample chamber of the EUV reflectometer

Laser welding system for the joining of differential transmissions (system integrator Arnold)

Part feeder of the laser welding system

Laser Welding and Laser Induction Welding: IWS Process Development for Industrial Manufacturing

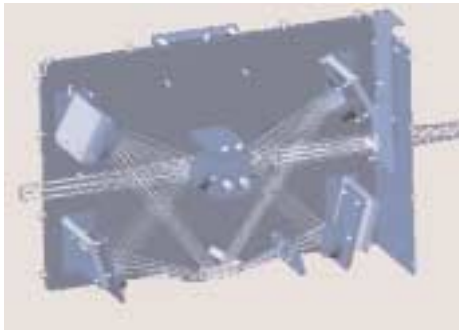
Once again IWS succeeded in transferring two induction assisted laser welding systems to industrial manufacturing. One unit was installed at Daimler Chrysler in Stuttgart while Visteon in Dueren received their third system in 2003. With these installations there are now a total of eight laser induction systems implemented in series production. At the same time two more laser welding systems have been transferred to production at Winkelmann Palsis in Ahlen and ZF.

For the first time the latter system is capable of welding cast iron with case hardened steel. The process integrates a laser cleaning and sensors to control the mixing in the welding seam.

System for the induction assisted laser welding of automotive drive shafts at Visteon in Dueren (system integrators Arnold and EMAG)

FTIR Quality Control of 300 mm Wafers

A Fourier transformation infrared spectroscopy (FTR) based spectrometer has been developed for the quality control of 300 mm wafers and other pre-manufactured products and extended parts. With the system the lateral distribution of optical properties and the wafer topology (film thickness, roughness) can be easily measured. The IWS results are important for the development of quality control concepts for coating processes of large wafers. They are very interesting for the local semiconductor manufacturing companies for example.



Optical simulation for the design of the FTIR reflection measurement system

New measuring device for FTIR quality control of wafers

Development of a laser hardening process under protective gas for injection system parts

Laser Hardening: IWS Process Development for Industrial Manufacturing

A laser hardening process for injection systems has been developed for Siemens VDO Automotive in Limbach-Oberfrohna, Saxony. The process was then transferred to series production at Sitec Industrietechnologie Chemnitz. The system incorporates the temperature adapted laser power control system lasertronic® LompocPro that IWS developed, and the process development was performed at the IWS in Dresden.

Laser Hardening: IWS Process Development for Industrial Manufacturing

A total of three laser hardening systems have been transferred to production in 2003. The systems are used to harden turbo charger shafts at BorgWarner in Kirchheimbolanden (Rheinland-Pfalz). The biggest development task challenge was to be able to precisely harden 90 different types of shafts. The temperature adapted laser power control system lasertronic® LompocPro developed by IWS was the key for the successful development.

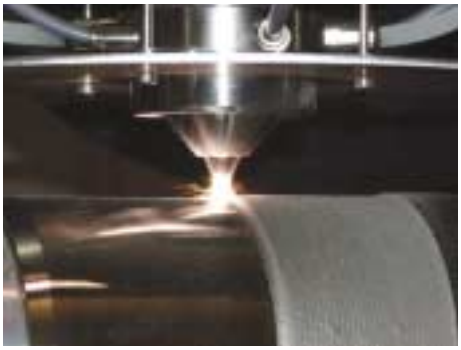
The hardened turbo charger shafts are used in exhaust gas turbo chargers of commercial vehicles from almost all manufacturers (i.e. DaimlerChrysler, MAN, Volvo, DAF, IVECO).

Laser hardening system at Sitec Industrietechnologie Chemnitz

Laser hardening system in series production at BorgWarner in Kirchheimbolanden (system integrator EFD)

Industry Transfer of Modular Powder Nozzles COAXn

A total of 35 powder nozzle systems for laser powder deposition welding processes have been installed worldwide since the year 2000. During the last year 6 more systems including the technology have been transferred to repair forming tools, aircraft engines, and stationary gas turbines. The customers were from Germany, Finland, Japan, and the USA.



Laser powder deposition welding of the wear ring of an industrial oil drill tool

Industry Transfer of a Robot Controlled Remote Welding System for Nd:YAG Laser

A robot controlled beam deflection system has been developed in the framework of the European "remoweld" program. The system has been implemented in production at the site of the Italian project partner Salvagnini in Sarego, Italy. The company is using the system to weld metal drawers for tool cabinets.

Remote laser welding system at Salvagnini (Italy)

System to weld high-quality steel pipes at Abrecht Zwick GmbH, Hagen

Industry Transfer of a Laser System for the Welding of Pipes

Laser welding is a modern welding process that enjoys widespread industrial applications, especially in mass production. With the help of an IWS technology, the company Albrecht Zwick GmbH in Hagen, Nordrhein-Westfalen, has been welding high-quality steel pipes (square cross section of the materials 1.4301, 1.4571, 1.4003) since the summer 2003.

Successful Recertification According to ISO 9001:2000

In October 2003 IWS passed a recertification audit of its quality management system according to the ISO 9001:2000 industry standard. In 1997 the IWS was the first Fraunhofer Institute that successfully implemented a quality management system following the ISO 9001 standard in all areas.


CERTIFICATE

DIN EN ISO 9001:2000

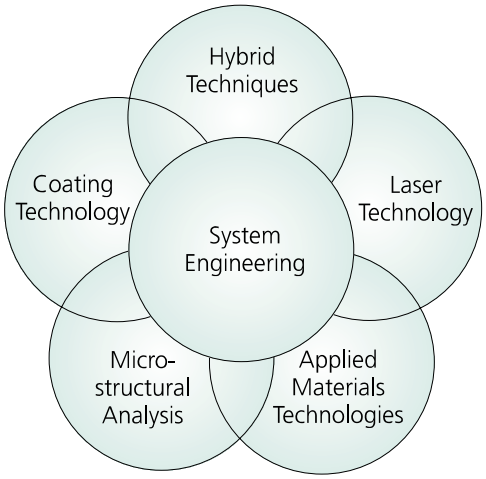
All areas at IWS are certified according to ISO 9001:2000

The secret of all inventors is
to think of nothing as being impossible.
Justus von Liebig

Overview

The Fraunhofer Institute for Material and Beam Technology conducts application-oriented research and development in the areas of laser and surface technology.

Key points are:
- Laser beam welding, cutting and ablation,
- Surface treatment as well as
- The deposition of thin films.



The main working areas of IWS, which enable us to provide you with one-stop solutions

A special feature of the IWS is the experience in beam and coating technologies in combination with a profound know-how in materials and comprehensive capabilities of material characterization. In order to offer optimized solutions for industrial production, we exploit the option of coupling beam technologies with other power sources. This leads to so-called *hybrid technologies*, which combine advantages of laser techniques with special features of other techniques in a cost-effective manner.

Through the close collaboration with system suppliers and equipment manufacturers, we are able to offer our customers *one-stop solutions* based on novel concepts. As a basis for this, the working system, the process, and the component performance must all be taken into overall consideration. The excellent facility at IWS enables us to respond to customer's requests with state of the art equipment. Furthermore, we are capable of running pilot production and testing, in house.

Laser Technology

- Laser welding and soldering
- Laser hardening, re-melting and cladding
- Laser surface modification with additional materials (alloying and disperging)
- Repair coatings
- Rapid prototyping
- Laser cutting and parting
- Laser cleaning and ablation (for restoration and technical purposes)
- Laser finishing
- Microstructuring, engraving and marking

Thin Film Technology

- Thin film technology on the basis of laser, vacuum arc, CVD, sputtering and electron beam processes
- Film systems and processes for hard coatings with carbides, nitrides, oxides, etc.
- Super hard amorphous carbon films
- Nanometer multilayer films for X-ray optical components
- Atmospheric pressure plasma-assisted CVD and atmospheric pressure laser-assisted CVD
- Plasma spraying

Hybrid Processes

- Induction assisted laser welding of heat treatable steels
- Plasma augmented laser processing (welding, re-melting)
- Laser assisted plasma spraying
- Thin film deposition through combined laser, vacuum arc, electron beam and CVD processes
- Modeling of short time heat treatment processes

Materials Testing

- Characterization of laser irradiated materials and components
- Wear and fatigue tests
- Mechanical, tribological and optical film properties
- Thermal shock resistance and temperature stability of ceramics
- Failure analysis

Structure Analysis

- Metallographical material characterization
- Structure analysis with electron-microscopy (REM, TEM)
- Characterization of surface properties with optical spectroscopy

System Technology

- Development of system components such as high speed beam scanners, flexible laser beam shaping units and welding monitors
- Optimization of laser machining systems
- Process diagnostic of PVD and CVD processes
- Coating modules for atmospheric pressure plasma CVD and PVD processes

Our Offer

We offer one-stop solutions in:

- Consulting
- Feasibility studies
- Contract research and development
- Process testing
- System development jointly with industrial partners
- Design and implementation of pilot systems
- Material and component testing
- Failure analysis
- Training of scientists, engineers, operators and laboratory assistants

Contacts

The Fraunhofer IWS offers you service and contract work and guarantees strict confidentiality upon request.

Business fields	Core services	Laser processing tech.	Coating processes	Materials tech./Analysis	Simulation	System technologies
Joining						
Welding	■	■		■	■	□
Soldering	■	■		■		
Adhesive bonding	■		■	■		
Cutting	■	■				□
Surface technology						
Removal / Cleaning	■	■		■	■	□
Wear protection	■	■	■	■	■	□
Repairs	■	■				□
Friction reduction	■		■	■		□
Oxidation protection	■	■	■	■		□
Functional coatings	■		■	■		□
Microtechnology	■	■	■	■		□
Optics						
X-ray optics, EUV optics	■		■	■	■	□
IR optics	■		■	■	■	
Rapid prototyping, Rapid tooling	■	■		■		□
Process monitoring	■	■	■			□

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Organization and Contacts

External Project Groups

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Executive Director Prof. Dr. Beyer
Deputy Director Dr. Leson
Assistant Mrs. Weinberg
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Infrastructure

Head of Administration
Dr. Wilhelm
Tel.: 312

Public Relation Manager
Dr. Jaeckel
Tel.: 444

Surface Engineering and Coatings

Laser Materials Processing

X-Ray and EUV-Optics
Dr. Leson
Tel.: 317

- **Coating** — Mr. Braun, Tel.: 432
- **Metrology/ Applications** — Dr. van Loyen, Tel.: 422

PVD Thin Film Technology
Dr. Schultrich
Tel.: 403

- **Pulsed Arc** — Dr. Siemroth, Tel.: 409
- **PVD Technologies** — Dr. Zimmer, Tel.: 257

CVD Thin Film Technology
Dr. Hopfe
Tel.: 402

- **Atmospheric and in-line CVD** — Dr. Dani, Tel.: 405
- **Process Monitoring** — Dr. Graehlert, Tel.: 406

Thermal Coating
Dr. Nowotny
Tel.: 241

- **Thermal Spraying** — Dr. Berger, Tel.: 330
- **Cladding** — Dr. Techel, Tel.: 255

Joining/Surface Treatment
Prof. Dr. Brenner
Tel.: 207

- **Welding** — Dr. Standfuß, Tel.: 212
- **Surface Treatment** — Dr. Bonß, Tel.: 201

Laserablation and Cutting
Dr. Morgenthal
Tel.: 322

- **Laser Cutting** — Dr. Morgenthal, Tel.: 322
- **Microprocessing/ Cleaning** — Mr. Klotzbach, Tel.: 252

Materials Testing and Characterization
Prof. Brenner / Dr. Winderlich, Tel.: 207 / 224

System Engineering and Laser Processing
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Dr. Voellmar
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Tel.: 201

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Production technology
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TU Dresden

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 2003, 35 colleagues were employed in the university department. The third party revenues yielded more than 1,5 Mio. €.

The department of laser and surface technology is the driving component of the institute for surface technology and production metrology, which was newly founded on July 1, 2003, 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

The following courses were offered:
- Prof. Beyer: Manufacturing technology II, (Surface and coating technology)
- Dr. Schultrich, Prof. Beyer: Thin film technologies
- Dr. Leson, Prof. Beyer: Surface engineering / Nanotechnology
- Prof. Beyer: Laser basics / Laser system technology
- Prof. Beyer: Laser and plasmas in the production technology

Cooperation Fraunhofer IWS - TU Dresden

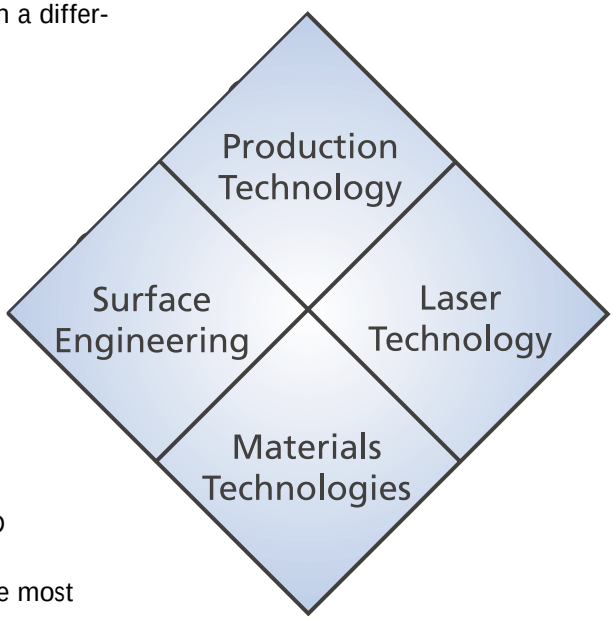
A special agreement regulates the cooperation between the IWS and the TU Dresden. Prof. Beyer works simultaneously as the executive director of the IWS as well as a chairman at the University. The work is distributed as follows: Research and education are performed at the university and applied research 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

Science needs cooperation,
in which the knowledge of the one gains
from the discovery of the other.
Jose Ortega y Garset

TU Dresden



CD for manufacturing technology course (II)

CD laser lexicon
informations: www.laserlexikon.de

CD for laser technology course

Centers and External Project Groups of the Fraunhofer IWS

Innovations are pillars carrying the future.
Norbert Stoffel

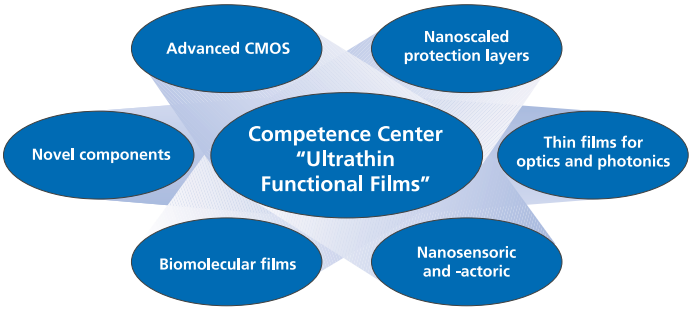
Nanotechnology Competence Center "Ultrathin Functional Films"

Nanotechnology is one of the key technologies for the 21st century. Already there are products in the market such as magnetic storage media and read / write heads for data storage which are covered with nanometer films, or scanning tunnel microscopes which make the world of molecules and atoms visible. Ultrathin films are a key element of nanotechnology. Applications range from microelectronics and optics to medicine and tribological systems.

To consequently explore the possibilities of industrial applications, fifty-one companies, ten university institutes and twenty-two research institutes have formed a know-how network. IWS was awarded the coordination of the network by the Federal Ministry of Research. IWS is one of the main contributors to the Nanotechnology Competence Center, with nanometer film structures for X-ray optics being one prime example.

A highlight in 2003 was the execution of the European nanotechnology symposium "Nanofair 2003". 300 participants from industry and science joined the fair, which was substantially arranged with the help of the IWS.

Opening ceremony of the Nanofair 2003 in the plenary hall of the Saxony parliament



Workgroups of the Nanotechnology Competence Center

Application Center for High Power Diode Lasers

In cooperation with leading laser and equipment manufacturers, the Fraunhofer IWS established a high power diode laser application center with the objective to offer optimized problem solutions to our customers.

Due to their comparatively high efficiency of about 50 % and the very compact design, high power diode lasers are ideal tools for the localized distortion-free hardening and coating. The welding of sheet metal of up to 1 mm in thickness can be done faster and at higher quality compared to conventional welding techniques. In response to customer requirements over the last years, special software products such as post-processors and surface temperature based laser power control packages have been developed, which simplified the application of high power diode lasers for surface engineering and surface refinement tasks as well as improved the process stability.

The application center is capable to accomplish processing tasks with leading know-how and the newest diode laser systems.

Demonstration of a hardening machine with an integrated high power diode laser in the laser hall of IWS

Production Technology Center

The integration of efforts at the IWS and the Technical University Dresden occurs in research, development, and the application of production technology ranging from process development to the design of production flows.

Work emphasis:

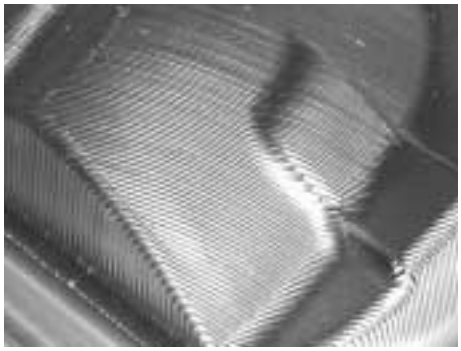
- Process development in conventional and high-speed sector as well as development of hybrid-processes
- Feasibility studies and performance analysis, studies (products, manufacturing processes, technological and logistic process chains)
- Material flow and production simulation
- 3D visualization and animation of products, production chains, and production systems

Rapid Prototyping Center

Time-to-market: the time frame from an idea to the marketing of a new product decides success or failure. This correlation caused the institute's involvement in rapid prototyping and rapid tooling beginning several years ago.

There are several prototyping systems installed at IWS. The capabilities include 3D modeling and data processing, contour scanning, the different processes to produce the models (such as direct metal deposition (DMD) and laser beam sintering (SLS)), laminated object manufacturing (LOM) with sheet metal, and the final processing (milling, coating, measuring) of the tools.

Tools can be manufactured in a fraction of the time needed in the past with the help of MELATO® (Metal Laminated Tooling) as a rapid tooling process.



Surface of a tool made by metal-LOM

Beam technology:
Water jet abrasive cutting machine

Laser integrated CNC milling center

Blank lamellas of a stamping tool

An invasion of armies can be resisted,
but not an idea
whose time has come.

Viktor Hugo

Industrial Project Group at the Dortmund Surface Center (DOC) at the ThyssenKrupp Stahl AG

Dr. Axel Zwick
Manager of the project group at DOC in Dortmund
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Facility of the Dortmund Surface Center

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

The DOC is the largest research and development center in the area of surface treatments for sheet steel in Europe. It was launched in December 2000 on the site of the Dortmunder Westfalenhuette. 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). The Fraunhofer project group demonstrated the case of laser welding in that these new coatings combine the corrosion protection of conventional zinc coatings at half the thickness with a significantly improved machinability of the coated material.

Beyond this the Fraunhofer project group offers in its 1,100 m² 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.

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 worldwide unique mobile 4 kW Nd:YAG laser and a 75 m long optical fiber it is even possible to perform process development or "trouble shooting" directly at the customer's facility.

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

Prof. Jes Asmussen
Center Director
CCL / USA
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The USA activities of the Fraunhofer IWS Dresden are concentrated in the Center for Coatings and Laser Applications. The CCL is headed by Prof. Dr. Jes Asmussen (Michigan State University). Prof. Asmussen is an expert in the area of diamond coatings. His work ideally complements the expertise of the IWS in the area of DLC coatings. Therefore it is the goal to establish a carbon center under his guidance in East Lansing.

The CCL is comprised of two divisions, the "Coating Technology Division" at Michigan State University in East Lansing managed by Dr. Thomas Schuelke, and the "Laser Applications Division" located in the building of Fraunhofer USA Headquarters lead by Christian Walz.

Laser Applications Division
The first year in the Fraunhofer building at Port Street lies behind the CCL laser group. Aside from completing extensive reconstruction work, several new systems have been installed. These include a diode-pumped 4 kW Nd:YAG laser, an 8 kW CO_2 laser, a 5 axis robot and a universal laser hardening machine. These systems extend the substantial equipment base already installed at the center.

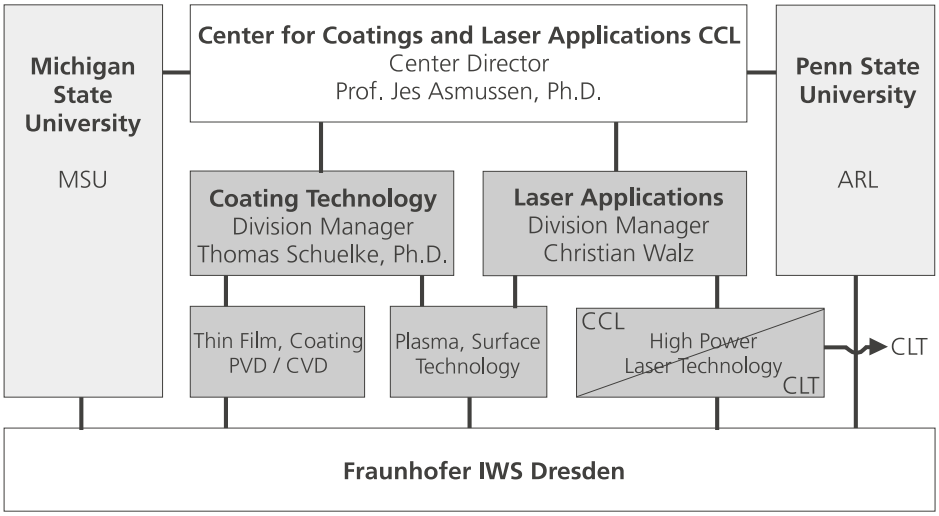
On the project list is the development of laser welding of pressurized parts in a hydro form. The temperature adapted laser power control system that was developed for laser hardening could be successfully used for the laser annealing of transmission parts. Revenues and number of employees increased in 2003.

Coating Technology Division
Since January 2003 CCL's thin film group has been based in East Lansing, Michigan. The group occupies about 500 m^2 in laboratory and office space at Michigan State University. The technology spectrum of the group has been substantially increased due the cooperation with the university. In addition to the originally offered PVD technologies the group now works on microwave based CVD and material processing techniques. The tight integration with the university enables the group also to offer extended characterization services (material composition, electron microscopy, nano-indentation, atomic force microscopy) and process development services for the manufacturing of micro-electro-mechanical systems (MEMS).

Outstanding projects this year included the development of micrometer thick freestanding diamond foils, which are used at the high-energy ion accelerator at the university, as well as the development of MEMS based eye pressure sensors.

Building of CCL, CLT, and Fraunhofer USA Headquarters in Plymouth, Michigan

Building of CCL in East Lansing, Michigan



Institute Equipment

Technology does not save any time, but it distributes it in a different way.
Helmar Nahr

View of the IWS technology hall

High-speed laser cutting machine

Atmospheric plasma spraying with laser coupling

Laser Systems

Several CO_2 laser, 2 to 6 kW (HF-pumped)

Several Nd:YAG laser to 4.4 kW cw (lamp and diode pumped) and 1 kW pm laser

Nd:YAG laser system with pulse widths in the millisecond, nanosecond and picosecond range for the fine machining

Several high power diode lasers, 1.4 to 2.5 kW

TEA CO_2 laser

Excimer laser (248 nm)

Frequency-multiplied Nd:YAG laser (532 and 355 nm)

Pulsed Nd:YAG laser with OPO

Handling Systems

Gantry with 5 CNC-axes (plus external rotating axis) work range 4000 · 3000 · 1500 mm^3, with 2.5 to 6 kW CO_2 laser beams

CNC-laser processing equipment with 8 axes, speed up to 20 m min^{-1}, working range of 2400 · 1800 · 600 mm^3, with 2.5 to 6 kW CO_2 laser beams

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

Precision machines (accuracy class 5 µm) with 5 and 4 CNC-axes, with 6 kW CO_2 laser beams

Combined CO_2 and Nd:YAG machine (2 or 3 kW) with 4 CNC-axes for precision cladding

Cutting machine with linear drives up to 300 m min^{-1} feed with 3.5 kW CO_2 laser beams

Universal Excimer-laser-micromachine

Coating Systems

Laser PVD (LPVD) coating device (Nd:YAG, Excimer, TEA CO_2 laser) in high vacuum and ultra high vacuum

Equipment for film deposition with vacuum arc technology (Laser-arc, pulsed high current arc, DC-arc, plasma filter)

Laser CVD device with 6 kW CO_2 laser and lamp CVD machine (24 kW) for fiber coating

Devices for plasma-assisted CVD coating at atmospheric pressure (6 kW microwave, 30 kW dc-Arc)

Six inch-cluster tool for combined large area PLD and magnetron sputtering

Hybrid coating equipment: 40 kW electron beam and high current arc

Devices for atmospheric and vacuum plasma spraying with robot handling (APS, VPS)

Device for laser assisted atmospheric plasma spraying (LAAPS)

Special Components

Static and flexible dynamic beam shaping systems for beam power up to 10 kW

CNC sensor controlled wire feeder for laser welding

Mobile medium and high frequency induction sources (4 - 20 kHz, 100 - 400 kHz)

Power feeder and special equipment for independent laser cladding as well as temperature measurement system for process control

SCOUT sensor system for 3D shape recording (automatic teach-in) for laser handling of components (on-line / off-line contour tracing)

Beam diagnostic system for CO_2 and Nd:YAG laser

UV / VIS, FTIR und NIR diode laser spectrometer for process gas and plasma diagnostic

Camera system for short-time process analysis (4 channel high speed framing camera with 5 ns exposure time)

Special Equipment

Mobile 4 kW Nd:YAG laser in a container

Equipment for rapid prototyping by laser sintering

Portable Nd:YAG laser (6 ns pulses of $5 \cdot 10^7$ W, repetition rate up to 20 Hz) with articulated beam guide and zoom optic (Art-Light NL 102) for outdoor cleaning

Turnable laser handling system (400 ... 2000 nm, > 100 mJ) with flexible beam guide and controlled motion for the ablation of thin layers

Laser handling station with industrial robot system and CO_2 slab laser

CNC treatment center for 5-axis milling and built-up welding

Laser integrated milling center for generating and repair

Mobile equipment for anti-slip equipment of tiled floors (by diode pumped Nd:YAG laser)

Measurement Instruments

Materials analyses including:
- Metallography
- Analytical transmission electron microscopy
- Analytical scanning electron microscopy
- Adequate sample technique preparations

Materials testing:
- Servo hydraulic testing system
- Mechanical stress / strain tester
- Pendulum impact tester
- Automatic hardness tester
- Computer controlled micro hardness test system
- High frequency fatigue tester
- Flat bending torsion machine
- Different wear testing systems (abrasive, cavitation, oscillating wear)

Laser acoustic systems for measuring the Young's modulus of thin films

Laser shock instrumentation with high speed pyrometer

Equipment for surface analysis:
- Automatic spectral ellipsometer (270 - 1700 nm)
- UV / VIS spectrometer
- Raman micro spectrometer
- FTIR spectrometer, FTIR microscope
- Depth sensing indentation device
- Scratch tester
- Profilometer
- Tribometers
- X-ray florescence film thickness measuring device
- Sheet resistivity measuring device

X-ray diffractometer (CuKα)
X-ray diffractometer (MoKα)

Optical 3-D coordination system

Vacuum plasma spraying

Laser-Acoustic measurement station for the non-destructive determination of thin film properties, acknowledged through the "R&D 100 Award 2001" in the USA

Laser-Arco® - the technology to deposit Diamor®

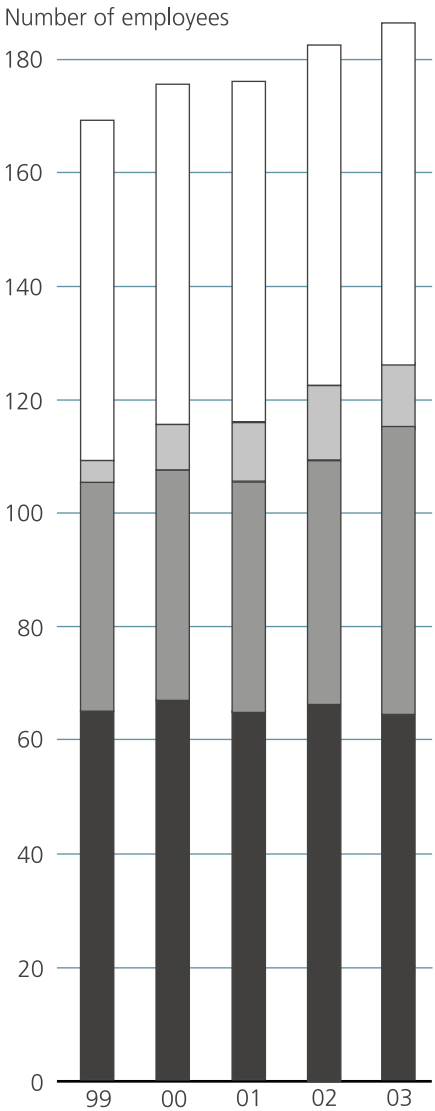
The phone book is full of facts, but it does not contain a single idea.
Mortimer J. Adler

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 2003 the employees are divided up as follows:

Employees of Fraunhofer IWS	Number	Employees of Chair for Laser and Surface Technology of TU Dresden	Number
Staff	115	Staff	35
- Scientists	64	- Scientists	27
- Technical staff	42	- Technical staff	6
- Administrative staff	9	- Administrative staff	2
Apprentices	12		
Research assistants	60	Research assistants	8
Total	187	Total	43



Building	5050 m^2
- Processing technology area	1200 m^2
- Lab space, workshops	1760 m^2
- Office space	1550 m^2
- Conference rooms, seminar rooms etc.	540 m^2
Technology area at the DOC (Dortmund)	1100 m^2

Budget and Revenue 2003 (preliminary*)

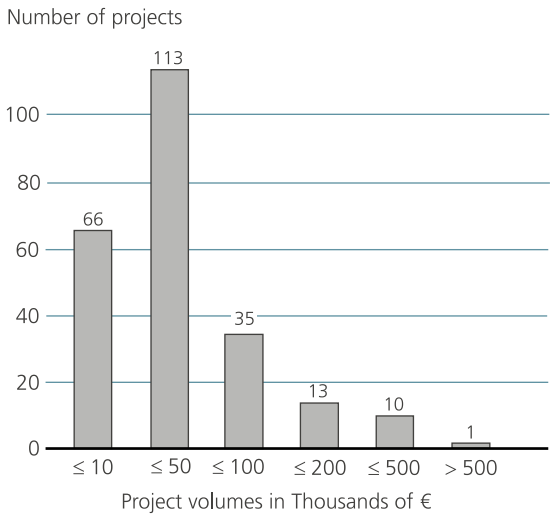
* Actual cost determination not yet finalized

	Mio. €	
Operational costs and investments 2003	14.6	
Budget	12.4	
- Cost of sales	6.0	
- Other expenses	6.4	
Investment	2.2	
	Mio. €	%
Revenue 2003	14.6	
Revenue operations	12.4	
- Industrial revenues	6.6	53
- Revenues of public funded projects	3.3	27
- Base funding IWS	2.5	20
Revenue investment	2.2	
- Industrial revenues	0.1	
- Revenues of public funded projects	1.1	
- Base funding IWS	1.0	

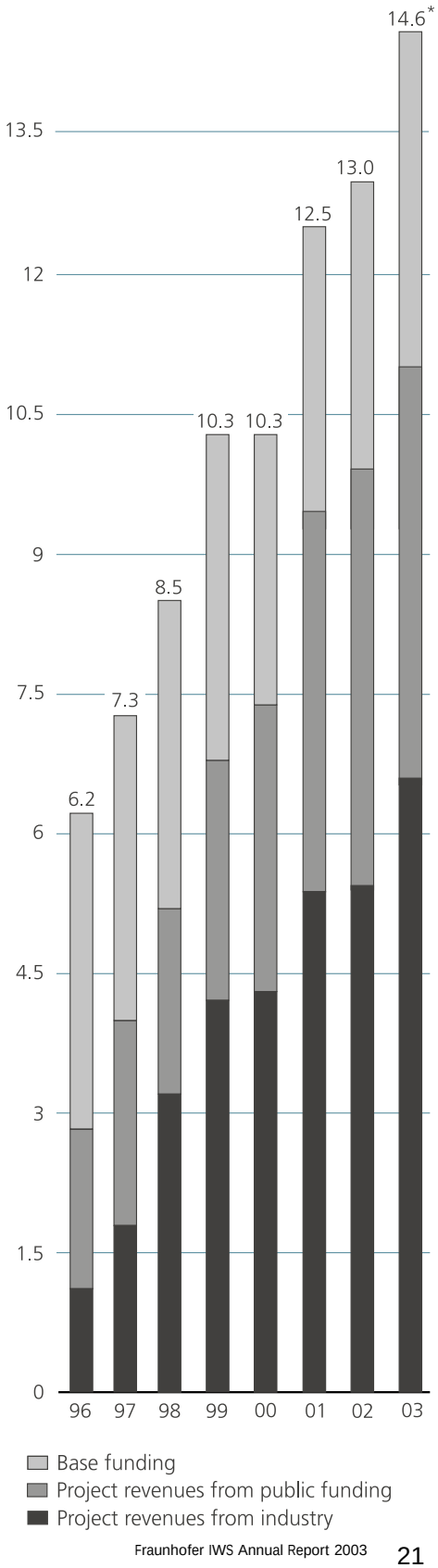
In 2003 IWS received additionally 1.0 Mio. € as strategic investment from the Fraunhofer Society.

Projects

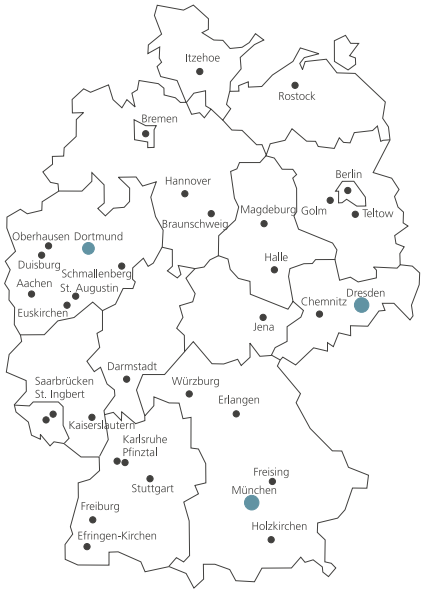
In 2003, IWS handled 238 projects. The distribution of the projects with respect to their volume is shown in the graphic below. One hundred thirteen of the projects were for 10 to 50,000 T€ (Thousands of Euro), for example.



Revenues in operations and investments without strategic investments (in Mio. €)



The state is there for people
and not people for the state.
The same can be said of science.
Albert Einstein



The Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft undertakes applied research of direct utility to private and public enterprise and of wide benefit to society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration. The organization also accepts commissions and funding from German federal and *Länder* ministries and government departments to participate in future-oriented research projects with the aim of finding innovative solutions to issues concerning the industrial economy and society in general.

By developing technological innovations and novel systems solutions for their customers, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. Through their work, they aim to promote the successful economic development of our industrial society, with particular regard for social welfare and environmental compatibility.

As an employer, the Fraunhofer-Gesellschaft offers a platform that enables its staff to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, in other scientific domains, in industry and in society.

At present, the Fraunhofer-Gesellschaft maintains roughly 80 research units, including 58 Fraunhofer Institutes, at over 40 different locations in Germany. A staff of some 12,700, predominantly qualified scientists and engineers, work with an annual research budget of over 1 billion euros. Of this sum, more than €900 million is generated through contract research.

Roughly two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. The remaining one third is contributed by the German federal and *Länder* governments, as a means of enabling the institutes to pursue more fundamental research in areas that are likely to become relevant to industry and society in five or ten years' time.

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

The Fraunhofer-Gesellschaft was founded in 1949 and is a recognized non-profit organization. Its members include well-known companies and private patrons who help to shape the Fraunhofer-Gesellschaft's research policy and strategic development.

The organization takes its name from Joseph von Fraunhofer (1787-1826), the illustrious Munich researcher, inventor and entrepreneur.

The Advisory Committee

The advisory committee supports and offers consultation to the Fraunhofer IWS. Members of the advisory committee in 2003:

P. Wirth, Dr.
Chairman of Rofin-Sinar Laser GmbH, Committee Chair
(since March 2003)

O. Voigt, Prof.
Chairman of Windsolar AG, Committee Chair
(until February 2003)

K. Arnold, Prof. Dr.
General Manager of Niles-Simmons Industrieanlagen GmbH
(until June 2003)

R. Bartl, Dr.
Director Production Planning MB Cars der DaimlerChrysler AG

I. Bey, Dr.
Head of Project Board Production and Manufacturing Technology Forschungszentrum Karlsruhe GmbH

H. Buecher, Dr.
Coordinator Innovation Management and Technology Marketing, German Aerospace Center (DLR)

E.-J. Drewes, Dr.
Head of Research, Central Quality and Testing of ThyssenKrupp Stahl AG
(until March 2003)

H. Ennen, MinR. Dr.
Saxony Office, Brüssel

F. Junker, Dr.
Member of the Board of Directors of the Koenig & Bauer AG, Planeta-Bogenoffset

J. Klenner, Dr.
Leader Centre of Competence Engineering Structure, Airbus

P. Lenk, Dr.
General Manager of von Ardenne Anlagentechnik GmbH

P. Linden, Dr.
Head of Production Technology of DaimlerChrysler AG

A. Mehlhorn, Prof. Dr.
President of the Technical University Dresden

R. J. Peters, Dr.
General Manager VDI Technology Center, Physics Technologies

W. Pompe, Prof. Dr.
Technical University Dresden

F. Schmidt, MinDir. Dr.
Saxony Ministry of Science and Art

J. von Schaewen, MinR.
Federal Ministry for Education and Research
(Guest)

R. Zimmermann, MDgt. Dr.
Saxony Ministry of Science and Art
(Guest)

The twelfth committee meeting took place on February 26, 2003, at Fraunhofer IWS in Dresden.

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 Counsel 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 2003 were:
- Prof. Dr. E. Beyer
- Dr. S. Bonß

The 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:

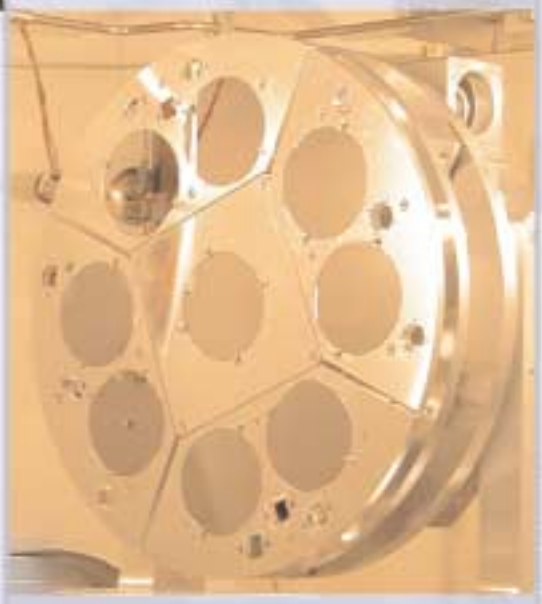
Prof. Dr. E. Beyer	Executive Director
Dr. A. Leson	Deputy Director
Dr. S. Wilhelm	Head of Administration
Prof. Dr. B. Brenner	Department Head
Dr. V. Hopfe	Department Head
Dr. L. Morgenthal	Department Head
Dr. S. Nowotny	Department Head
Dr. B. Schultrich	Department Head

Guests are:

Dr. S. Bonß	WTR Agent
Prof. Dr. U. Guenther	Agent of the Professorship
Dr. R. Jaeckel	PR-Manager
Dr. S. Schaedlich	QM Representative
Dr. B. Schoeneich	Works Committee

Network Surface Engineering and Photonics

The IWS is a member of the network Surface Engineering and Photonics. Members of the network are:
- Fraunhofer FEP Dresden
- Fraunhofer ILT Aachen
- Fraunhofer IOF Jena
- Fraunhofer IPM Freiburg
- Fraunhofer IST Braunschweig
- Fraunhofer IWS Dresden



R&D-Offer: X-ray and EUV Optics

Editor: In a large project in 2003 a EUV reflectometer has been assembled together with Carl Zeiss SMT AG Oberkochen. What is the current status?

Dr. Leson: In October 2003 the system was transferred to Oberkochen, reassembled and successfully demonstrated which marked the end of the project. For the first time in Europe a compact reflectometer operating at extreme ultraviolet (EUV) wavelengths from 10 - 16 nm is now available. This EUV reflectometer is the result of a project that has been funded by the Federal Ministry of Education and Research (BMBF). The IWS, as the program managing institution, cooperated with Carl Zeiss SMT AG Oberkochen, the Physikalisch-Technische Bundesanstalt (PTB is the national metrology institute in Germany) Berlin, the Max Born Institute Berlin, the Bestec GmbH Berlin, and the AIS Automation Dresden GmbH. This reflectometer enables a more effective development of EUV optics. In the past it was always necessary to use an expensive radiation source at the Bessy II in Berlin, with the consequence of loss of time.

Editor: Your department is also successfully engaged in the development of EUV optics. Can you elaborate on this?

Dr. Leson: In the last year we built the first collector optics and a Schwarzschild lens. Strongly curved substrate surfaces have to be precisely coated with gradient layers. This requires the utilization of high precision masks with laterally varying transmission during the deposition process, which has been developed by IWS. By the end of 2003 we could take the first high-resolution pictures.

Editor: Many Fraunhofer Institutes are involved in the area of nanotechnology. How do you cooperate with them?

Dr. Leson: One example is the cooperation between the WISA (scientific strategic alliance) with the Fraunhofer Institute for Photonic Micro Systems (IPMS). Within WISA we performed initial successful tests to smooth substrate surfaces with the goal to improve the quality of micro mirrors for short wavelengths. At the same time we continue to coordinate Nanotechnology Competence Center "Ultrathin Functional Films", which reached its five year anniversary in October 2003. The center has meanwhile grown to 88 members of which 3 joined in 2003.

The biggest enemy of creativity is not making a mistake, it is being lazy.

Henry T. Buckle

Dr. Andreas Leson
Department Head
(Tel. +49 (0) 351 / 2583 317,
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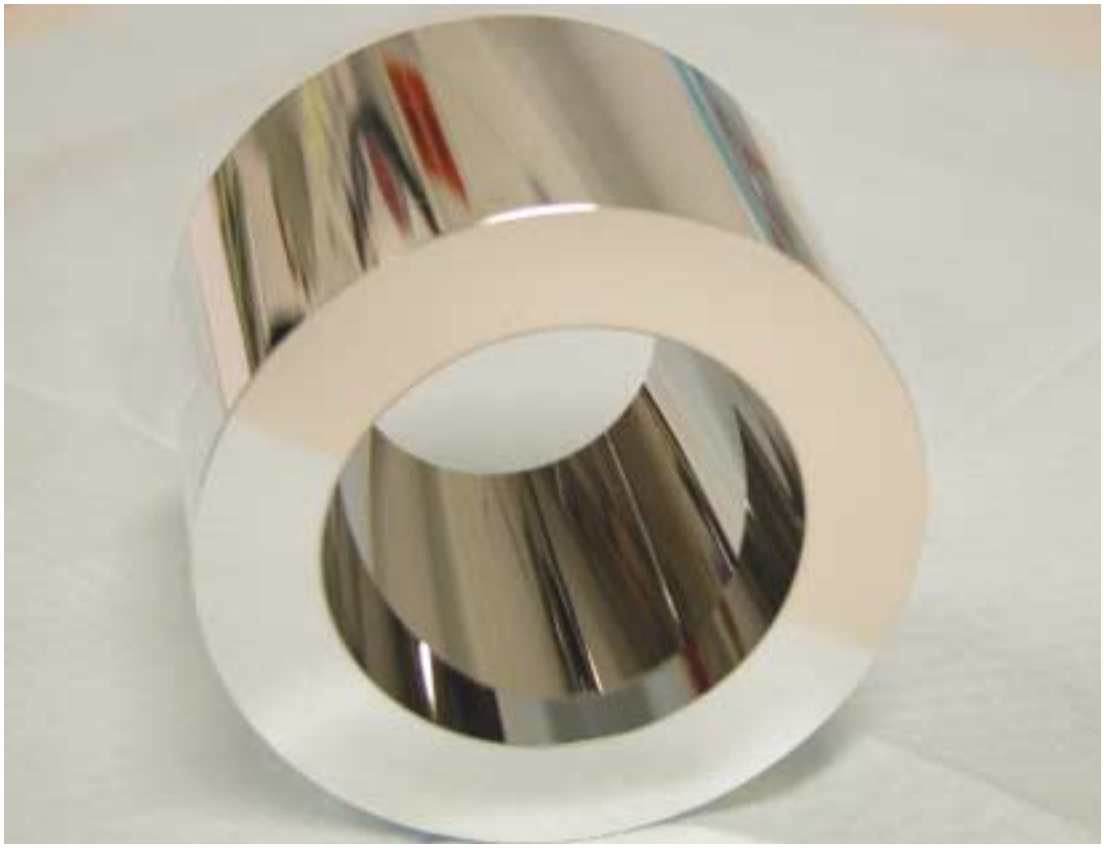
Examples of projects 2003

1. Quality control of EUV optics at operating wavelength with laboratory reflectometer
2. PLD inner diameter coating with superhard carbon for wear and corrosion protection
3. Inner diameter coating of EUV collector optics
4. Reduction and compensation of inner stresses in interface optimized Mo/Si multilayers
5. X-ray optical multilayers for the photon energy range from 900 - 1800 eV



Dipl.-Phys. Stefan Braun
Team Leader Coating
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stefan.braun@iws.fraunhofer.de)

Multilayer Coatings for EUV and X-ray Optical Applications

Single and multilayer coating systems which are deposited through pulsed laser deposition and magnetron sputtering, are distinguished by:
- highest thickness accuracy,
- lowest interface roughness,
- high chemical purity,
- high lateral homogeneity and
- very good thickness reproducibility.

Coating systems of different material combinations can be deposited on plane and curved substrates with diameters of up to 150 mm with and without a gradient of the period thickness.

The main application area of these multilayer coatings is the production of X-ray optical components for beam shaping and monochromizing. Besides the synthesis of single and multilayer coatings according to customer specifications, we also offer our extensive experience in the area of preparation, characterization, and simulation of X-ray optical components.

Substrate loading at an EUV precision coating machine for the manufacturing of nm-multilayer coatings

Dr. Ludwig van Loyen
Team Leader Metrology / Applications
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ludwig.vanloyen@iws.fraunhofer.de)

Metrology and Applications

This group emphasizes on reflectometry, diffractometry, and the development of optical systems and measurement techniques.

Standard X-ray analysis tools apply Cu-Kα or Mo-Kα radiation for non-destructively measuring the coating thickness, roughness, and density as well as the qualitative phase analysis. Measurements are predominantly done on thin and / or multilayer coatings, but also on powders. Special beam shaping optical elements such as beam collimators and beam compressors have been developed to optimize the analysis techniques.

Optical components for applications in the range of extreme ultraviolet (EUV) radiation also require their characterization in the EUV range. Therefore we have developed a special laboratory tool, an EUV reflectometer, for the analysis in the wavelength range form 10 to 16 nm.

Overall view of the EUV reflectometer

R&D-Offer: PVD Thin Film Technology

Editor: A new technology for the coating of hard disks has been developed and transferred to prototype manufacturing in the framework of the Nanotechnology Center of Competence "Ultrathin Functional Films". However, a decision at IBM destroyed the hopes for the initially so promising technology. What is the current status?

Dr. Schultrich: Unfortunate. Over the past years the Fraunhofer IWS developed a high current arc source technology. A modular plasma source was then integrated into an industrial hard disk coater at our partner IBM Germany. The source enabled the deposition of 2 - 3 nm thick carbon films in the desired cycle time of less than one second. Despite the thin thickness which is necessary to achieve storage densities of > 100 GB / in^2, the films provided scratch and corrosion protection. However, the hard disk production was outsourced by IBM as a result of a company internal decision. As a consequence there will be no utilization of our technology in Germany. This was a hard blast for this work direction in my department.

Editor: Nonetheless by the end of the year there appeared some light at the horizon, how come?

Dr. Schultrich: It was very difficult, we tried everything to secure more funding for the continuing qualification of this technology. However, the public funding sources are basically exhausted … then our involved colleagues, spearheaded by Dr. Peter Siemroth, decided together with another Saxony partner to found a new company with the mission to continue the development to commercialization with funding from the "Future" program. The company, Arc Precision Dresden GmbH i.G. registered at the notary public on December 12, 2003. That was a very brave decision. We will support the young company especially through the joint exploration of additional applications, e.g. as protection layers in the micro system technology or as ultra thin barrier coatings.

Editor: There are also new results in the area of superhard Diamor® coatings. 2 … 3 years ago the thickness limit for first-rate adhering films was 1 µm. By the end of 2003 it was 50 µm. Why do we need such thick films?

Dr. Schultrich: Such thick films are a special development for selected X-ray optical applications. For the mainstream application as wear protective coating we prefer (already because of economic reasons) Diamor® films in the thickness range from 1 - 5 µm. The result demonstrates however that we are now able to control the adhesion promoting interface.

He who does not act
won't find help in heaven.
Sophocles

Dr. Bernd Schultrich
Department Head
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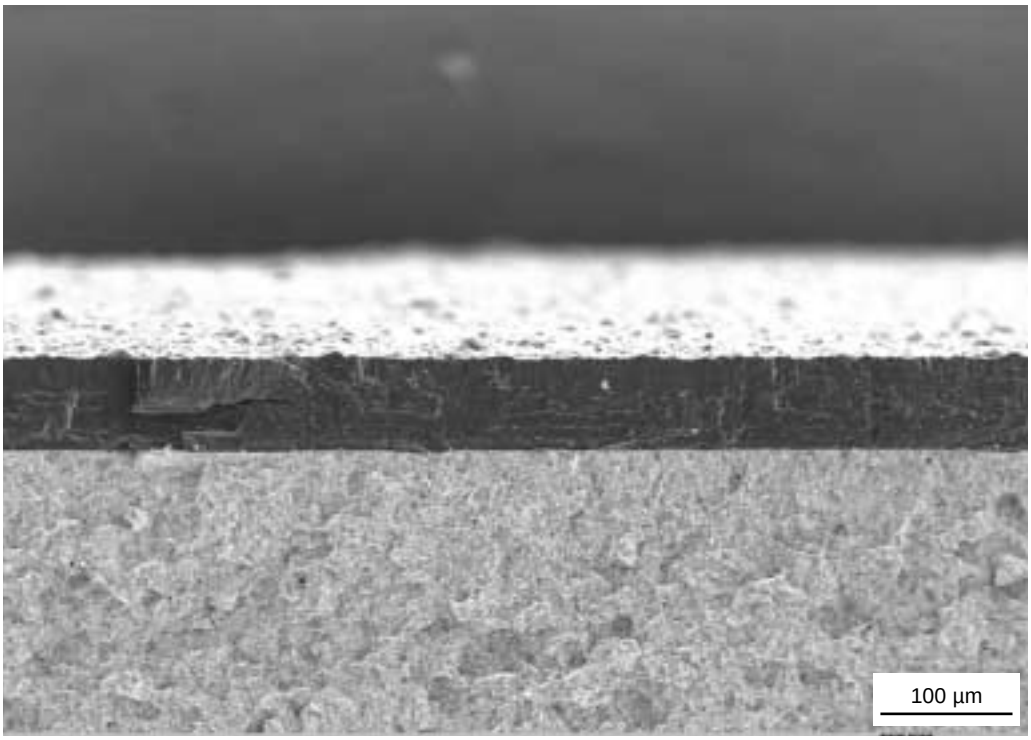
Examples of projects 2003

1. Friction reduction and wear protection due to superhard amorphous carbon coatings
2. Laser arc module for the deposition of superhard amorphous carbon coatings
3. Scaling of the LaserArco® technology for the coating of large components and tools
4. Filter arc technique for the deposition of ultra thin protective and barrier coatings
5. LAwave® testing of porous coatings
6. Tailored coatings for forming tools in the manufacturing of glass



Ultra thick Diamor® coating on a steel substrate, scanning electron micrograph of the cross section

Dr. Peter Siemroth
Team Leader Pulsed Arc
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peter.siemroth@iws.fraunhofer.de)

Coating and Surface Modification with Arc Technologies

Arc discharges as a source of energetic vapor jets are extensively used in the industrial hard coating of tools. The achieved coating and surface properties are excellent. Good adhesion can be realized at low deposition temperatures. Other promising applications (e.g. component coating, surface activation for adhesively bonded joints) offer development potential for arc technologies.

Innovative solutions in this area are developed at the IWS based on the experience with basic processes and applications of arc techniques and the utilization of modern pulse techniques. The broad application spectrum ranges from ultra thin protective coatings to activated large area coatings.

Dr. Otmar Zimmer
Team Leader PVD Technologies
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otmar.zimmer@iws.fraunhofer.de)

Coating with Activated High Rate Processes

PVD (physical vapor deposition) processes are used for the deposition of coatings with thicknesses from a few nanometers to some tens of microns. Techniques from high rate vapor deposition to highly activated plasma processes as well as their combinations are available at IWS. Based on these technologies we offer:

- Demonstration coatings,
- Mechanical and tribological characterization,
- Development of deposition processes,
- Development of coating systems,
- Cost and feasibility studies,
- Development and manufacturing of adapted system components.

Preparation of Diamor® coated samples for the micro analysis

Arc coating of temperature sensitive fibers

R&D-Offer: CVD Thin Film Technology

Editor: Your department CVD Thin Film Technology was founded in January 2003. What were the major results in this first year?

Dr. Hopfe: First I would like to point out the dynamic growth of our two main competence areas, the atmospheric pressure CVD and process monitoring, which lead to the formation of two new work groups at the IWS. This development was catalyzed through our wide network of European cooperation partners. Meanwhile we are in a front position together with our partners. Our growing expertise increasingly qualifies us for cooperation with the high tech industry in Dresden, especially with the semiconductor manufacturers AMD and Infineon. And the potential for a continuing cooperation is growing even more as a result of the decision of AMD to build another plant in Dresden. Everything has been possible due to our highly motivated and flexible staff that understands the need of purpose driven teamwork.

Editor: Equipment has been recently installed in your laboratories for plasma assisted CVD at atmospheric pressures. Now that you have the first results, are there already applications?

Dr. Hopfe: This equipment is the critical mass necessary for our new research area. The platform have been established in a larger European project, which was coordinated by the IWS. The reactor design was based on fluid dynamic calculations and not in the conventional intuitive and empirical way. The installed systems are prototypes of atmospheric pressure inline reactors. They are useful for the effective large area coating of (for example) steel, glass, or semiconductor wafers. Medium sized companies directly ordered the work. Realistically, however, we have to say that there is quite a way to go before we will have first applications. We will approach these hopefully in 2004.

Editor: In the area of process monitoring, you transferred a spectroscopic sensor process to the manufacturing floor of Infineon in the north of Dresden. Congratulations for this success!

Dr. Hopfe: I think it is still to early for congratulations. We will accept them when this innovative technology has demonstrated its use and proven stability. Quality and throughput of semiconductor wafers, which are processed through hundreds of steps, depend very much on the tight tolerance functioning of each individual production machine. We developed a FTIR spectroscopic sensor for the control of deposition and etching systems together with a medium sized company. After thorough testing at IWS we were able to install the technology by the end of 2003.

A pessimist sees the difficulty
in every opportunity,
an optimist sees the opportunity
in every difficulty.
Sir Winston Churchill

Dr. Volkmar Hopfe
Department Head
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Examples of projects 2003

1. Plasma assisted atmospheric pressure CVD process for large area deposition
2. Monitoring of semiconductor processes with FTIR spectroscopic sensors
3. Nondestructive infrared characterization of functional surfaces on components
4. Complex control systems for CVD machines and gas delivery systems

Dr. Ines Dani
Team Leader Atmospheric and in-line CVD
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Plasma Activated CVD Process at Atmospheric Pressure

The large area deposition of high quality functional coatings is possible through atmospheric pressure plasma CVD processes (AP-PECVD) avoiding the need for expensive vacuum equipment. It is possible to implement continuous coating processes with high deposition rates on flat and even slightly curved temperature sensitive materials such as special steels, lightweight metals, glasses, and polymers.

At the IWS we develop prototype AP-Plasma-CVD in-line reactors with gas locks for the deposition of oxides and non-oxide coatings at atmospheric pressure. The optimization of the reactor design is based on experimental results and fluid dynamic simulations. The modular reactor design allows for a cost effective adaptation of the process to new application areas and coating materials.

View of the coating area of the ArcJet-PECVD System

Dr. Wulf Graehlert
Team Leader Process Monitoring
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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.

FTIR monitoring of high temperature processes

R&D-Offer: Thermal Coating

Editor: The powder nozzles for the precision deposition welding with lasers have a new name - COAXn. And as in the past have been transferred to German and international companies. What were the results of 2003?

Dr. Nowotny: Over the past years the laser beam deposition welding has been firmly established in industrial manufacturing. Our robust and user-friendly deposition heads contributed to the fact that this technology is available today as a highly precise process variation for demanding tasks to repair, generate, and coat.

Meanwhile we offer a modular powder nozzle system that consists of basic parts, which can be combined to adapt for numerous customer tailored solutions. One of the title page photos of this annual report shows a nozzle that can perform deposition welding in extreme welding positions. Stable welding conditions are ensured during rotating and swiveling motions and even overhead welding can be performed.

Last year alone we transferred 6 of these systems including the technology package to industry to repair forming tools, aircraft engines, and stationary gas turbines. The customers came from Germany, Finland, Japan, and the USA. Since year 2000 we have established 35 industrial COAXn powder nozzle solutions worldwide.

Editor: At the same time, the Melato® process is making headlines. What successes could be achieved here?

Dr. Nowotny: MELATO® (Metal Laminated Tooling) is a technology for the fast manufacturing of larger tools and dies made from steel. The CAD models of the tools are diced in slices that then will be laser cut out of sheet metal. Subsequent stacking and joining of the sheets builds up the tool - sheet by sheet. This technology allows the manufacturing of fully functional stamping dies in only 10 % of the conventionally necessary time, for example. The technology is currently under testing in a BMBF funded project that runs out in the summer of 2004. Today we can already manufacture real tools with proven success at industrial partners. Current progress is made for the joining technique of the metal sheets. Methods such as soldering, adhesive bonding, laser welding, and a mechanical joining technique are available. It is also possible to combine sheets of different thicknesses and materials to better target the tool properties and improve the contour matching. We are now finally able to quickly manufacture injection molds with contour tracing cooling, a technique that many customers have long been waiting for.

An investment in knowledge always brings the best returns.
Benjamin Franklin

Dr. Steffen Nowotny
Department Head
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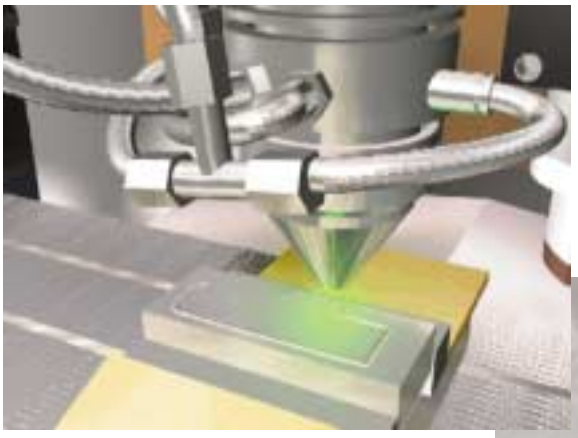
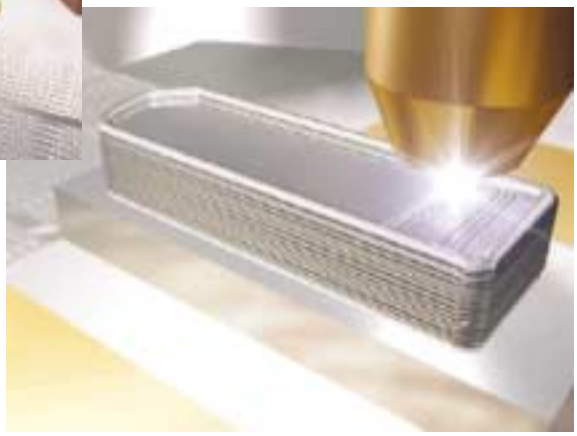
steffen.nowotny@iws.fraunhofer.de)

Examples of projects 2003

1. Joining technology for Melato® tools
2. DCAMnc for the programming of robots and CNC machines
3. Precision deposition welding with laser based hybrid manufacturing processes
4. Deposition welding of titanium carbide powders
5. Thermal spray hard metal coatings for highest mechanical loads
6. Thermal spraying - from the powder to the coating solution
7. Vacuum plasma spraying as a forming manufacturing process
8. Progress at the laser assisted atmospheric plasma spraying





Dr. Lutz-Michael Berger
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Wear Protection and Functional Coating

The atmospheric (APS) as well as vacuum based (VPS) plasma spraying and flame spraying are available at IWS for the coating of components made of steel, light metals or other materials with metals, hardmetals and ceramics. The hybrid technology Laser Assisted Atmospheric Plasma Spraying (LAAPS) complements the technology spectrum.

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. Anja Techel
Team Leader Cladding
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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:

- Fast and flexible work piece digitization and data processing,
- Precise repair and coating of components and tools, even with complex shapes,
- Manufacturing of metallic and hard material containing samples and prototypes directly from the CAD data of the customer,
- System components and support during the introduction of the technology into production.

Plasma spraying of a shaft

Different powder nozzles developed at IWS

R&D-Offer: Joining and Surface Treatment

Editor: In 2003 you managed to once again successfully transfer IWS developed welding technologies to high volume industrial production. Which trends can you see?

Prof. Brenner: We see a continuing trend to use highly strength materials, especially in the area of automotive powertrains, which cannot be safely welded with "conventional" laser welding. In addition we see the need for saving process steps such as hard turning. Both trends are even increasing as a result of successful installations of our solutions. To prepare ourselves for this challenge in the future we began to concentrate on laser beam welding with material adapted filler wires as well as the laser induction welding. We aim to make this process available to industry for the material combination cast iron / heat treatable or case hardening steel. A nice success in 2003 on this path was the transfer of a laser beam joining technology for cast iron cases with gears for differential transmissions at ZF.

The very positive industry response is also demonstrated by several projects from other automotive customers, which are working on similar welding technology solutions. In the near future we are confident to see more such transfers. I like to mention the ZF transfer example because it reflects another trend: The need in industry for complex solutions that include a significantly improved process stability and integrated quality control. We were able to respond to this trend by combining core competencies across the IWS departments and of the equipment manufacturer, Arnold. For the first time the system integrated a laser precleaning of the welding site and a spectroscopic monitoring of the weld seam quality.

Editor: LompocPro® is a system in the IWS lasertronic® family. Last year you sold 4 systems. What can be improved with that system?

Prof. Brenner: The IWS developed temperature adapted laser power control system lasertronic® LompocPro allows for an optimized utilization of the possibilities of laser hardening. The system offers an extremely fast and very precise temperature control even on 3D components. It includes quality control and monitoring functions. It is possible to constantly verify and document whether the actual process conditions are within the defined design limits.

Over the past years several systems have been transferred to industry. However, we were especially happy about the 4 systems shipped out in 2003 since those outperformed directly competing technologies and are now used to harden parts and part families with annual production volumes in the millions.

The essence of knowledge is,
to take it to heart and to apply it.
Confucius

Prof. Dr. Berndt Brenner
Department Head
(Tel. +49 (0) 351 / 2583 207,
berndt.brenner@iws.fraunhofer.de)

Examples of projects 2003

1. Laser module for integrated heat treatment
2. Laser power control "LompocPro" guarantees reproducible hardening results
3. Novel heat treatment process improves the wear resistance of precipitation hardenable steels
4. Notch sensitivity of laser beam welding seams of Mg extruded profiles
5. Process integrated tempering improves formability of laser welded ultra high strength steel sheets
6. Improvement of the weldability of heat treatable free cutting steel through laser induction welding
7. Increased fatigue resistance strength of welding seams through laser beam hybrid welding with integrated weld root dressing
8. Laser beam hybrid welding ensures high load bearing capacity for lightweight constructions
9. Improved laser welding ability through novel zinc magnesium coatings
10. Electron microscopic investigation of rapid solidification of aluminum alloys
11. A structure analytical investigation of laser micro bores
12. Laser structuring increases the strength of metal ceramics joints

Dr. Steffen Bonß
Team Leader Surface Treatment Technologies
(Tel. +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
(Tel. +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 a 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 a unique welding station with our integrated heat treatment process, we are able to offer:

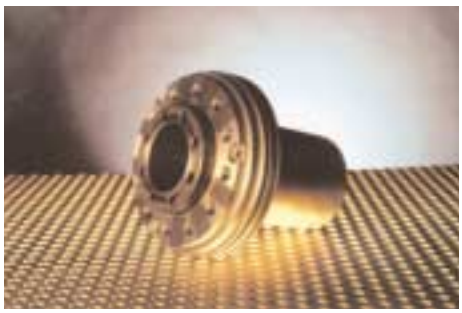
- Development of welding technologies,
- Prototype welding,
- Process and system optimization,
- Preparation of welding instruction.

Dr. Bernd Winderlich
Team Leader Materials Testing and Characterization
(Tel. +49 (0) 351 / 2583 224,
bernd.winderlich@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.



Part of the main drive shaft of a lathe, which was hardened with a high power diode laser

Laser beam welding of a gear for automotive manual shifter, 16MnCr5 hardened

Servo hydraulic fatigue testing of laser hybrid welding joints for steel based lightweight constructions

R&D-Offer: Laser Ablation and Cutting, System Engineering

Editor: Laser beam cutting technology is a widely implemented industrial manufacturing process. Is there any need for further research and development?

Dr. Morgenthal: Although many applications of laser cutting are explored there is still room for technical and economical improvements. Our investigations have repeatedly shown that even with modern laser cutting machines the potential of the tool laser is in many cases not completely utilized. This is especially true for the high speed and precision cutting as well as the cutting of materials, which were so far considered unfavorable for laser cutting. In that sense we were especially happy to transfer high-speed precision laser cutting at the company Partsch in Doebeln. The project was funded by the AIF and addresses the precision cutting of dynamo metal sheets. According to CEO Thomas Partsch, the company is planning on installing a second system in the near future.

Editor: The laser ablation technology is used in different process variations such as the micro processing, the micro structuring, or the cleaning. On which concrete applications are you working?

Dr. Morgenthal: After we established the laser as a precise and selective cleaning tool in the restoration business we are now interested in an increased utilization for technical cleaning. An example is the local cleaning of the joining area of transmission components, which are subsequently going to be laser welded. The potential of this application is demonstrated by a reference solution, which has been implemented at a German car manufacturer and a US supplier.

Editor: Another highlight has been transferred to manufacturing in Italy. Were you colleagues always underway last year?

Dr. Morgenthal: Over the past years we have developed a number of stationary scanning systems for the remote laser welding and transferred them to industry, for example at the company Behr in Stuttgart. At Behr they weld annually hundreds of thousands of heat exchangers for the exhausts of diesel cars and trucks of the brands Renault, Volvo, and Mercedes. As a consequent continuation of the development of this remote technique we added in 2003 a robot controlled remote welding system for Nd:YAG lasers. This systems enables the "on the fly" processing of large parts. The first industry system successfully passed its evaluation at Salvagnini in Italy.

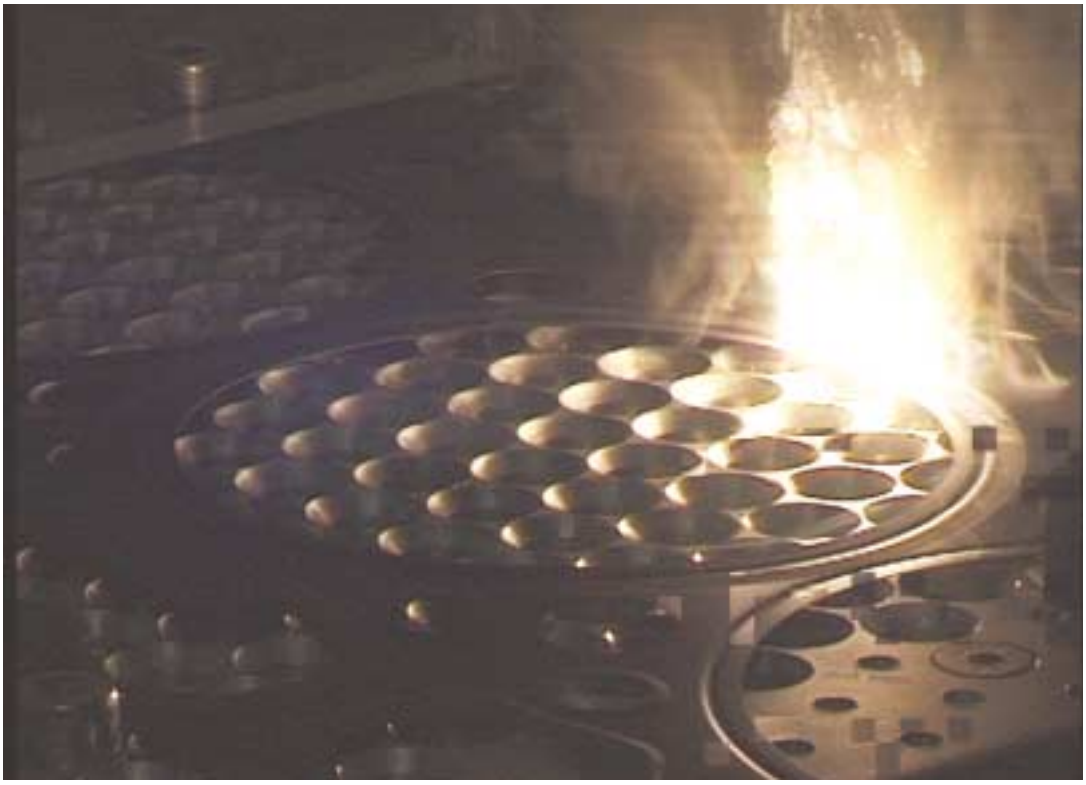
Fantasy is more important than knowledge, because knowledge is limited.

Albert Einstein

Dr. Lothar Morgenthal
Department Head
(Tel. +49 (0) 351 / 2583 322,
lothar.morgenthal@iws.fraunhofer.de)

Examples of projects 2003

1. Location selective surface functionalization through laser irradiation in a reactive gas atmosphere
2. Process control for the laser processing with short pulses and high pulse repetition frequency
3. Restoration of art work in the Herrenhaeuser Gardens
4. Process monitoring for laser welding with additives
5. Flexible laser testing system
6. Laser system for the precision processing of large format components
7. Nd:YAG laser remote welding with process control



Dr. Lothar Morgenthal
Team Leader Laser Cutting and System Engineering
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lothar.morgenthal@iws.fraunhofer.de)

Cutting Technology

We offer applied research for laser cutting with lasers of different wavelength and power to cut parts with millimeter to meter dimensions. The focus is on precision high speed cutting on highly dynamic cutting machines with linear drives or through beam scanning. For quality control we have a flat part scanner system for part dimensions of up to 1800 mm · 1200 mm.

In detail we offer:
- Technology and system development, testing, and optimization,
- Feasibility studies, prototype manufacturing for all variations of laser cutting on material samples and work pieces,
- Development of system components for high speed processes as well as for process control.

Dipl.-Ing. Udo Klotzbach
Team Leader Microprocessing / Cleaning
(Tel. +49 (0) 351 / 2583 252,
udo.klotzbach@iws.fraunhofer.de)

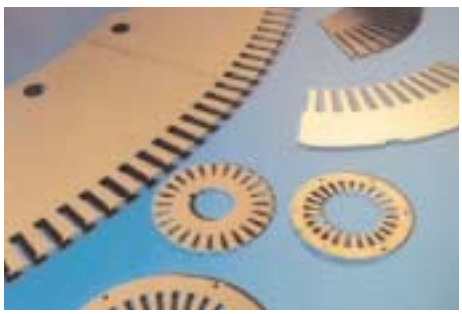
System Engineering and Laser Processing

The departments of the IWS offer the implementation of manufacturing ready and process adapted system solutions in the following areas:
- Processing optics, beam scanners for high speed and precision processing, process monitoring and control,
- Handling systems, process monitoring and control for the industrial utilization of high power diode lasers for surface engineering,
- Prototype development of coating systems or their core modules for the PVD precision coating of high volume parts and the continuous atmospheric pressure sheet CVD including system and process control software,
- Process monitoring and control for coating processes,
- Measurement systems for coating characterization and non-destructive work piece testing through laser acoustic and spectroscopic methods.

Microstructure generation through lasers

Our extensive and modern equipment base combined with our solid know how enable us to perform applied research and development in the area of micro and fine processing with laser radiation for the miniaturization of functional elements in mechanical, automotive, systems, medical, and bio engineering. Examples are 3D structures in the sub millimeter range and lateral structures in polymers, metals, ceramics, quartz, and biocompatible materials.

We offer:
- Microstructuring of a variety of materials with excimer and Nd:YAG lasers for the purpose of generating 3D shapes and inscribing,
- Subsurface engraving of transparent materials,
- Microdrilling with high aspect ratios and different bore geometries,
- Structure resolving and testing.



Laser-cut electro sheet metals

Welding of the tube / base plate joint of an exhaust gas heat exchanger utilizing a beam scanning optics

Precision engraving of glass with frequency tripled Nd:YAG laser

R&D-Offer: Bonding

Dr. Irene Jansen
Team Leader Bonding
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irene.jansen@iws.fraunhofer.de)

Example of projects 2003

1. Pretreatment and adhesive bonding of magnesium parts

Adhesive Bonding Technology

The group "Bonding" was formed two years ago. In 2003 we established a modern laboratory at the Institute for Surface Technology and Production Metrology IOF at the TU Dresden.

The main working areas are:

- Surface pretreatment through plasma and laser techniques applying Nd:YAG and pulsed diode lasers as well as different plasmas in low and atmospheric pressure ranges,
- Constructive adhesive bonding of different materials (metals, plastics, glass, wood),
- Characterization of surfaces and adhesive bonds through contact angle, roughness, film thickness measurements, SEM / EDX, and spectroscopic methods,
- Determination of adhesive bond strengths and aging simulation tests,
- Simulation and establishment of a database.

R&D-Offer: Multimedia and Simulation

Dr. Siegfried Voellmar
Team Leader Multimedia
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siegfried.voellmar@iws.fraunhofer.de)

Competence Center Multimedia

The explanation of the IWS research and development results requires frequently the utilization of modern communication technologies due to their complex character in a technological, material science and physical context. By combining text, image, video and audio we can illustrate invisible or fast running processes. This is especially important for safety relevant processes.

We offer the following:
- Photography and video recording with most modern digital equipment,
- Manufacturing of marketing material for technologies and products,
- Recording of scientific events with life representation in the Internet or as permanently available downloadable data,
- Design of presentations,
- Implementing of physical-technical processes in 3D simulations,
- Development work to provide modern "virtual reality" and "augmented reality" tools for the technological research,
- Design of a system for education and training events in laser and surface technology.

Dr. Dietrich Lepski
Team Leader Simulation / Fundamentals
(Tel. +49 (0) 351 / 2583 222,
dietrich.lepski@iws.fraunhofer.de)

Process Simulation and Software Development for the Laser Material Processing

The saying goes "Trial and error outweighs the theoretical". However, with modern high technologies "trial and error" might get very expensive. A possibly deep understanding of the processes in laser material processing makes their further development and optimization not only easier but also more cost-effective. Therefore process simulation at IWS has become an integral part of process development. This is also true for process modeling up to point of developing production capable software (e.g. laser hardening, laser powder deposition welding).

Model supported estimates (feasibility studies) make it easier to decide which methods have to be applied to fulfill concrete customer requests and they support the finding of proper process windows. Beyond this we develop at IWS material for training and education (e.g. laser lexicon, laser safety).

Examples of projects 2003

1. Controlled heating of plastic coatings with laser radiations
2. Process parameter determination during laser powder deposition welding through simulation with LAVA
3. Immerse simulation for complex three-dimensional processes
4. VELI Virtual European Laser Institute

Diploma Theses

F. Donner
(Westsächsische Hochschule Zwickau)
"*Laserstrahlreinigen von Fügestellen vor dem Laserstrahlschweißen*"

M. Bieda
(Fachhochschule Merseburg)
"*Untersuchungen zur Technologieentwicklung für die Herstellung durchflussbestimmter Bohrungen mittels Nd:YAG-Laser und Scannertechnik*"

D. Buschmann
(Hochschule für Technik und Wirtschaft Dresden (HTWD))
"*Untersuchungen zur Herstellung von Werkzeugen aus Blechpaketen*"
2nd prize awarded by the Dr. Rolf Umbach Foundation for the Advancement of Innovative Activities in Metal Working by Junior R&D Staff in the Free State of Saxsony

S. Fischer
(Hochschule für Technik und Wirtschaft Dresden (HTWD))
"*Untersuchungen zur konstruktiven Gestaltung eines integrierten Bearbeitungskopfes für die Schweißnahtverfolgung mit Strahlablenkoptiken als hochdynamische Zusatzachsen*"

M. Förster
(Hochschule für Technik und Wirtschaft Dresden (HTWD))
"*Einsatz der Verfahrenskette Laser-, Plasma-Auftragschweißen und Fräsen zur Reparatur, Oberflächenschutz und Rapid Tooling von Werkzeugen*"

M. Fritsch
(Technische Universität Dresden)
"*Untersuchungen zum statischen und zyklischen Festigkeitsverhalten von Laserstrahlschweißverbindungen aus Aluminium-Luftfahrtlegierungen*"

K. Hohmann
(Hochschule Mittweida (FH))
"*Entwicklung, Aufbau und Inbetriebnahme eines gekoppelten Achssystems für das Remote-Schweißen von Nd:YAG-Laserstrahlung*"

M. Ingwerth
(Hochschule für Technik und Wirtschaft Dresden (HTWD))
"*Ermittlung von Verfahrensgrundlagen zum Beschichten von Stahl-, Nickel- und Leichtmetallsubstraten durch Vakuum-Plasmaspritzen*"

F. Judas
(Hochschule Mittweida (FH))
"*Entwicklung und Konstruktion einer dynamischen Strahlformungseinheit für Hochleistungsdiodenlaser*"

G. Langner
(Technische Universität Dresden)
"*Verfahrens- und Technikentwicklung zum plasmaunterstützten Laserstrahl-Innenbeschichten*"

S. Maßwig
(Westsächsische Hochschule Zwickau (FH))
"*Aufbau eines Bearbeitungssystems für die Strukturierung von Feinsteinzeug auf Basis eines Nd:YVO_4-Slab-Lasers*"

M. Menzel
(Westsächsische Hochschule Zwickau (FH))
"*Untersuchungen zur Abscheidung von Kohlenstoff/Kohlenstoff-Nanometer-Multischichten mittels Pulsed Laser Deposition*"

R. Niederlein
(Technische Universität Dresden)
"*Zähigkeitsuntersuchungen an Laser-Hybrid- und MAG-Schweißungen des höherfesten Baustahls S1100QL*"

T. Schäfer
(Hochschule Mittweida (FH))
"*Laserstrahlschweißen einsatzgehärteter Getriebebauteile*"

M. Scheer
(Hochschule Mittweida (FH))
"*Untersuchungen zum Festigkeitsverhalten von Laserstrahlschweißverbindungen der Magnesiumlegierung AZ31*"

T. Schwabe
(Westsächsische Hochschule Zwickau)
"*Aufbau und Erprobung eines neuartigen Temperaturmessverfahrens für das Hochleistungs-Diodenlaserhärten*"

M. Tittmann
(Hochschule Mittweida (FH))
"*Untersuchung zu den prozess- und systemtechnischen Möglichkeiten und Grenzen des Hochgeschwindigkeits-Laserstrahlschweißens durch Strahlablenkung*"

C. Wallenhauer
(Technische Universität Dresden)
"*Entwicklung eines Messsystems zur Erfassung der Frequenz, Energie und Spitzenleistung gepulster Laserstrahlung*"

Doctoral Theses

J. Braumöller
(Technische Universität Dresden)
"*Beitrag zum flussmittelfreien Laserstrahlhartlöten von Aluminiumwerkstoffen*"

J. Hackius
(Technische Universität Dresden)
"*Laserstrahl-Hybridschweißen von Aluminiumlegierungen*"

Lecturing

Courses at the Institute for Production Technology at the TU Dresden in winter term 2002 / 2003:

- Prof. Beyer: Manufacturing technology II, (Surface and coating technology)
- Dr. Schultrich, Prof. Beyer: Coating technologies
- Dr. Leson, Prof. Beyer: Surface engineering / Nanotechnology

Courses at the Institute for Production Technology at the TU Dresden in summer term 2003:

- Prof. Beyer: Laser basics / Laser system technology

Courses at the Institute for Surface Technology and Production Metrology at the TU Dresden in winter term 2003 / 2004:

- Prof. Beyer: Manufacturing technology II, (Surface and coating technology)
- Dr. Schultrich: Thin film technology (special materials)
- Dr. Leson, Prof. Beyer: Surface engineering / Nanotechnology
- Prof. Beyer: Rapid Protocoating

Course at the Hochschule für Technik und Wirtschaft Dresden (HTWD):

- Dr. Nowotny: Laser materials treatment

Committees

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

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

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

Prof. E. Beyer:
Scientific Company for Laser Technology (WLT)

Prof. E. Beyer:
Laser Institute of America (LIA), Board of Directors, President Past 2003

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

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:
Board of trustees member of the Palucca High School Dresden

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

Prof. E. Beyer:
Member of the center of excellence Aviation and Space Technology Saxony e.V.

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

Prof. B. Brenner:
Member of the Advisory Board of AiF

Dr. I. Jansen:
Member of DECHEMA, division "Bonding"

Dr. R. Jaeckel:
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 Society

Dr. A. Leson:
Member of the Board of the German Physical Society

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 Future Technologies Board of the City of Dresden

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 International Advisory Board of the Journal "Micromaterials and Nanomaterials"

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

Dr. S. Nowotny:
Association of Thermal Sprayers e.V. (GTS)

Dr. B. Schultrich, Dr. H.-J. Scheibe, Dr. A. Leson:
Working Committee Plasma Surface Technology of the DGO

Dr. B. Schultrich:
Member of the Board of Directors of the European Research Society "Thin Films" e.V. (EFDS)

Dr. A. Techel, Dr. S. Nowotny:
VDI Working Committee "Rapid Prototyping" in the VDI District Society, Dresden

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

The latest research results and applications in the area of nanotechnology are presented at the Nanofair

Our best junior scientists, honored

Prof. Brenner receives the institute's prize for outstanding success in technology transfer to industry

Special Events

May 6 - 7, 2003
4. Workshop on "Industrial Applications of High Power Diode Lasers"

September 2 - 5, 2003
Surface Engineering and Nanotechnology (SENT)

This terminology expresses the importance of nanotechnolgical aspects for surface engineering. IWS in conjunction with the TU Dresden launched a course program for continuous education in industrial thin film technology. The program consists of general courses taught at IWS as well as special courses adapted to the need of the customer taught on location.

November 20 - 21, 2003
Nanofair 2003 - International Symposium on Nanotechnology between the cities of Dresden, Karlsruhe, and Strasbourg in the Saxon parliament, Dresden

November 30, 2003
4. Symposium on Surface Technologies at the Dortmunder Oberflaechen Centrum of the ThyssenKrupp AG (Surface Center of the ThyssenKrupp Stahl AG)

IWS Prizes in 2003

1. Best innovative product idea

   Mr. Stamm
   "Alloy welding of mixed material connections cast iron / case hardened steel in the powertrain area"

2. Best scientific technical result

   Mr. Hauptmann, Mrs. Klotzbach, Dr. Schwarz, Mr. Tittmann
   "Novel concept of a laser based system for the continuous structuring of the magnetic domain structure on grain orientated electro sheet metal"

   Dr. van Loyen, Mr. Boettger, Mr. Friedrich
   "Assembly of a laboratory EUV reflectometer"

3. Best scientific result from a junior scientist

   Mrs. Rogler, Mr. Maeder
   "Deposition of non-oxide functional coatings through atmospheric pressure plasma CVD for the example of silicon nitride"

4. Best scientific student result

   Mr. Wallenhauer
   "Development of a measurement system for the acquisition of frequency, energy, and peak power of pulsed laser radiation"

5. Special prize

   Prof. Brenner
   "Appreciation of the outstanding result of 9 technology transfers to industry in the year 2003"

Participation in Fairs and Exhibitions

Trade Fair Learntec 2003, Karlsruhe, February 04 - 07, 2003

Fifteen institutes of the Fraunhofer Society presented themselves in Karlsruhe under the motto "Fraunhofer - eQualification - The knowledge of science". The multimedia group together with other IWS groups participated for the first time at the 12th European Congress and Trade Fair for Education and Information Technology. The following items were presented on PC workstations:

- CD-ROMs "Laser Lexicon" and "Laser Safety",
- eLearning products "Hybrid Laser Welding Processes" and "Coating Technologies",
- Techniques for direct transmission of events "Business TV" and "Teaching Tool Set Reflectometry".

Hannover Industry Fair 2003, April 07 - 12, 2003

The IWS presented the latest results of applied research in the areas of laser material processing and micro machining at a joint 60 m² booth in hall 60, "Micro Technology". As in past years, the results of industry projects were presented jointly with our industry partners such as Alotec GmbH, Dresden, EFD Induction GmbH, Freiburg, Linde AG, Munich, and the Engineering Bureau Norbert Derenda.

Intelligent systems utilizing lasers under the trademark of lasertronic® represented a focus area at the exhibition. Using a robot the laser assisted thermal spraying, an at the IWS developed process, was demonstrated. The decision to extend the IWS representation at the Hannover Trade Fair proved to be proper which was demonstrated through the acquisition of about 165 relevant industry contacts.

Trade Fair Simpat 2003 Nuremberg, May 13 - 15, 2003

The IWS and University LOT (Chair for Laser and Surface Technology) workgroups "Basics / Simulation" and "Multimedia" participated for the first time at this special fair for simulation and visualization of processes, applications, and technologies and presented several products:

1. The IWS software products "LAVA" simulate the laser deposition welding process , "GEOPT" and "PrOFeT" simulate the laser hardening.
2. The simulation program "SimCoat" has been developed in the framework of the multi partner project "SIMKOPP". The software tool is used for the optimization of the coating process for three-dimensional parts in industrial systems.
3. A multimedia laser lexicon explains a large number of technologically important terms in the areas of laser technology, and laser material processing. The laser lexicon describes the physical basics of these technologies based on numerous visualizations and computer animations.
4. The IWS CD-ROM "Laser Safety" with the legal rules for protecting the working while operating laser technology also explains potential damage through laser radiation and possibilities to avoid them.

Large interest from visitors at the Fraunhofer IWS booth at the Laser Fair 2003

Fraunhofer IWS presentation at the Laser Fair 2003

Joint Fraunhofer booth at Biotechnica 2003

IWS presentation at the Euromold 2003

Fair Achema 2003, Frankfurt / M., May 19 - 24, 2003

Two IWS groups participated at this fair for chemical technology, environmental protection, and bio technology.

The IWS department Thermal Coating Processes presented with the Fraunhofer IKTS the technological chain from the manufacturing of the powder to the deposition onto the workpiece.

The Microprocessing and Cleaning group participated in the framework of the Fraunhofer alliance "Protein Chip". The IWS presented spatially selective functionalized and structured surfaces for biochip applications, components for microfluidic systems as well as hydrophobic DLC coatings for anti fouling surfaces.

Fair StoneTec 2003, Nuremberg, May 24 - June 01, 2003

The IWS presented as a world novelty the technology as well as a system for the anti skid preparation of already installed polished floors at this 13th international trade fair for natural stones and natural stone processing. The audience very well received this presentation. In addition we presented activities in the area of laser cleaning in restoration and monument cleaning.

Fair Thermprocess 2003, Duesseldorf, June 16 - 21, 2003

With the goal to foster a direct exchange between industrial users and associations and research institutions the 4 trade fairs GIFA, METEC, Thermprocess, and NEWCAST are held at the same location and time. Located directly next to our partner EDF Induction GmbH Freiburg, we presented predominantly laser hardening technology, which is especially used in automotive powertrain and tool making applications. Due to the large variety of exhibitors we received several requests going beyond the exhibited technologies and got involved in a very productive exchange of experiences.

Laser Fair 2003 Munich, June 23 - 26, 2003

We participated in a joint 160 m^2 booth together with two other Fraunhofer Institutes. The exhibition included latest results in laser assisted thermal spraying, laser welding, and laser hardening as well as laser micromachining.

Furthermore we present the novel mobile system to treat polished floors with a microstructured pattern to make the surface less slippery (anti skid treatment). For the first time we demonstrated to a broad audience the version 2.0 of our Laser Lexicon.

At the same time the IWS was present at the booth of Lambda Physics AG, Goettingen, showing a microstructuring system with frequency tripled diode pumped Nd:YAG laser.

Fair Biotechnica 2003 Hannover, October 7 - 9, 2003

The IWS group Microprocessing and Cleaning participated for the first time at the International Fair for Biotechnology. We showed the results of the Fraunhofer alliance project "Protein Chips". The IWS presented spatially selective functionalized and structured surfaces for biochip applications and components for microfluidic systems.

Fair Parts2Clean Friedrichshafen, October 28 - 30, 2003

The IWS presented a solution for the partial cleaning of parts with laser radiation. Special characteristics of this solution are its integration into automated manufacturing, the realization of short cycle times, the possibility to clean selected functional surfaces for the subsequent processing step and the avoidance of cleaning solutions. The technology was demonstrated for the example of cleaning coolants and lubricants off joint areas in the differential case and the bevel gear prior to the laser welding step in the manufacturing of the differential transmission.

Fair Euromold 2003 Frankfurt / M., December 3 - 6, 2003

It was the 8th appearance of the IWS at the branch trade fair of the die, mold, model and tool making industry. We presented results of the project "MELATO", which aims at developing a new process line for the rapid manufacturing of complex tools of up to 1.5 m in length. The exhibited stamping tools have been manufactured with the LOM (Laminated Object Manufacturing) technology. In addition we showed parts made by 3D laser deposition welding, which is used to repair tools and for wear protection. We were able to establish many contacts to users.

IWS presentation at the Parts2Clean fair 2003

Exchange of experience at the Euromold 2003

Patent Applications

[P1] S. Braun, H. Mai

"A Device and a Method for the Formation of Gradient Layers on Substrates in a Vacuum Chamber"

Anmelde-Az.: US 10 / 646,543

[P2] S. Braun, H. Mai

"Vorrichtung und Verfahren zur Ausbildung von Gradientenschichten auf Substraten in einer Vakuumkammer"

Anmelde-Az.: JP 2003-298538

[P3] B. Brenner, B. Winderlich, J. Standfuß, J. Schumacher, H. Brenneis, W. Zink

"Leichtbau-Strukturbauteil insbesondere für Flugzeuge und Verfahren zu seiner Herstellung"

Anmelde-Az.: 103 01 445.4-22

[P4] R. Dietsch, T. Holz

"Device for X-ray Analytical Applications"

Anmelde-Az.: PCT / DE 02 / 00572

[P5] T. Himmer, A. Techel

"Vorrichtung und Verfahren zur Herstellung von dreidimensionalen Bauteilen"

Anmelde-Az.: 103 10 987.0-14

[P6] T. Holz

"X-ray Optical System"

Anmelde-Az.: US 10 / 048,873

[P7] V. Hopfe, G. Mäder, D. Rogler, C. Schreuders

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

Anmelde-Az.: EP 03 018 084.8

[P8] H. Mai, S. Braun

"Optisches System mit einer Strahlungsquelle für elektromagnetische Strahlung im extremen ultravioletten Bereich und einem reflektierenden Element"

Anmelde-Az.: EP 03 400006.7-1524

[P9] M. Weihnacht, P. Siemroth, V. Weihnacht, R. Kunze

"Akustisches Oberflächenwellenbauelement"

Anmelde-Az.: PCT / DE 03 / 01172

[P10] O. Zimmer, P. Siemroth, B. Schultrich, S. Schenk, B. Schuhmacher, U. Seifert, C. Hecht, R. Ekkehart

"Vorrichtung und Verfahren zum reaktiven Elektronenstrahlaufdampfen von reaktiv gebildeten Schichten auf Substraten"

Anmelde-Az.: PCT / DE 03 / 01524

Issued Patents

[P11] J. Berthold, T. Witke, P. Siemroth

"Vakuumbogenverdampfer und Verfahren zu seinem Betrieb"

Veröffentlichungs-Nr.: DE 19924094 C2

[P12] J. Berthold, T. Witke, P. Siemroth

"Vacuum Arc Evaporator"

Veröffentlichungs-Nr.: US 6361663

[P13] E. Beyer, S. Nowotny, S. Scharek

"Method for Producing Shaped Bodies or Applying Coatings"

Veröffentlichungs-Nr.: EP 1230055 B1

[P14] E. Beyer, S. Nowotny

"Verfahren zum Aufbringen einer Beschichtung mittels Plasmaspritzens"

Veröffentlichungs-Nr.: EP 0903423 B1

[P15] B. Brenner, C. Duscheck, R. A. Gnann, D. Naunapper

"Verfahren zum Strahlschweißen von härtbaren Stählen mittels Kurzzeitwärmebehandlung"

Veröffentlichungs.-Nr.: EP 0925140 B1

[P16] B. Brenner, V. Fux

"Verfahren zur Erzeugung von verschleißbeständigen Randschichten"

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[P17] A. Hartmann, F. Kretzschmar, A. Klotzbach, L. Morgenthal, D. Pollack, T. Schwarz

"Method and Apparatus for the Laser Machining of Workpieces"

Veröffentlichungs-Nr.: US 6545250 B2

[P18] T. Holz

"X-ray Fluorescence Analysis Device"

Veröffentlichungs-Nr.: US 6577704 B1

[P19] C.-F. Meyer, H.-J. Scheibe

"Device and Method for Coating Substrates in a Vacuum"

Veröffentlichungs-Nr.: US 6533908 B1

[P20] C.-F. Meyer, H.-J. Scheibe, B. Schultrich, H. Ziegele

"Method and Device for Coating Substrates in a Vacuum"

Veröffentlichungs-Nr.: US 6558757 B1

[P21] L. Morgenthal, D. Pollack, D. Weißbach, R. A. Gnann, A. van Spankeren

"Laseroptisches Element zur Formung eines Laserstrahles"

Veröffentlichungs-Nr.: DE 10129982 C

Protection of Trademarks

[P22] *"MELATO"*

Anmelde-Az.: 30319 129.5 / 42

[L01] H.-A. Bahr, H. Balke, T. Fett, I. Hofinger, G. Kirchhoff, D. Munz, A. Neubrand, A. S. Semenov, H.-J. Weiß, Y. Y. Yang

"Cracks in Functionally Graded Materials"

Materials Science & Engineering A 362 (2003) 1-2, S. 2-16

[L02] L.-M. Berger, R. Lang, R. Neugebauer, S. Ortmann, E. Trageser, R. Wolf, R. Zieris

"Thermische Spritzschichten zur Erhöhung der Verschleißfestigkeit von innenhochdruck-umgeformten Rohren"

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[L03] L.-M. Berger, S. Zimmermann, H. Keller, G. Schwier, R. Scholl, S. Thiele, M. Nebelung, R. Enzl

"Microstructure and Properties of HVOF-Sprayed TiC-Based Coatings"

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[L04] E. Beyer

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[L05] E. Beyer, S. Bonß, S. Nowotny

"Anwendungen von Hochleistungsdiodenlasern"

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[L06] E. Beyer, B. Brenner, S. Nowotny

"Overview of Hybrid Technology"

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[L07] E. Beyer, B. Brenner, S. Nowotny, C. Walz

"Laser Applications for Automotive Powertrain Components"

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[L08] E. Beyer, A. Klotzbach, V. Fleischer, L. Morgenthal

"Nd:YAG - Remote Welding with Robots"

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[L09] E. Beyer, G. Wiedemann, J. Hauptmann

"Rutschhemmung vor Ort"

Stone Plus (2003) 5, S. 54-55

[L10] S. Bonß, B. Brenner, H.-J. Scheibe, E. Beyer

"Laser Gas Alloying of Titanium - Process Technology and Wear Test Results"

10th World Conference on Titanium (Ti-2003), im Druck

[L11] S. Bonß, G. Göbel, M. Seifert, B. Brenner, E. Beyer

"Fast and Innovative Determination of Parameters for Steel Hardening with High Power Diode Lasers"

High-Power Laser Macroprocessing - Proc. of the SPIE 4831 (2003), S. 53-58

[L12] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"Precision Hardening with High Power Diode Lasers using Beam Shaping Mirror Optics"

High-Power Diode Laser Technology and Applications - Proc. of the SPIE 4973 (2003) S. 86-93

[L13] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"Neue Entwicklungen zum Randschichthärten mit Hochleistungsdiodenlasern"

5. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik" (OWT '03) und 6. Werkstofftechnisches Kolloquium (WTK) 1 (2003) S. 175-180

[L14] T. Böttger, D. C. Meyer, P. Paufler, S. Braun, M. Moss, H. Mai, E. Beyer

"Thermal Stability of Mo/Si Multilayers with Boron Carbide Interlayers"

Thin Solid Films 44 (2003) 1-2, S. 165-173

[L15] S. Braun, T. Foltyn, L. van Loyen, M. Moss, A. Leson

"Multi-Component EUV Multilayer Mirrors"

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Vakuum in Forschung und Praxis 15 (2003) 2, S. 76-81

[L17] S. Braun, L. v. Loyen, H. Mai, A. Leson

"Lichtstarke Röntgenspiegel - Interferenz-Multischichten zwingen Röntgenstrahlen in produktive Bahnen"

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[L19] S. Braun, H. Mai

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[L21] B. Brenner, J. Standfuß, A. Zwick, B. Winderlich, A. Jahn, E. Beyer

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[L22] N. J. M. Carvalho, E. Zoestbergen, B. J. Kooi, J. Th. M. De Hosson

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Thin Solid Films 429 (2003) 1-2, S. 179-189

[L23] S. Carvalho, E. Ribeiro, L. Rebouta, F. Vaz, E. Alves, D. Schneider, A. Cavaleiro

"Effects of the Morphology and Structure on the Elastic Behavior of (Ti,Si,Al)N Nanocomposites"

Surface & Coatings Technology 174-175 (2003) S. 984-991

[L24] R. Dietsch, S. Braun, T. Holz, A. Leson

"High Precision PLD of nm-Single and Multilayer and Their Applications as X-Ray Optics"

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"Deposition of Multilayer Mirrors with Arbitrary Period Thickness Contributions"

Advances in Mirror Technology for X-Ray, EUV Lithography, Laser and other Applications - Proc. of the SPIE 5193 (2003), S. 124-133

[L26] P. Gawlitza, K. Jacob, T. Sebald, S. Beyer, A. Leson

"Tailored Internal Coating of Components by PLD and Pulsed Laser Evaporation"

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[L27] J. Hauptmann, G. Wiedemann

"Laser Microstructuring of Polished Floor Tiles"

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[L28] L. Herbst, J. P. Quitter, G. M. Ray, T. Kuntze, A. O. Wiessner, S. V. Govorkov, M. Heglin

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[L29] T. Himmer, E. Beyer

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Der Stahlformenbauer 20 (2003) 4, S. 36-39

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[L32] T. Himmer, A. Techel, S. Nowotny, E. Beyer

"New Developments in Metal Laminated"

24th Japan Rapid Prototyping Symposium (2003) S. 97-102

[L33] T. Himmer, A. Techel, S. Nowotny, E. Beyer

"Recent Developments in Metal Laminated Tooling by Multiple Laser Processing"

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[L34] V. Hopfe, D. W. Sheel, C. I. M. A. Spee, R. Tell, P. Martin, A. Beil, M. Pemble, R. Weiss, U. Vogt, W. Grählert

"In-Situ Monitoring for CVD Processes"

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[L35] R. Jäckel

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[L36] I. Jansen, E. Beyer

"Vergleich verschiedener Klebflächenvorbehandlungen von Magnesiumbauteilen"

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[L37] J. Kaspar, A. Luft, S. Bonß, B. Winderlich, B. Brenner

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[L38] G. Kirchhoff, T. Göbel, H.-A. Bahr, H. Balke, K. Wetzig, K. Bartsch

"Damage Analysis for Thermally Cycled (Ti,Al)N Coatings-Estimation of Strength and Interface Fracture Thougness"

Surface & Coatings Technology (2003), im Druck

[L39] H. Kleinert, S. Bräunling, I. Jansen, R. Häßler, F. Liebrecht

"Patchworkkleben - partielle Verstärkung von Blechbauteilen für Fahrzeuge"

17. Internationales Sympsium Swiss Bonding (2003) S. 142-154

[L40] A. Klotzbach, V. Fleischer, L. Morgenthal, E. Beyer

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[L42] T. Kuntze, M. Panzner, U. Klotzbach, E. Beyer

"New Excimer Laser Marking Method Using MMD"

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[L43] H.-G. Kusch, T. Heinze, G. Wiedemann

"Hazardous Emissions and Health Risk During Laser Cleaning of Natural Stones"

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[L44] R. Lenk, A. Nagy, A. Techel

"Lasersintern von technischer Keramik"

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[L45] R. Lenk, A. Nagy, A. Techel

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"Software zur Prozess-Simulation des Laser-Pulver-Auftragschweißens"

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[L47] D. Lepski, H. Eichler, S. Scharek, V. Fux, S. Nowotny, E. Beyer

"Simulation of Laser Beam Cladding by Powder Injection"

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[L48] D. Lepski, S. Pamin

"Simulation komplexer oberflächentechnischer Produktionsprozesse"

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[L49] A. Leson

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[L50] A. Leson

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[L51] L. van Loyen

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[L53] M. Menzel, D. Weißbach, P. Gawlitza, R. Dietsch, A. Leson

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[L55] K. Neufuss, J. Dubsky, P. Rohan, B. Kolman, P. Charska, L.-M. Berger, R. Zieris, S. Thiele, M. Nebelung

"Structure and Properties of $CaZrO_3$ Coatings Prepared by WSP and APS Spraying"

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[L56] S. Nowotny, T. Himmer, A. Techel, E. Beyer

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[L58] S. Nowotny, S. Scharek, T. Naumann

"Integrated Machine Tool for Laser Beam Cladding and Freeforming"

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"Präzisionsauftragschweißen mit laserbasierten hybriden Fertigungsverfahren"

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[L60] B. Petereit, H.-H. Schneider, P. Siemroth, H. Hilgers

"Hochstrom-Filterbogen: eine neue Technik zur Abscheidung von Kohlenstoffschutzschichten in der Magnetspeichertechnologie"

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[L61] B. Petereit, P. Siemroth, H.-H. Schneider, H. Hilgers

"High Current Filtered Arc Deposition for Ultra Thin Carbon Overcoats on Magnetic Hard Disks and Read-Write Heads"

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[L62] P. Pesch, S. Sattel, S. Woestmann, P. Masarczyk, K. Herden, T. Stucky, A. Martens, S. Ulrich, H. Holleck

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"Precision Laser Beam Cutting of Sheet Metal Segments"

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[L64] A. Rudolf, J. Gehrke, W.-D. Kaiser, H. Kleiner, I. Jansen

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[L65] T. Rümenapp, A. Lenk

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[L71] B. Schultrich

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[L75] A. Techel

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[L76] A. Techel

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[L77] A. Techel

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[L82] A. Techel, R. Lenk

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[L89] S. Völlmar, B. Schultrich, D. Römer

"Simulationsprogramm für die industrielle Vakuumbogenbeschichtung"

Journal für Oberflächentechnik (JOT) 43 (2003) 1, S. XIV-XVI

[L90] S. Völlmar, B. Schultrich, D. Römer, H.-J. Scheibe

"SimCoat - Ein Programmsystem zur Optimierung von Beschichtungstechnologien"

Coating 36 (2003) 8, S. 318-322

[L91] V. Weihnacht, W. Grimm

"Puls-Arc-Technik für die Abscheidung von harten Kohlenstoffschichten"

5. Industriefachtagung "Oberflächen- und Wärmebehandlungstechnik" (OWT '03) und 6. Werkstofftechnisches Kolloquium (WTK) 1 (2003) S. 259-264

[L92] G. Wiedemann, A. Klotzbach, R. Gnann

"Fertigungsintegrierte, partielle Bauteilreinigung mittels Laser"

Reinigungsprozesse bei der Metallbearbeitung (2003) S. 23-34

[L93] R. Zieris

"Kundenorientiert: Neues zum laserunterstützten Plasmaspitzen"

Photonik (2003) 2, S. 46

[L94] R. Zieris, S. Nowotny, L.-M. Berger, L. Haubold, E. Beyer

"Characterization of Coatings Deposited by Laser-Assisted Atmospheric Plasma"

International Thermal Spray Conference 1 (2003) S. 567-572

[L95] O. Zimmer, P. Siemroth, J. Berthold, H. Hilgers, W. Hentsch

"Gefilterte Bogenbeschichtung - alte Probleme und neue Lösungen"

Vakuum in Forschung und Praxis 15 (2003) 4, S. 202-208

[L96] J.-H. Zollondz, J. Krauser, A. Weidinger, C. Trautmann, D. Schwen, C. Ronning, H. Hofsaess, B. Schultrich

"Conductivity of Ion Tracks in Diamond-Like Carbon Films"

Diamond and Related Materials 12 (2003) 3-7, S. 938-941

[T01] M. F. Becker, E. Flint, T. Schülke

"Wet Chemical Etching Process to Remove TiN from WC-CO Substrates"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T02] L.-M. Berger, R. Lang, R. Neugebauer, S. Ortmann, E. Trageser, R. Wolf, R. Zieris

"Thermische Spritzschichten zur Erhöhung der Verschleißfestigkeit von innenhochdruck-umgeformten Rohren"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM), Mittweida, 06.-07. November 2003

[T03] L.-M. Berger, M. Nebelung

"Vom Pulver zur Schicht - Neue thermisch gespritzte Beschichtungslösungen"

6. Werkstofftechnisches Kolloquium (WTK) und 5. Industriefachtagung "Oberflächen und Wärmebehandlungstechnik" (OWT '03), Chemnitz, 25.-26. September 2003

[T04] E. Beyer

"Industrielle Lasertechnik für neue Märkte - Anwendungs-Highlights"

6. International Laser Marketplace - Anwendung im Dialog München, 26. Juni 2003

[T05] E. Beyer

"Anwendungsbeispiele für geformte Lichtbündel: Produktionstechnik"

29. DGaO-Schule Optik "Formung von Licht" (räumliche und zeitliche Modulation) Jena, 16.-19. September 2003

[T06] E. Beyer

"Overview of Hybrid Technology"

2nd Internationl WLT-Conference on Lasers in Manufacturing (WLT 2003) München, 24.-26. Juni 2003

[T07] E. Beyer, A. Klotzbach, V. Fleischer, L. Morgenthal

"Nd:YAG-Remote Welding with Robots"

2nd International WLT-Conference on Lasers in Manufacturing (WLT 2003) München, 24.-26. Juni 2003

[T08] S. Bonß, M. Seifert, B. Brenner, E. Beyer

"Neue Entwicklungen zum Randschichthärten mit Hochleistungsdiodenlasern"

6. Werkstofftechnisches Kolloquium (WTK) und 5. Industriefachtagung "Oberflächen und Wärmebehandlungstechnik" (OWT '03), Chemnitz, 25.-26. September 2003

[T09] S. Braun, T. Böttger, R. Dietsch, T. Foltyn, P. Gawlitza, T. Holz, H. Mai, M. Menzel, L. van Loyen, J. Schmidt, D. Weißbach, A. Leson

"Periodic Mulitlayers with Nanometer Thickness for EUV and X-Ray Optical Purposes"

9th International Symposium on Microwave and Optical Technology (ISMOT 2003) Ostrava (CZ), 11.-15. Aug. 2003

[T10] S. Braun, T. Foltyn, H. Mai, M. Moss, A. Leson

"Multicomponent EUV Multilayer Mirrors"

Emerging Lithographic Technologies VII (Mircolithography 2003) Santa Clara (CA / USA), 25.-27. Februar 2003

[T11] S. Braun, A. Leson

"Nanometer Multilayers for X-Ray Optics"

2nd Germany-Korea Workshop on Nanostructured Materials, IKTS Dresden, 19. November 2003

[T12] B. Brenner

"Moderne Laserstrahlschweißverfahren in der Fertigung"

OTT-Profiforum "Lasereinsatz in der Fertigung und Materialbearbeitung", Regensburg, 29.-30. September 2003

[T13] I. Dani, V. Hopfe, D. Rogler, G. Mäder, C. Schreuders, K. Landes, E. Theophile, M. Dzulko, R. Spitzl

"Influence of Plasma Source on Atmospheric Pressure PECVD Process Characteristics"

16th International Symposium on Plasma Chemistry, Taormina (I) 22.-27. Juni 2003

[T14] R. Dietsch, S. Braun, T. Holz, A. Leson

"High Precision PLD of nm-Single and Multilayer and Their Application as X-Ray Optics"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T15] T. Foltyn, S. Braun, M. Moss, A. Leson

"Deposition of Multilayer Mirrors with Arbitrary Period Thickness Distributions"

Advances in Mirror Technology for X-Ray, EUV Lithography, Laser, and other Applications (SPIE Annual Meeting 2003: Radiation Technologies), San Diego (CA / USA), 07.-08. August 2003

[T16] P. Gawlitza

"Maßgeschneiderte Innenbeschichtung von Bauteilen mittels Pulsed Laser Deposition PLD"

DKI-Arbeitskreissitzung "Verschleiß in der Kunststoffbearbeitung", Darmstadt, 25. März 2003

[T17] P. Gawlitza, A. Leson

"Präzise Innenbeschichtung von Bauteilen mit der Puls Laser Deposition"

Kooperationsforum "Materialien und mechanische Komponenten aus der Raumfahrt für industrielle Anwendungen", München, 10. Dezember 2003

[T18] T. A. Grotjohn, K. Hemawan, S. Zuo, J. Asmussen

"Miniature Microwave Plasma Torch Applicators"

50th AVS International Symposium Baltimore (MD / USA), 02.-07. Nov 2003

[T19] K. Hansen, C. Walz, E. Beyer, M. Mason

"In-Die Laser Welding of Hydro-Form Tubes"

22nd International Congress on Applications of Lasers & Electro-Optics (ICALEO 2003), Jacksonville (FL / USA), 13.-16. Oktober 2003

[T20] T. Himmer

"New Developments in Metal Laminated Tooling"

24th Japan Rapid Prototyping Symposium Tokyo (J), 24. Juni 2003

[T21] T. Holz, S. Braun, R. Dietsch, D. Weißbach

"Ultrapräzisionsbeschichtungen mittels Magnetronsputtern und Puls Laser Deposition (PLD) für röntgenoptische Anwendungen"

DPG Frühjahrstagung des Arbeitskreises Festkörperphysik Dresden, 24.-28. März 2003

[T22] T. Holz, R. Dietsch, S. Braun, A. Leson

"Design of Multilayer X-Ray Mirrors and Systems"

52nd Annual Denver X-Ray Conference Denver (CO / USA), 04.-08. Aug. 2003

[T23] V. Hopfe, R. Liske, D. Rogler, G. Mäder, C. Schreuders

"Atmospheric Pressure Microwave CVD for Barrier Layers on Steel Sheets"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T24] R. Jäckel

"Ultradünne funktionale Schichten - Ein Schlüsselelement der Nanotechnologie"

Industriefachmesse IFM 2003, Dresden, 6. November 2003

[T25] I. Jansen, E. Beyer

"Vergleich verschiedener Klebflächenvorbehandlungen von Magnesiumbauteilen"

17th International Symposium Swiss Bonding 2003 Rapperswil (CH), 20.-22. Mai 2003

[T26] H. Kleinert, S. Bräunling, F. Liebrecht, I. Jansen, R. Häßler

"Patchwork-Kleben - Partielle Verstärkung von Blechbauteilen für Fahrzeuge"

17th International Symposium Swiss Bonding 2003 Rapperswil (CH), 20.-22. Mai 2003

[T27] A. Klotzbach, V. Fleischer, L. Morgenthal, E. Beyer

"Remote-Welding mit Hochleistungs-YAG-Lasern"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T28] U. Klotzbach

"Mikromaterialbearbeitung mit dem Laser"

Lasereinsatz in der Fertigung und Materialbearbeitung, Regensburg, 29.-30. September 2003

[T29] F. Kretzschmar, D. Pollack, L. Morgenthal, E. Beyer

"Kontrolliertes Randschichthärten mit dem CO_2-Laser"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T30] T. Kuntze

"Excimerlaser werden flexibel - Markierungsverfahren mit Mikrospiegelarrays"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T31] T. Kuntze, M. Panzner, U. Klotzbach, E. Beyer

"New Excimer Laser Marking Method using MMD"

2nd International Conference on Lasers in Manufacturing (WLT 2003) München, 24.-26. Juni 2003

[T32] T. Kuntze, M. Panzner, U. Klotzbach, E. Beyer

"New Excimer Laser Masking Method using MMD"

4th International Symposium on Laser Precision Microfabrication München, 21.-24. Juni 2003

[T33] D. Lepski, H. Eichler, S. Scharek, V. Fux, S. Nowotny, E. Beyer

"Simulation of Laser Beam Cladding by Powder Injection"

2nd International Conference on Lasers in Manufacturing (WLT 2003) München, 24.-26. Juni 2003

[T34] A. Leson

"Licht als Werkzeug - Materialbearbeitung mit dem Laser"

Moderne optische Technologien, Regensburg, 03.-04. Dezember 2003

[T35] A. Leson

"Nanometer-Schichtsysteme für Röntgenoptiken"

Nanotechnologie, Würzburg, 04.-05. November 2003

[T36] A. Leson

"Functionally of Ultrathin Films, Production and Characterization"

European Vacuum Congress Berlin, 23.-24. Juni 2003

[T37] A. Leson

"Nanotechnologie-Kompetenzzentrum Ultradünne funktionale Schichten - Perspektiven für den Automobilbau"

Microcar 2003 Leipzig, 26. Juni 2003

[T38] L. van Loyen, T. Böttger, S. Braun, H. Mai, A. Leson, F. Scholze, J. Tümmler, G. Ulm, H. Legall, P. V. Nickels, W. Sandner, H. Stiel, C. Rempel, M. Schulze, J. Brutscher, F. Macco, S. Müllender

"A New Laboratory EUV-Reflectometer for Large Optics using a Laser Plasma Source"

Metrology, Inspection and Process Control for Microlithography XVII (Microlithography 2003), Santa Clara (CA / USA), 23.-28. Februar 2003

[T39] G. Mäder

"Atmosphärendruck-Plasma-CVD: Einfluß verschiedener Plasmagaseinspeisungen und Düsengeometrien auf die Schichtabscheidung"

Fluent CFD Konferenz 2003 Bingen, 24.-25. September 2003

[T40] A. Moon, T. A. Grotjohn, M. K. Yaran, T. Schülke, D. K. Reinhard, J. Asmussen

"Mechanical Properties of Ultrananо, Nano, and Polycrystalline Diamond Films and Membranes"

50th AVS International Symposium Baltimore (MD / USA), 02.-07. November 2003

[T41] P. Mottner, G. Wiedemann, G. Haber, W. Conrad, A. Gervais

"Laser cleaning of metal surfaces - laboratory investigations"

5th International Conference Lasers in the Conservation of Artworks (LACONA V) Osnabrück, 15.-18. September 2003

[T42] J. Narenda, T. A. Grotjohn, J. Asmussen

"Creation and Characteristics of Miniature Microwave Plasmas"

50th AVS International Symposium Baltimore (MD / USA), 02.-07. November 2003

[T43] S. Nowotny

"Laserstrahl-Präzisionsauftragschweißen: neue industrielle Lösungen zum Oberflächenschutz, Reparieren und Generieren"

Fertigungstechnisches Kolloquium der BÜHLER-Stiftung Pforzheim, 03. Dezember 2003

[T44] S. Nowotny, S. Scharek, F. Kempe, E. Beyer

"Laser Beam Precision Build-Up Welding: A New Industrial Solution"

LaserAP 5 Marquay (F), 22.-26. September 2003

[T45] E. Pfeiffer, L. Morgenthal, E. Beyer

"Precision Laser Beam Cutting of Sheet Metal Segments"

2nd International Conference on Lasers in Manufacturing (WLT 2003) München, 24.-26. Juni 2003

[T46] K. Rehm, H. Wust

"Neue Oberflächenbearbeitungsverfahren für Holz- und Holzwerkstoffe"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T47] D. K. Reinhard, M. F. Becker, R. A. Booth, T. P. Höpfner, T. A. Grotjohn, J. Asmussen

"Fabrication and Properties of Ultra-Nano, Nano, and Polycrystalline Diamond Membranes and Sheets"

50th AVS International Symposium Baltimore (MD / USA), 02.-07. November 2003

[T48] S. Scharek

"Systemtechnik zum Laserstrahl-Auftragschweißen"

4. Workshop Industrielle Anwendung von Hochleistungs-Diodenlasern im Fraunhofer IWS Dresden, 06.-07. Mai 2003

[T49] H.-J. Scheibe, B. Schultrich

"Neuere Entwicklungen reib- und verschleißmindernder Schichten"

Verarbeitungsmaschinen und Verpackungstechnik (VVD 2003) Dresden, 03.-04. April 2003

[T50] D. Schneider

"Laserakustik"

10. Workshop "Physikalische Akustik" Bad Honnef, 11.-13. September 2003

[T51] D. Schneider

"Laserakustische Bewertung von Randschichten und Oberflächen"

VDI/VDE-GMA Fachtagung Oberflächenmesstechnik Langen, 01.-02. Dez. 2003

[T52] B. Schultrich

"Superharte Kohlenstoffschichten - Werkstoffentwicklung mit einem einzigen Element"

3. Dresdner Materialforschungstag Dresden, 10. Oktober 2003

[T53] B. Schultrich

"Superharte Kohlenstoffschichten durch nm-Schichtdesign"

Nanotechnologie, Würzburg, 04.-05. November 2003

[T54] B. Schultrich, H. U. Jäger

"Influence of the Deposition Conditions on the Structure of Tetrahedrally Bonded Amorphous Carbon Films - A Simulation Approach"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T55] B. Schultrich, S. Völlmar, D. Römer, O. Zimmer

"Process Optimisation of Industrial Vacuum Deposition by SimCoat Simulation"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T56] P. Siemroth, H. Jacoby, H. Hilgers, B. Petereit

"Ultra-Thin Carbon Coatings for Next Generation Hard Disk - Nanotribology of Filtered Arc Films"

4th International Conference on Tribology of Information Storage Devices (TISD) Monterey (CA / USA), 01.-03. Dez. 2003

[T57] P. Siemroth, D. Schneider

"Non-Destructive Determination of Mechanical Properties of Ultra-Thin Films by Laser-Acoustics"

4th International Conference on Tribology of Information Storage Devices (TISD) Monterey (CA / USA), 01.-03. Dez. 2003

[T58] P. Siemroth, V. Weihnacht, B. Schultrich, H.-J. Scheibe

"Superharte Kohlenstoffschichten für die Präzisionstechnik"

Workshop Innovative Oberflächen für Uhren und Präzisionstechnik Dresden, 09. Oktober 2003

[T59] F. Sonntag

"Möglichkeiten und Potentiale der UV-Lasertechnologie in der Biomedizintechnik"

16. Internationale wissenschaftliche Konferenz Mittweida (IWKM) Mittweida, 06.-07. November 2003

[T60] T. Stucky, H. Paschke, A. Techel, A. Zwick

"Werkzeuge - vom Generieren bis zum Topcoat"

4. Fachsymposium Oberflächentechnik des Dortmunder OberflächenCentrums Dortmund, 26. November 2003

[T61] T. Stucky, H.-J. Scheibe, B. Schultrich

"Laserunterstützte Beschichtung von Werkzeugen mit superharten Kohlenstoffschichten"

13. Werkzeugseminar "Laser-Einsatz in der Werkzeug- und Schneidwarenindustrie" Remscheid, 30. Sep. 2003

[T62] A. Techel

"Rapid Prototyping and Rapid Tooling - Schneller von der Produktidee zum Marktangebot"

2. Industrielles Symposium Mechatronik Linz (A), 15. Mai 2003

[T63] A. Techel, T. Himmer, S. Nowotny, E. Beyer

"Joining Techniques for Metal Laminated Tooling"

22nd International Congress on Applications of Lasers & Electro-Optics (ICALEO 2003) Jacksonville (FL / USA), 13.-16. Oktober 2003

[T64] A. Techel, T. Kretzschmar, S. Scharek, S. Nowotny, A. Uelze

"Spannungs- und Verformungsuntersuchungen beim Laser- und Plasma-Pulver-Auftragschweißen"

6. Werkstofftechnisches Kolloquium (WTK) und 5. Industriefachtagung "Oberflächen und Wärmebehandlungstechnik" (OWT '03) Chemnitz, 25.-26. September 2003

[T65] A. Techel, S. Nowotny, A. Nagy, R. Lenk

"Laser Sintering of Complex-Shaped Ceramic Prototypes"

22nd International Congress on Applications of Lasers & Electro-Optics (ICALEO 2003) Jacksonville (FL / USA), 13.-16. Oktober 2003

[T66] V. Weihnacht, W. Grimm

"Puls-Arc-Technik für die Abscheidung von harten Kohlenstoffschichten"

6. Werkstofftechnisches Kolloquium (WTK) und 5. Industriefachtagung "Oberflächen und Wärmebehandlungstechnik" (OWT '03) Chemnitz, 25.-26. September 2003

[T67] V. Weihnacht, B. Schultrich, P. Siemroth

"Preparation and Characterization of Superhard Amorphous Carbon Films up to 10 µm Thickness"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T68] G. Wiedemann

"Lasereinsatz in Restaurierung und Denkmalpflege"

9. Internationale Sommerakademie der DBU Ostritz-St. Marienthal / Dresden, 13.-18. Juli 2003

[T69] G. Wiedemann

"Möglichkeiten und Grenzen des Lasereinsatzes bei der Restaurierung"

Internationale Dommeistertagung Dresden / Meissen, 24.-25. Sep. 2003

[T70] G. Wiedemann

"Aktuelle internationale Tendenzen auf dem Gebiet der Lasertechnik"

7. Forum Laser in Restaurierung und Denkmalpflege im Rahmen der internationalen Fachtagung Oberflächenreinigung des VDR Düsseldorf, 29. September - 04. Oktober 2003

[T71] G. Wiedemann

"Laserstrahlreinigen"

Workshop Reinigen in der Lebensmittelindustrie im Rahmen der Messe ANUGA Köln, 14. Oktober 2003

[T72] G. Wiedemann, A. Klotzbach, R. Gnann

"Fertigungsintegrierte, partielle Bauteilreinigung mittels Laser"

Reinigungsprozesse bei der Metallbearbeitung 2003 Stuttgart, 09. Dez. 2003

[T73] H. Wust, K. Püschner, G. Wiedemann

"The Potential of Laser Application for Selectiv Cleaning and Removal of Different Layers on Wooden Artworks"

5th International Conference Lasers in the Conservation of Artworks (LACONA V) Osnabrück, 15.-18. September 2003

[T74] R. Ziervogel, M. F. Becker, K. Yaran, T. Schülke

"Laser-Acoustic Quality Control of Wear Coatings on Cutting Tools"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T75] O. Zimmer, B. Schultrich, J. Vetter, O. Kaiser

"Maßgeschneiderte Beschichtungen zur Leistungssteigerung im Werkzeug- und Formenbau für die Kunststoffverarbeitung"

1. Kolloquium Werkzeugbau und Kunststoffverarbeitung Dresden, 5. Mai 2003

[T76] O. Zimmer, P. Siemroth

"Vacuum Arc Deposition by using a Venetian Blind Particle Filter"

International Conference on Metallurgical Coatings and Thin Films (ICMCTF 2003) San Diego (CA / USA), 28. April - 02. Mai 2003

[T77] A. Zwick

"Laserstrahl-Schweißen im Automobil-, Flugzeug- und Stahlbau"

Symposium Lasertechnik Iserlohn, 14. Januar 2003

[T78] A. Zwick

"Verbesserte Laserschweißeignung durch neuartige Zink-Magnesium-Überzüge"

ThyssenKrupp Steel Fachpresseforum Stahl-Oberflächen Schloß Landberg, 24. September 2003

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- Take the Hamburger Straße and continue straight (along tram rails)
- Take Schweriner Straße (here, traffic veers right; go around the Telekom Building)
- Continue straight, along Wilsdruffer Strasse and Stuebelallee
- At the end of the "Grosser Garten" turn right onto Karcherallee
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- exit at Zwinglistrasse station
- IWS is a ten minute walk from there, in the direction of Grunaer Weg

Diese Seite wird auf den Innenumschlag gedruckt

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Quotations:	The quotations are translated faithfully to their meanings	

Title Photos

top: sample manipulator system in the goniometer chamber of the EUV reflectometer

middle: tripode flange connector, made by inductively supported laser beam welding

bottom: nozzle arrangement for deposition welding with moving processing head