

Cold Laser Processing of Fiber-reinforced Plastics

New Thinking of FRP Processing – Contact Free and Clean

Pulsed laser radiation enables material-sensitive processing of almost all materials, whether brittle ceramics, ductile elastomers or meltable plastics. The surfaces of all these materials can be structured, cleaned, decanted, cut or otherwise modified without thermal damage. In joining technology, laser microstructuring shows its comprehensive potential for surface pre-treatment, replacing environmentally harmful processes such as etching baths. Furthermore, it demonstrates massive increases in adhesive strength after injection molding, coating deposition or adhesive bonding compared to commonly used pre-treatment methods.

Functionalization

Composite components are characterized by their resilience and lightness. However, new requirements such as functional integration, wear resistance, electromagnetic shielding and others are constantly being added. These non-material properties can be applied to the surface using coating processes. However, this requires extensive know-how in the pre-treatment of surfaces and process control on temperature and wear-sensitive materials. Laser microstructures developed at Fraunhofer IWS enable the production of metal coatings with at least 80 percent higher adhesive strength than conventional pre-treatment processes. The scanner-based method allows mask-free coating, even locally limited. This technology is used from EMC protection of battery housing, impact protection of rotor

blades, wear reduction of hydraulic cylinders and media resistance of rollers through heating layers on airplane wings.

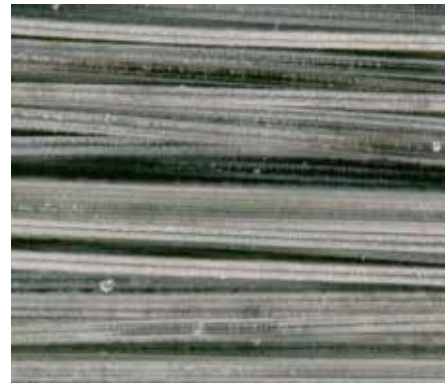
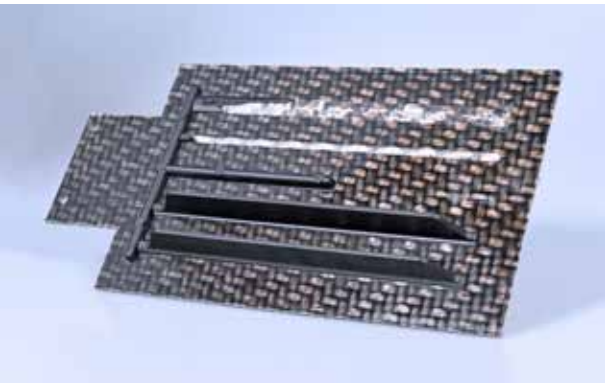
Reinforcement and Extension of Components

The complexity of assemblies is constantly increasing. In addition to well-known economic constraints, ecological requirements such as recyclability and environmentally friendly manufacturing processes are increasingly leading to accelerated technological innovations. Measures such as the material change from metal to fiber-reinforced plastic (FRP) offer extensive opportunities but also numerous challenges. This requires flexible and smart production processes. Microstructuring permits surface joining on metallic inserts or FRP components by individual and optimal design.

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This allows the application of rib reinforcement during injection molding, which has five times the adhesive strength of conventional processes. Metal inserts and additively manufactured load introduction elements can be reliably attached to pultrusion components thanks to laser pre-treatment.

Micro-precision Machining

Using ultra-short pulsed laser beam sources allows the processing of materials without melting. Laser cutting facilitates separating materials with a minimal heat-affected zone, ultra-thin layers can be removed with high precision, for example, in photovoltaics, or delicate sensors can be contacted using micro welding.

Functional Principle

Fraunhofer IWS Dresden utilizes high-precision laser machining technology offering contact and wear-free treatment of FRP. Pulsed lasers with pulse durations from nanoseconds down to femtoseconds and wavelengths from the ultra violet to the infrared spectrum allow a flexible adaption of the laser process. They can also treat all kinds of fiber reinforcement and matrix materials. Within ultrashort pulses, there is no time for the material to heat up compared to a continuous laser regime. This way, ultrashort pulsed lasers enable material ablation by a "cold process", meaning that thermal stress or damage keeps out of critical

areas. The laser process can be modified from selectively removing the matrix material to homogeneously ablating the complete composite.

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Left:

Subsequent application of stiffening ribs and connecting parts to complex-shaped components with substrate failure after pull of testing.

Middle:

Multimaterial joint CFRP to aluminum.

Right:

Selective matrix removal on glass fiber-reinforced polyamide.

Benefits of Laser Processing

- Customized surfaces for joining technologies of all materials
- Functionalization enables new properties
- Increased adhesion strengths in several joining techniques due to laser micro structuring
- Smart processes: automatable with process control
- High-precision material ablation
- Minimally invasive processing of components

More Information

Laser Micro Processing



s.fhg.de/microprocessing

CHIMERA Project



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