Fraunhofer IWS Dresden

FRAUNHOFER-INSTITUT FÜR WERKSTOFF- UND STRAHLTECHNIK IWS

COLD LASER PROCESSING OF FIBER-REINFORCED PLASTICS

New thinking of FRP processing – contact free and clean

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Motivation

The importance of fiber-reinforced plastic (FRP) has been increasing constantly for years. In contrast to manufacturing processes of metal components, conventional processes are not suitable to FRP. New technologies are being developed to cut, join or coat FRP. Especially the procedure of joining FRP with metal or other materials still belongs to the most challanging tasks in production. This is why FRP are still present in less sections than they could be. The constantly recurring challenges are the high temperature sensibility of most plastics and the abrasive fibers, leading to unprofitable tool wear.

Solution

The Fraunhofer IWS Dresden utilizes high precision laser machining technology offering contact and wear free treatment of FRP. Pulsed lasers with puls durations from nanoseconds down to femtoseconds and wavelengths from the ultraviolet to the infrared spectrum allow a flexible adaption of laser process. Moreover, all kinds of fiber reinforcement and matrix materials can be treated. Within ultrashort pulses there is no time for the material to heat up compared to continuous laser regime. This way, ultrashortpulsed 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 homogeniously ablating the complete composite.

Potentials and advantages

- **Contact free** process offers treatment without or with less mechanical stress or damage
- Thermal damages avoided by ultrashort laser pulses and tailored process strategies
- "Cold volume ablation" for integration of sensor elements, inserts or buried electrical contacts
- **Selective matrix removal** exposes load-bearing fibers damage free (Fig. 3)
- Surface roughening and patterning
- **Maximum of design freedom**
- **High precision** cutting and drilling with less damage compared to mechanical processing

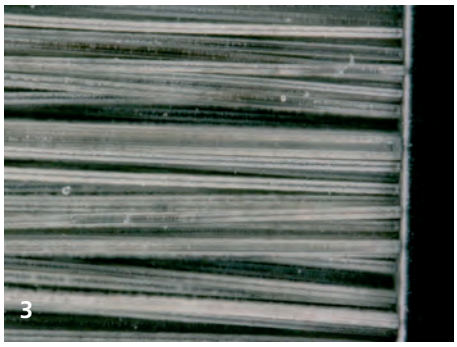
Applications

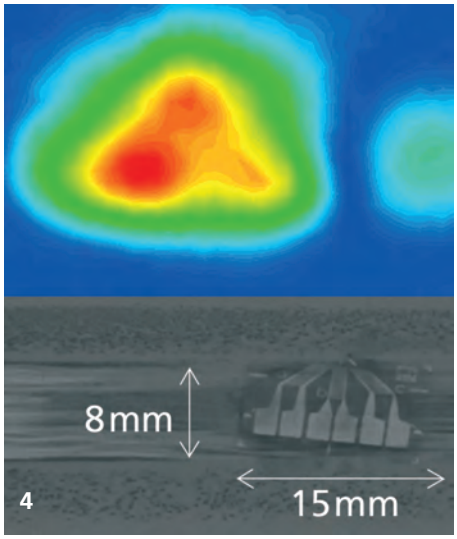
Examples for cold laser processing:

- Surface pre-treatment of joining surfaces (e.g. adhesion bonding, injection moulding, hybrid joining) → mechanical strength of overmolded structures has been increased by a factor of 5 compared to untreated condition
- Injection moulding of a **strenghtening rib structure** on laser processed organic sheets (Fig. 1) for light weight automotive components
- **Integration and connection of sensor elements** like accelleration or strain sensors facilitates monitoring of FRP components during life time especially for crash relevant components
- Surface pre-treatment for metal coating → **40% higher adhesion strength** by laser pre-treatment compared to mechanical blasting before thermal spraying
- Coating of laser structured FRP **increases wear resistance** (Fig. 2) and can be used to generate **electric or dielectric characteristic of FRP** components
- Durable engraving and marking of FRP components without affecting the mechanical strength
- Terahertz technology offers a look into the material and can **detect delamination** effects or hidden elements (Fig. 4)

Sectors:

- Electro-Mobility
- Aerospace Technology
- Automotive Industry
- Paper Industry





1 Load-through system with rib-application on laser structured organic sheet.

2 Metallization of laser structured FRP by thermal spraying.

3 Selective matrix removal on GF-PA6.

4 Terahertz technology detection of integrated strain gauges.

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