Cold surface treatments on fiber-reinforced plastics by pulsed laser

J. Gebauer[1], V. Franke[1], U. Klotzbach[1], E. Beyer[1]

[1]Fraunhofer Institute for Material and Beam Technology IWS, Dresden, Germany

Keywords – laser processing, pulsed laser, fiber reinforced plastic, selective matrix removal, lightweight, surface pretreatment

Abstract

The importance of lightweight materials increases in all aspects of manufacturing, e.g. automotive, sports equipment and aerospace [1]. Making fiber reinforced plastics suitable for use in mass production new technologies have to be developed to overcome existing challenges e.g. shorter cycle times or more efficient resource usage.

Innovative laser systems are used for a full range of treatments for all materials, like structuring, drilling, joining and cutting [2] - [4].

This paper presents laser processes for surface treatment of fiber reinforced plastics and their potentials to improve adhesive bonding, molding processes and coating deposition. Pulsed laser ablation is offering a promising alternative to state of the art mechanical milling for material removal. The most important advantages of the laser are: non-contact processes, no tool wear, design flexibility and no need for post treatments.

Especially selective matrix removal that exposes the reinforcing fibers without damaging them (as shown in figure 1) is a unique characteristic that only laser treatment can offer.

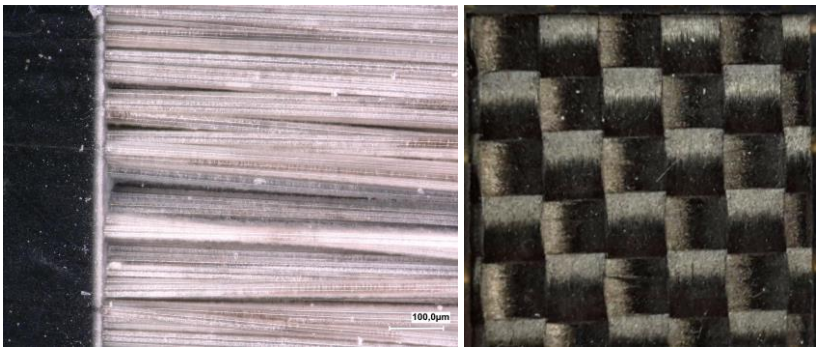

Figure 1: microscopic image of selective matrix removal, top view, exposing reinforcing glass fibers (left) and carbon fibers (right)

This structure exhibits a surface enlargement, enables form lock and offers an undercut area over 100 µm depth. As a consequence ten times higher tensile strength is reached in pull-off tests compared to untreated surfaces. The laser structured organic sheet was injection molded with the matrix polymer on top of the structured zone.

The next step will be the transfer of developments into industry to further improve the process. Laser based surface pretreatment will be used to apply e.g. rip structures on semi-finished organic sheets and laser ablated cavities will be exerted to integrate inserts or sensors on fiber-reinforced plastic.

References

[1] H. Schürmann: Konstruieren mit Faser-Kunststoff-Verbunden, Springer-Verlag Berlin Heidelberg, Berlin, Heidelberg, 2006, S. 1-11

[2] Eichler, J.; Eichler, H.: Laser- Bauformen, Strahlführung, Anwendungen, 6. Auflage, Springer-Verlag Berlin Heidelberg, Berlin, Heidelberg, 2006

[3] Hügel, H.; Graf, T.: Laser in der Fertigung. Strahlquellen, Systeme, Fertigungsverfahren, 2. Auflage, Vieweg + Teubner, Wiesbaden, 2009

[4] Poprawe, R.: Lasertechnik für die Fertigung, Springer-Verlag Berlin Heidelberg, Berlin, Heidelberg, 2005