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PRESS RELEASE

Bonding without adhesive

Fast direct joining of metal and thermoplastic materials

(Dresden, February 20, 2018) The Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS Dresden has developed a new process for joining materials with different properties. Thermal direct joining presses laser-structured metal with thermoplastic components and heats them locally. This causes the thermoplastic to melt, to penetrate into the structures and to adhere to the surface. A specially developed joining gun generates robust connections within seconds. The "HeatPressCool-Integrative" (HPCI) process is highly suitable for replacing complex adhesive processes.

Modern lightweight construction often requires the combination of metal with polymers. In addition, efficient process chains are required for use in industrial production bringing pretreatment and joining technology in agreement with the specific load case. Tools for process simulation and property characterization also play an important role. A new Fraunhofer IWS development meets these requirements: The HPCI process combines many years of experience in adhesive bonding with modern technological developments in the laser remote technology field. The researchers thus achieved their self-defined goal of developing productive solutions for direct and form-fit joining.

Pre-treatment is important

Since thermoplastics and metal have very different physical properties – such as melting temperature or thermal expansion coefficient – optimizing the adhesive force between the two joining partners is of outstanding importance. For this reason, the IWS researchers developed a laser ablation process that generates structure depths of 100 micrometers and more at surface rates of up to 30 square centimeters per second. Remote or scanner optics focus the continuously radiating laser on the metal and quickly deflect it. This process cleans the surface from adhering oils or dirt on the boundary layer. At the same time, the later penetrating polymer can fill the generated structures so that there is a positive fit between polymer and metal. This eliminates the need to clean the surface with solvents or pickling baths.

Sponsored by the the Federal Ministry for Research and Technology BMBF within the framework of the research project "LaserLeichter" (FKZ: 13N12878)

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Federal Ministry of Education and Research

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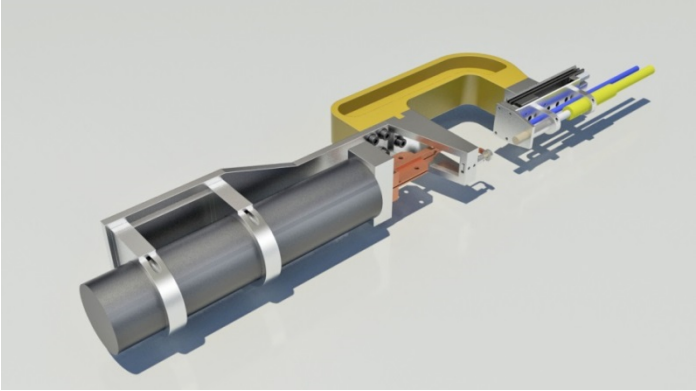
Fast heat provides direct joining

The actual joining process is quite simple: the pre-structured metallic joining partner is pressed with the polymer. At the same time, the metal is heated at the joint and the thermoplastic is partially melted. In order to adapt this process for industrial use, IWS scientists developed a modularly designed joining gun that can be mounted on a robot arm instead of a spot welding gun. This allows proven system technology to be used for multi-material applications as well. A particular challenge consists in the uniform heating of the metallic joining partners. In addition to inductive heating, laser heating offers a similarly adequate solution. The use of a two-dimensional laser beam oscillation enables extremely fast beam movement and control. This procedure allows the temperature field to be adjusted dynamically to compensate for the specific heat dissipation conditions of the joined parts.

Technological implementation

Together with industrial and research partners, Fraunhofer IWS evaluated the developed method using a complex technology demonstrator. The researchers replaced a pure welded construction steel assembly with a multi-material component made of organo sheet and metallic cover plate in order to demonstrate the lightweight construction potential. In addition to thermal direct joining, they also generated form-fit connections in web-slit design between the metal and organo sheet. The basic study showed that thermal direct joining suits multi-material and component designs, in particular due to short process times, robust process control and good automation capability.

Visit us at the JEC World 2018 in Paris (6.3.–8.3.2018) at the joint booth of Carbon Composite e. V. in hall 5A, booth E46/56.



In order to adapt the HCPI process for industrial applications, IWS scientists developed a modularly designed joining gun that can be mounted on a robot arm instead of a spot welding gun.
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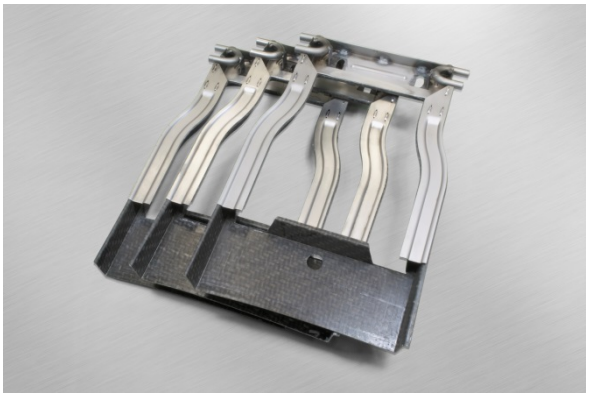

Technology demonstrator for thermal direct joining of metal with thermoplastic fiber composite components
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