LASER MICROSTRUCTURING FOR PLASTIC-METAL HYBRID INJECTION COMPONENTS

Task

A key requirement in the automotive and aerospace industries is to reduce weight through innovative lightweight construction concepts. To achieve this, a newly developed multi-material construction has opened up avenues for weight optimization through the use of different materials, each adapted to local loads. While plastics are characterized by their low weight, low price and almost unlimited shape, metals can withstand significantly higher loads due to their mechanical properties. In the manufacture of plastic-metal hybrid components, however, the two materials have such a great chemical and physical dissimilarity that connecting them poses a particular challenge.

Method

Fraunhofer ILT has developed a process chain that uses laser modified metallic inserts to generate a high strength bond between plastic and metal without additives in an injection molding process. For this, laser radiation is used to generate microstructures in the metallic joining partners; the microstructures are then filled with molten plastic in the subsequent injection molding process. After the plastic solidifies in the structures, a solid and permanent bond is created, based on a positive interlock. In cooperation, the BARLOG GRUPPE integrated microstructured metallic inserts that Fraunhofer produced within the injection molding process to produce hybrid bonds with various plastic materials. To evaluate the ideal structure geometry and process parameters, Fraunhofer ILT varied the microstructures while BARLOG varied the molding parameters so that the molten plastic fills the microstructures homogeneously.

Results

The process, with hybrid injection molding and laser-structured metal components, has generated durable and solid connections with a tensile shear strength of more than 22 MPa. In this process, the strength is not only significantly influenced by the structural density and orientation on the metal joining partners, but also by the process control, in particular by the metal components temperature during the injection molding process.

Applications

The process is particularly suitable for all components in the automotive and electrical engineering sector that can be produced with injection molding. Thanks to the laser patterning of metallic microstructures, process chains can be shortened; in addition hermetically sealed and permanently fixed connections can be generated via the adhesive and positive-locking connection.

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1 Hybrid connection via injection molding (left) and a laser-based thermal conduction bonds (right).

2 Sample for tensile shear tests with various plastics.

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