Ceramic heater

Photo: Schunk Kohlenstofftechnik GmbH

TEXTILE FOLLOWS FORM

CERAMIC COMPOSITES

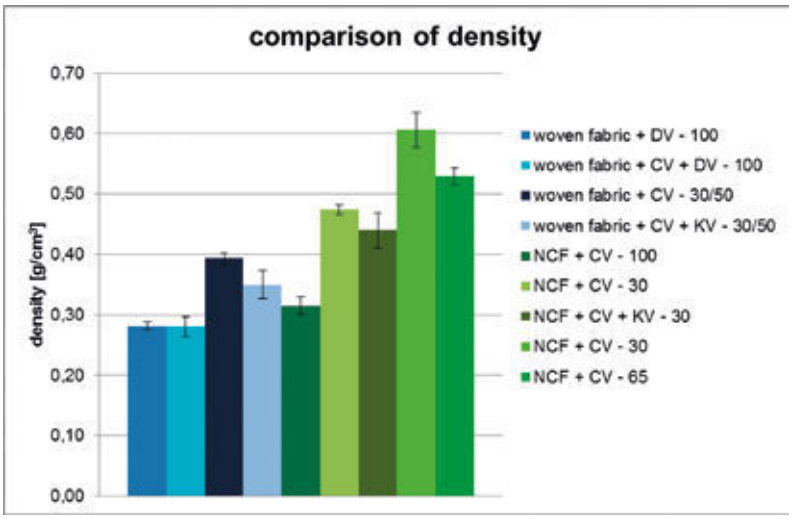
New class of carbon fiber preforms for ceramic matrix composites

Coordinated by Hof University of Applied Sciences seven companies from textile and ceramic industry and four research institutes are developing innovative carbon fiber preforms for ceramic matrix composites (CMC) within the BMBF research project "CaGeFa".

CMCs are well known for their application as friction linings and insulation material in the aerospace and automotive industry. The preforms for the composites are conventionally built up by stacking and laminating woven fabrics and non-crimp-fabrics (NCF) or by CFRP-forming using short cut and staple fibers. As a result, the process steps for the production of CMCs are expensive, time-consuming and thus limiting a wider application.

Improvement wanted

In view of the low commercial availability, it is the goal of the current BMBF research project "Highly drapable carbon-NCF-fiber-preforms for efficient ceramic matrix composites – CaGeFa" to develop carbon preforms with a defined z-reinforcement to improve the material performance of CMCs (e. g. interlaminar shear strength, thermal conductivity, etc.) and to reduce process times and costs. In line with the project, the focus of the research activities is set along the entire process chain of the fabrication of fiber-reinforced ceramics – from textile semi-finished products and preforming up to coating, ceramization and testing.



Variation of the sandwich preforms density according to requirements from 0.28 to 0.61 g/cm³; NCF – non crimp fabric; CV – chopped fiber nonwoven; KV – carded nonwoven; DV – carded nonwoven as top layer; 100/65/50/30 – penetration density

Innovation encouraged

Textiles developed for the preforms are special NCFs, radial woven fabrics, as well as carded, chopped and endless fiber nonwovens, which are processed in different combinations to achieve the respective requirements. Aside from PAN-based carbon fibers, pitch-based fibers are used as well, because they feature an improved thermal conductivity by comparison, though accompanied by a very high brittleness. By the subsequent preform needling of the semi-finished textiles a defined z-reinforcement is achieved through reorientation of the fibers, so that the required properties of structural density, interlaminar shear strength and impregnation behavior can be specifically adjusted. This requires a special layer selection in terms of fiber orientation and density as well as an adapted definition of needling parameters.

Application tested

Accompanying processing, the qualification of the materials is carried out by textile and ceramic test procedures as well as by the non-destructive method of computed tomography (CT). The collected data includes information such as internal structure, fiber orientation, porosity and fiber length to provide the basis for a simulation program and consequently for a successful component design. In conjunction with the ceramization results, the aim is to derive a cause-effect-relationship between textile and fiber-reinforced ceramics in order to ensure a defined adaption of textile preforms for the application in CMCs.

Sandwich-Preform build up by stacking non-crimp-fabric and chopped fiber nonwoven

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