Quantitative measurement of fiber pull-out by laser scanning confocal microscopy

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Abstract

Carbon/carbon composites exhibit excellent mechanical properties even at temperatures up to 2000°C. One important aspect for the performance of a carbon/carbon composite is the failure behaviour of the composite material. Strength and fracture toughness are mainly determined by the fibre-matrix interface. For the characterization of this interface, one can determine the fibre-pullout length after mechanical testing instead of facing the difficult task of determining the interfacial shear strength itself. Here, we demonstrate a new technique that allows the quantitative determination of fibre pull-out length: 3D topography images of fracture surfaces are acquired by laser scanning confocal microscopy. From these images, fiber pullout-length is determined quantitatively.

Carbon/carbon composites consisting of PAN high-tensile carbon fibres and a high-textured matrix generated by chemical vapour infiltration were investigated: After infiltration, some of the specimens were heat-treated for two hours at temperatures of 1900°C, 2200°C and 2500°C. Then tensile test were performed on samples as received and on heat treated samples. Finally – after investigation of the fracture surfaces by scanning electron microscopy – the distribution of fiber pull-out lengths was determined quantitatively applying laser scanning confocal microscopy.