Ceramic Fibers, Distribution of Fiber Strengths and Continuos Fiber-Reinforced Ceramic Matrix Composites[1]

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Continuous Fiber-Reinforced Ceramic Matrix Composites (CFCCs) are candidate materials for numerous applications in the energy and aerospace industries. For example, these materials are being considered for the fabrication of: combustor liners for gas turbine engines, heat exchangers and filters for the chemical and energy industries, and thermal protection systems for atmospheric re-entry vehicles. CFCCs are attractive because they have the potential of retaining their mechanical properties at elevated temperatures, and in contrast to monolithic ceramics, they fail in a graceful manner. The backbone of CFCCs is a fibrous preform, and ultimately the tensile strength of CFCCs is determine by the distribution of strengths of the reinforcing fibers. Therefore, the determination of the parameters of this distribution is of practical interest. For the last 25 years, ASTM D3379 "Standard test Method for Tensile Strength and Young's Modulus for High-Modulus Single-Filament Materials" has been the accepted standard for the determination of fiber strengths. According to this document, the tensile strength of a fiber is determined as the ratio of the breaking load and the average of the cross-sectional areas of a sample of fibers that is assumed to be representative of the fiber population. In this presentation, it will be shown by means of Monte Carlo simulations that this approach leads to erroneous estimates for the parameters of the distribution of fiber strengths, and a series of recommendations (which already have been adopted for the drafting of a new ASTM standard) will be discussed. An introduction to the unique properties of CFCCs and the mechanics of fiber bundles will be made.

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