MODELS FOR SUBCRITICAL CRACK GROWTH FOR SIC FIBERS IN AIR AND STEAM

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Subcritical crack growth (SCG) based models were used to predict failure times and brittle-creep rates during static fatigue of Hi-Nicalon™-S SiC fiber tows in air and steam. A reaction-rate based SCG model and a bond-energy based SCG model were used to describe crack growth that caused sequential filament failure, and ultimately tow failure. Model parameters determined for data collected at 700 to 1100°C were updated to fit new data collected at 500 and 600°C with initial applied stresses up to 1350 MPa. Orthogonal direction regression was used to fit model parameters to data. The stress increases for intact filaments as they oxidized and as other filaments fractured, and the change in stress intensity geometric factors with crack size were incorporated in the models. The possible effects of filament residual stress were explored by fitting data to model parameters using residual stress between 300 MPa compression and 600 MPa tension. The new data at 500 and 600°C in steam does not fit trends found at higher temperatures, and is very similar to data collected in air, suggesting a mechanism change between 600 and 700°C in steam. The filament strength distributions in Hi-Nicalon™-S SiC fiber tows are not well described by a Weibull distribution after extensive SCG. Alternative distributions with better fit to the calculated strength distributions are explored. The merits of various models, SCG mechanisms, and effects of residual stress are discussed.