Bruchmechanische Analyse der Entstehung und Ausbreitung von Matrix- und Grenzflächenrissen in thermisch belasteten Faserverbundmodellen

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Elementary failure mechanisms like matrix and interface cracks, respectively, arising in self-stressed models of fibrous composites due to a steady cooling process are investigated by numerical as well as experimental methods of fracture mechanics. Further, by introduction of an appropriate nomenclature for special variations of the model geometries used in the cooling experiments thermal stress states originated in the uncracked as well as cracked composite structures, respectively, have been determined by using the finite element method. Moreover, by applying the substructure technique as well as by implementation of a maximum strain energy release rate criterion a simulation of a thermal crack propagation known from associated cooling experiments could be performed.
Furthermore, fracture mechanical data like crack opening displacements, strain energy density variations and strain energy release rates, respectively, were calculated where these quantities have been used for the prediction of crack initiation as well as of further crack growth of branched thermal crack systems. Finally, by applying the method of caustics in transmission and reflection, respectively, opening-mode stress intensity factors K_I at the tips of propagating thermal matrix cracks were determined. A comparison of these experimental fracture mechanical quantities with associated finite element calculations obtainable by using the local as well as the global energy method, respectively, showed a very good agreement in the region of stable crack propagation.