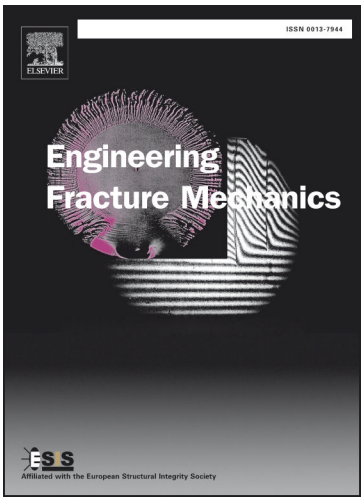

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Investigations on Fracture Toughness and Fracture Surface Energy of 3D Random Fibrous Materials at Elevated Temperatures

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Abstract: The model Ⅰ fracture toughness of three-dimensional random fibrous (3D RF) materials with the porosity 83% is investigated from room temperature to 1273 K by means of experiments of compact tension (CT) specimens in the through-the-thickness (TTT) and in-plane (IP) directions. The experiments show that the fracture toughness in the TTT and IP directions increases (0.0842 - 0.1162 $MPa \cdot m^{1/2}$ and 0.4292 - 0.6767 $MPa \cdot m^{1/2}$ for TTT and IP directions, respectively) as increasing the temperature until reach a critical temperature (1073 K and 1223 K for TTT and IP directions, respectively) then the fracture toughness decreases from 0.1162 to 0.0819 $MPa \cdot m^{1/2}$ and from 0.6767 to 0.6170 $MPa \cdot m^{1/2}$, respectively. The significant changes at elevated temperatures are directly attributed to the viscous flow of the crack tip. In addition, the viscous flow contribution to the fracture surface energy of the 3D RF material is identified at elevated temperatures. Two curves of fracture surface energy vs. temperatures are obtained by fitting the experimental observations for the TTT and IP directions, respectively. Based on two fitted curves, we acquire that the activation energies of viscous flow are 220.3 kJ/mol and 811.1 kJ/mol for the TTT and IP directions, respectively.

Keywords: Random fibrous materials (RF materials); Elevated temperatures; Fracture toughness; Fracture surface energy; Viscous flow