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Numerical modeling of thermally induced microcracking in porous ceramics: an approach using cohesive elements

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Abstract

A numerical framework is developed to study the hysteresis of elastic properties of porous ceramics as a function of temperature. The developed numerical model is capable of employing experimentally measured crystallographic orientation distribution and coefficient of thermal expansion values. For realistic modeling of the microstructure, Voronoi polygons are used to generate polycrystalline grains. Some grains are considered as voids, to simulate the material porosity. To model intercrystalline cracking, cohesive elements are inserted along grain boundaries. Crack healing (recovery of the initial properties) upon closure is taken into account with special cohesive elements implemented in the commercial code ABAQUS. The numerical model can be used to estimate fracture properties governing the cohesive behavior through inverse analysis procedure. The model is applied to a porous cordierite ceramic. The obtained fracture properties are further used to successfully simulate general non-linear macroscopic stress-strain curves of cordierite, thereby validating the model.