6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

A MIXED ASSUMED STRAIN FINITE ELEMENT FORMULATION FOR VARIATIONAL-BASED ENERGY-MOMENTUM TIME INTEGRATIONS IN THERMODYNAMICS OF FIBER-REINFORCED CONTINUA

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Keywords: *Fiber-reinforced continuum, anisotropy, energy-momentum time integration, higher-order finite elements in space and time, multi-field principle of virtual power.*

In this paper, we present a new higher-order accurate energy-momentum time integration of fiber-reinforced thermo-viscoelastic continua. The energy-momentum schemes are derived from a multi-field principle of virtual power, in which mechanical as well as thermal fields are approximated independently by higher-order finite elements in space as well as in time. In comparison to Reference [1], we also consider thermal volume expansion of a visco-elastic matrix material and thermal expansion of unidirectional fibers, as well as tranversely-isotropic heat conduction due to Reference [2]. Therefore, in addition to the linear momentum and the deformation, the entropy and the temperature are approximated independently in space and time. The used multi-field principle of virtual power also introduces the strains and stresses of the matrix as well as the fiber strains and stresses as independent variables. As we consider an isochoric-volumetric decoupling of the free energy function of the matrix material, the volumetric strain and stress fields are approximated independently by spatial and temporal finite elements. In this way, the third and fourth tensor invariant of the right-Cauchy Green tensor and the structural tensor of the considered tranversely-isotropic material are independent fields and discretized independently in space and time together with their associated dual variables. We show numerical examples with transient Dirichlet and Neumann boundary conditions.

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