Phase field modeling of the crack propagation within multilayer HTS thin films under mechanical-thermal-electromagnetic multi-physical fields

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Abstract

Due to its outstanding electromagnetic properties, high temperature superconductor (HTS) has attracted much attention during the last few years. Nowadays, HTSs have already been widely used in many application areas such as high magnetic field magnets, electric cables, maglev trains etc. Among these, high magnetic field magnet is one of the most important application areas. HTSs will experience large thermal stress due to the mismatch of thermal expansion coefficients between materials constitute the magnets during cool down from room temperature to the operation temperature. In addition, significant electromagnetic stress will be introduced into the HTSs due to the huge Lorentz force induced during operation. Under these severe conditions, the safety and stability of HTSs are key issues that need to be taken care of. We introduce the phase field modelling framework of fracture to numerically simulate the crack propagation within HTS thin films under the mechanical-thermal-electromagnetic multi-physical fields. The phase field approach combined with the cohesive zone model is adopted to characterize the failure at the interface between layers of the HTSs. The crack patterns and the crack propagation paths within HTSs will be presented. The failure mechanism for the HTSs under different loading conditions will be discussed in detail.

Keywords: phase field, crack, multilayer thin film, high temperature superconductor, multi-physical field