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Mechanical–electric Model for Multifilament Composite Superconducting Strands

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In this study, a 3D multi-filament FEM model is developed for some kinds of superconducting strands, such as LMI strand, SMI-PIT strand and Bi2212 round wire. Some important factors, such as the initial thermal residual stress, the breakages of superconducting filament and twist pitch (for LMI, SMI-PIT) are taken into account. In this FEM model We calculate this thermal residual stress system, and apply the results into the multi-filament model. For considering the influence damage of SC filament on the electromechanical behavior of SC strand, we choose the representative volume element (RVE) as a concentric cylinder with a single filament in the matrix. Since the damage of the filament and its evolution are almost random, hence, we consider the distribution of the break points to be of a Weibull form. According to the GLS model of Curtin and Zhou, the effective constitutive relation of this RVE can be obtained. So a 3D FEM model of SC strand is built. The tension, bending and cyclic behaviors of these strands have been investigated, respectively. From the comparisons with these two experiments in axial tension and bending respectively, it can see that our model has good accuracy in the prediction of the mechanical behavior of the SC strands. The critical current of the strand under axial and bending loads are calculated with the invariant temperature and field strain functions, the results indicate that the damage and current transfer length in the strand have significant effects on the critical current. The calculated critical currents under tensile and bending load with every factor taken into consideration agree well with the experiments.

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