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[Invited] Modeling and simulation of flux pinning of REBCO thin films with artificial pinning centers

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Along with the progress of coated conductors, research to introduce artificial pinning centers into REBCO superconducting films is actively underway. Nanorods and nanoparticles or their hybrid structures were tried as artificial pinning centers, and, as a result, large global pinning forces of 20-30 GN/m3 at 77 K and values exceeding 1TN/m3 at 4.2 K have been realized. However, it is still insufficient to construct a practical model to understand these excellent superconducting characteristics. We consider data from several experiments taken at various conditions in order to discern the nature of the pinning mechanism in REBCO films with artificial pinning centers. Firstly, in this research, we proposed a new model on the angular dependence of Jc caused by nanorods and tried to understand its behavior. In addition, we further improved a flux pinning simulation based on TDGL equation so that it can be applied to REBCO thin film, and attempted to evaluate the optimum pinning volume fraction under the conditions of different temperatures and magnetic fields. According to these results, it became clear that not only the nanorods but also the pinning force of the matrix are very important for controlling the angle dependence of Jc. It is considered that Jc can be improved by adding second pinning centers instead of nanorods alone, as in the hybrid pinning structure. According to the TDGL simulation, the optimum pinning volume fraction is expected to be about 15-20%, but in experimental results it is only 3-5%. We will also discuss this difference.

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