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Shielding Current Analysis in High-Temperature Superconducting Film and Its Application

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For the purpose of contactlessly measuring a critical current density in a high-temperature superconducting (HTS) film, the contactless methods such as the inductive method, the hall probe method, and permanent magnet method have been developed. These methods are applied to the distribution measurement of the critical current density for the case with large-area samples such as an HTS wire or tape. On the other hand, they are also used to the defect detection of the HTS bulk or film. As a contactless method for measuring the critical current density, Claassen et al. have proposed the inductive method. By applying an AC current to a small coil placed just above an HTS film, they monitored a harmonic voltage induced in the coil. They found that, only when a coil current exceeds a threshold current, the third-harmonic voltage develops suddenly. They conclude that the critical current density can be evaluated from the threshold current. Incidentally, this method has been successfully employed as the distribution measurement of the critical current density the detection of a crack. The purpose of the present study is to develop a finite element method code for analyzing the time evolution of the shielding current density in a multiple-layered HTS film containing a crack and simulate the superconducting devices. For example, the inductive method was reproduced numerically in the previous study. The results of the computations show that when the coil approaches any cracks, the estimated value of the threshold current always decreases. Furthermore, even when the outer diameter of the coil is in contact with the edges, the accuracy of the inductive method is slightly degraded.

Submitters Country

Japan

Author: TAKAYAMA, Teruou (Yamagata University)

Co-authors: Prof. SAITOH, Ayumu (Yamagata University); Prof. KAMITANI, Atsushi (Yamagata University)

Presenter: TAKAYAMA, Teruou (Yamagata University)

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