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Current Capacity of Cu-sheathed Multi-filamentary Coated Conductors under the Influence of Spatial Variation of Local Critical Currents in Each Filament

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We have investigated the relationship between local critical current distribution and global current capacity of multi-filamentary RE-123 coated conductor (CC). RE-123 CCs have critical issues on (1) spatial inhomogeneity in local critical current distribution which would become an origin of local burnout of a magnet coil and on (2) magnetization current which affects the spatial and temporal stabilities of magnetic field distribution of a magnet. To compensate (2), striation or slitting of a CC to obtain narrow filaments would become a possible solution. However, (1) will become more serious because smaller defects affect more on it than the case of a wide CC. In other words, the relationship between (1) and (2) have been recognized as a trade-off problem. On the other hand, narrower filaments with electrical coupling will become a promising solution. For example, current in a filament can flow into the adjacent filament avoiding a local defect; this will contribute to the reduction of local heat generation. Furthermore, with the finite coupling resistance, the magnetization current will be confined just in each filament in a steady state; magnetization will be reduced successfully. However, the quantitative impact, which is indispensable for the design of a conductor, has not been clarified yet. We characterized local critical current distribution in each filament of a long multi-filamentary CC based on the experiment by Reel-to-reel scanning Hall-probe microscopy, and then estimated its local heat generation distribution and current capacity. The relationship among (i) inhomogeneity of local critical current distribution, (ii) inter-filament resistance, and (iii) current capacity of the multi-filamentary CC with an appropriate criterion will be summarized systematically. This will become very important information for deciding how homogeneous, how narrow, and how many filaments are needed for an appropriate conductor satisfying the requirements from magnet applications.
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