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Influence of local critical current degradation on quench characteristics of a ReBCO coil

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The simulation analysis of thermal and electromagnetic behaviors in ReBCO coils after a local normal conduction transition has been performed by many research groups. The numerical analysis, however, were about the behaviors after generating an initial normal spot and the occurrence factor of the initial normal conduction transition has not been sufficiently clarified yet. To clarify the occurrence factor of the initial normal conduction transition is very important to take coil protecting measures against the local normal conduction transitions. We focused on local critical current degradation and investigated the influence of the local critical current degradation on the thermal and electromagnetic behaviors around the local degradation region and the time change characteristics of the voltages across the degradation region. The local critical current degradation was produced by cutting a part of the width of a GdBCO tape. The current at the disconnection of the tape and the increasing speed of the voltages across the degradation region were measured in short samples and coils using the GdBCO tape. In the sample without stabilized copper layers covered by Styrofoam, the voltage rapidly increased in a short time and the sample was disconnected soon after the operating current exceeded the local critical current. On the other hand, the tape with the stabilized copper layers cooled by LN2 could stably maintain the voltage even when the operating current largely exceeded the local critical current. Moreover, the current at the disconnection of the tape with the stabilized copper layers cooled by LN2 was improved much more than that of the tape without the stabilized copper layers covered by Styrofoam. The differences of the current and thermal distributions between these samples and the relationship between the voltage increase and the current and thermal distributions were investigated by the finite element analysis.

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