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Study on conditions for successful quench protections of coils wound with coated conductors by short-sample experiments and quench simulations

Many coils wound with coated conductors burned, and there are arguments that the quench / thermal runaway of coated-conductor coil is peculiar and that its quench protection is difficult. Indeed, the non-uniform critical current of a coated conductor or its poor mechanical property on various aspects causes quench / thermal runaway. However, it should be noted that some coated-conductor coils were operated at currents that were more than their local critical currents and, then, thermally ran away. Quench over the critical current is quite natural in coils wound with low Tc superconductors (LTSs). Furthermore, the amount of stabilizer was rather small in early-stage coated conductors than in LTSs. We might expect too much the stability of coated-conductor coils, because of their high critical temperatures. One of the most important issues is to determine the conditions at which a coil can be protected after quench / thermal runaway.
We are studying these conditions for successful quench protections by experiments using short pieces of coated conductor, which simulate the quench and protection processes of coils wound with coated conductors. Our focus is on the feasibility of quench protection rather than the cause of quench / thermal runaway or quench propagation. Fast turnaround experiments enable us to acquire well-organized set of experimental data. The experimental results were compared with the results of numerical quench simulations. They agreed with each other reasonably by using the heat pulse initiating quench and the coefficient of thermal conductivity between the sample and the sample holder as fitting parameters.

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