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Quench behaviors of conduction-cooled coated conductors subject to transient and localized thermal disturbances

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If we use coated conductors for accelerator magnets, they might be subject to the transient and localized thermal disturbances caused by beam losses. There are various types of beam losses, but, here, we focus on the direct injections of particle beams to superconducting coils as the most severe event. We are studying the responses of coated conductors against such disturbances.
First, we study the modes of thermal disturbances caused by beam injections by using PHITS (Particle and Heavy Ion Transport code System), which was a software developed at JAEA. The compositions of coil, the energy of injected beam, the angle of the beam injection etc. are varied, and the magnitudes and the spatial distributions of deposited energy are studied.
Then, we carry out quench experiments using short pieces of coated conductors. The 20 cm-sample is cooled to 15 –40 K by using a GM cryocooler. The magnetic field up to 5 T can be applied, and the sample current up to 500 A can be supplied. After initiating quench by a small heater, the voltage near the heater and that across the entire sample are measured. The sample current is shut down after the entire voltage reaches a threshold value (50 mV, for example). This simulates the quench detection and protection. The hot spot temperature is estimated from the voltage near the heater and the temperature dependence of critical current as well as that of the resistance of copper stabilizer. After each quench experiment, the critical current of the sample is measured to see whether the sample degrades or not. The experimental results are compared with the numerical results by a quench simulation code. Using such experimental and numerical results, we discuss the conditions (current, detection time, shutting down time, etc.) required to protect magnets.

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