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Quench Properties of Resistive Superconducting Fault Current Limiters

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We have investigated quench properties of resistive superconducting fault current limiters (SFCL). Knowledge on quench properties of superconductors is important for the research and development of SFCLs, because quench property determines their performance. Investigation was focused on quantitative understanding of quench development in SFCLs. The SFCLs used in most of experiments presented here were fabricated by patterning Au/$YBa_2Cu_3O_7$ (YBCO) thin films grown on sapphire substrates into meander lines by photolithography. Sometimes a gold film was grown on the back side of the substrate and patterned into a meander line to measure the temperature at the back side of the SFCL. Some SFCLs were fabricated from bulk $Bi_2Sr_2CaCu_2O_8$. The SFCL was immersed in liquid nitrogen during the experiment for effective cooling, and subjected to simulated AC fault currents for quench resistance measurements. Analysis of the oscillatory component of quench resistance provided a way to investigate thermal properties of the SFCL in relation to quench phenomena. The oscillatory component of the resistance of the back meander line was smaller than, and out-of-phase with that of the front meander line. This observation enabled one to understand the manner the heat generated during quenches is transferred within the SFCL. The oscillatory component of the quench resistance was much smaller than the background component, and lagged behind the dissipated power by a certain value in phase angle throughout quenches. This behavior was universal for all Au/YBCO meander lines on sapphire substrates. Analysis showed that difference in phase and magnitude between resistance and power of SFCLs was related only with the thermal properties and the dimension of the SFCL. Thus, thermal properties of the SFCL could be investigated effectively by studying behavior of the oscillatory component of the quench resistance.

keywords : quench, superconducting fault current limiter, heat transfer, thermal properties

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