

Dynamic Magneto-optical Imaging of Transport Current Redistribution and Normal Zone Propagation in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Coated Conductor

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$\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ (YBCO) coated conductors (CC) with very high critical current density (J_c) over a broad range of magnetic field and temperature are now commercially available. Despite extensive study of the macroscopic quench behaviors, there is little understanding of the dynamic, microscopic behavior during the development of a normal zone and quench.

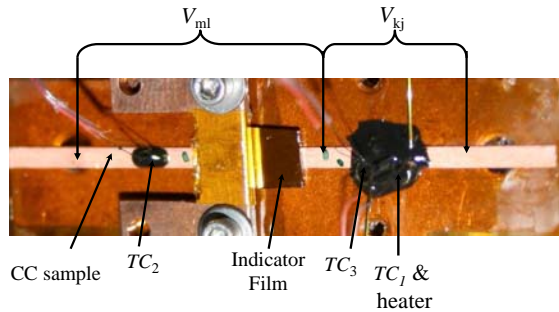


Figure 1. A photo of the mounted and instrumented YBCO sample (~1.42 mm wide) on the MOI cold finger

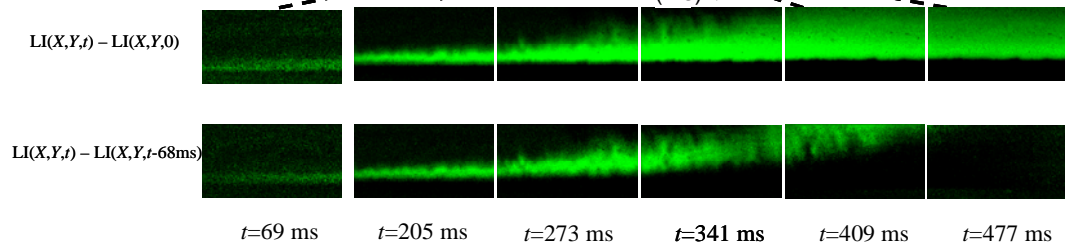
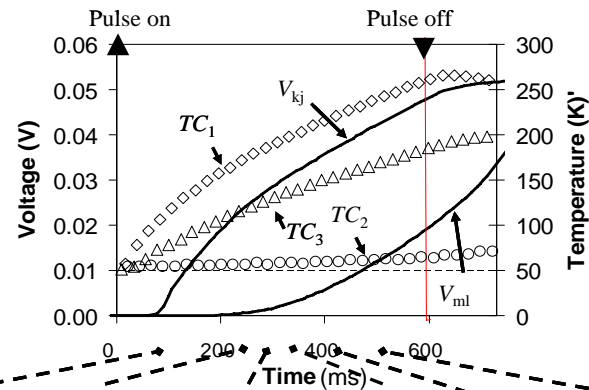


Figure 2 The graph plots the time-dependent voltages and temperatures during a quench with $I = 50$ A and heater pulse $V_p = 7.5$ V at 45 K. $t = 0$ is defined as the beginning of the heater pulse; the current is established prior to that.

In this letter, we for the first time present the real-time, dynamic observation of magnetic field redistribution during a thermal disturbance via magneto-optical imaging (MOI) with a high-speed, high-resolution CCD camera. It is found that the normal zone propagation front is diagonally-shaped while moving along the conductor length as shown in Figure 1. The real-time images are converted to a two-dimensional time-varying data set, providing additional insight into the current and magnetic field redistribution process and also establishing a new application of magneto-optical imaging. The sequence of MOI images, whose time-stamps are illustrated relative to the graph, are results from the two differentiation methods that show the dynamic penetration of magnetic field into the CC due to normal zone propagation as shown in Figure 2. Using this approach, the normal zone propagation velocity at 45 K is calculated as 22.7 mm/s for $I = 50$ A (~50% I_c).