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Critical Currents in Pulsed Fields from Non-linear Electrical Transport

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Abstract—A detailed understanding of vortex pinning and dynamics is imperative for technological applications of type II superconductors. One particularly powerful approach to probe vortex physics is nonlinear electrical transport measurements. Achieving non-linear curves and the extraction of the critical current density (*Jc*) and *n*-value in pulsed magnetic fields provides key tools for these studies. Using Fast Programmable Gate Array electronics, we measured reproducible current–voltage curves (I-V) in different superconducting thin films on single crystals and metal substrates grown by different methods. We show it is possible to measure *Jc* in high pinning coated conductors up to 65T, if the rapid vortex movement occurring during field pulses is considered to analyze the results. We compare measurements in three magnet systems with different maximum magnetic fields (*H*), duration and *dH/dt* at Los Alamos Pulsed Field Facility of the National High Magnetic Field Laboratory, here *t* is the time. We show the ability to measure *Jc* and *n* up to the highest accessible fields as well as to determine *Jc* and *n* continuously as a function of *H* in our newly commissioned mid-pulse magnet (300ms long pulse). We determined the window of *dH/dt* where meaningful data can be obtained. We also explore the effect of sample geometry in vortex dynamics and show what are the maximum currents we can apply. We compare the *Jc* performance of standard samples and those with nanoparticle additions, correlating linear and non-linear results in pulsed fields.

Keywords (Index Terms)—Critical currents, superconductors, pulsed magnetic field, vortex pinning, high magnetic fields

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