LN-1-INV

Accessing critical currents in large pulsed fields: challenges and opportunities

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Expanding non-linear transport (I-V) studies to magnetic fields above those accessible by DC magnets can bring valuable information on vortex pinning and phase diagram of superconductors. Very-high field all-superconducting and hybrid magnets make it technologically relevant to study vortex matter in this regime. However, pulsed magnetic fields reaching 100T in milliseconds impose technical and fundamental challenges that have prevented the realization of these studies. Here, we present a fast I-V DC technique that enables determination of the superconducting critical current in pulsed magnetic fields, beyond the reach of DC magnets.[1] We demonstrated this technique on standard and pinning enhanced REBa$_2$Cu$_3$O$_7$ (RE = rare earth) on single crystal and metallic substrates with excellent agreement with DC field measurements.[1,2] The I-V characteristics change with the magnetic field rate. We capture this unexplored vortex physics through a model based on the broken symmetry of the vortex velocity profile produced by the applied current.[1] By measuring J_c at 65T, 4K, we are able to observe the end of the power-law regime with important implications to applications and fundaments of the change of pinning regime.[2]

References

[1] Maxime Leroux, Fedor F. Balakirev, Masashi Miura, Kouki Agatsuma, Leonardo Civale, and Boris Maiorov, Phys. Rev. A. (2019)
[2] M. Leroux, F. F. Balakirev, L. Civale and B. Maiorov (in preparation)

Keywords: pulsed magnetic fields, current voltage curves, critical current, REBCO