Response of YBCO to Subcritical, Injected DC Current and 4MT/s Pulsed Magnetic Field

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Introduction

Integrating superconducting switches into emerging Superconducting Magnetic Energy Storage (SMES) devices would be an organic route for more efficient power conditioning enabling wider SMES use. While there has been considerable research in photo-induced yttrium barium copper oxide (YBCO) switching using ultra-fast lasers [1] and inductive switching with Type 1 superconductors (cryotrons) [2], there has been little effort with inductive YBCO switching for power applications-- mainly because of the high critical fields (H_{c2}) found with YBCO. To mitigate this, we want to investigate the inductive switching capability of YBCO when we simultaneously inject a near critical, DC current through YBCO—as what would be found in an operational SMES device.

Experimental

The 300 T single turn magnet supports this experiment. Air Force Research Laboratory provided the YBCO bridges. We inject a near critical, DC current into a superconducting YBCO bridge, while simultaneously injecting a RF current to probe the switch's state (as described in [3]). The surrounding single turn pulse magnet fires to transition the YBCO bridge from a superconducting to normal (S-N) state in a periodic manner.

Results and Discussion

See **Figures 1 and 2** below. For these un-doped samples within two degrees of the critical temperature, injecting a DC current suppressed the overall superconductivity, but does not appreciably change the S-N transition time or pulsed field value. Not shown, initial results suggest 1) the melting field (and not H_{c2}) is affected by injected current and 2) pulsed field ramp rate has no impact on H_{c2}.

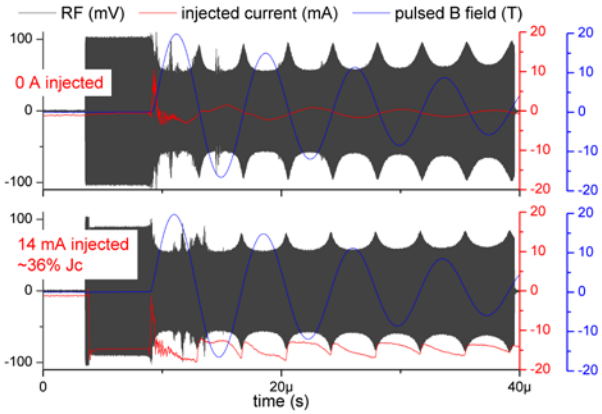

Figure 1. The RF modulates as the pulsed field swings and switches the YBCO. Two cases are shown-- without and with injected current.

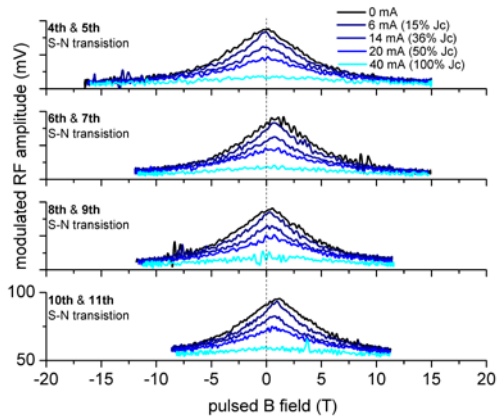

Figure 2. S-N transition time or field point is unaffected by injecting current.

The Way Forward

Now that this unique and challenging experiment is established with the right data analysis techniques, we should explore colder temperatures with doped YBCO, where flux pinning will play a larger roll with the switching behavior.

Acknowledgements

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References

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[2] Walker, R., Radio and Electronic Engineer, **25** (5), May 1963.
[3] B.E. Kane *et al*., Rev. Sci. Instr., **68** (1997).