Magnetic Field Dependence of the Critical Current in S/N Bilayer Thi lms

3EPT-01

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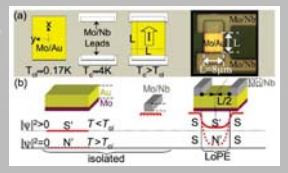
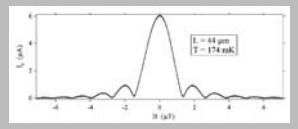
Abstract: Here we investigate the effects a non-uniform applied magnetic field has on superconducting transition-edge sensors' (TESs') critical current. This has implications on TES optimization. It has been shown that TESs' resistive transition can be altered by magnetic fields. We have observed critical current rectification effects and explained these effects in terms of a magnetic self-field arising from asymmetric current injection into the sensor. Our TES physical model shows that this magnetic self-field can result in significantly degraded or improved TES performance. In order for this "magnetically tuned" TES strategy to reach its full potential we are investigating the effect a non-uniform applied magnetic field has on the critical current.

Weak-link Behavior of TES

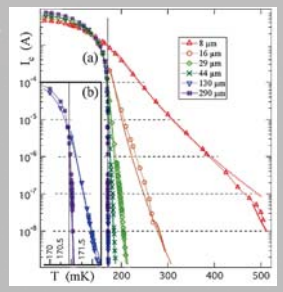




Fraunhofer-like oscillation of Ic(B) measured with uniform magnetic field applied with 400-turn superconducting coil

B_0: periodicity ($B_0 = \Phi_0/L^2$)

Ginzburg-Landau theory



Critical current (Ic) as a function of both temperature (T) and the TES length (L)

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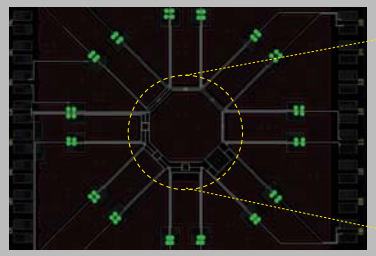
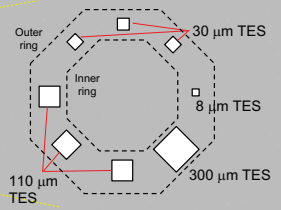
Experimental Set-up for Non-uniform Field

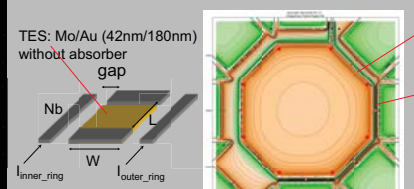


Schematic diagram (not to scale)



Calculated magnetic field

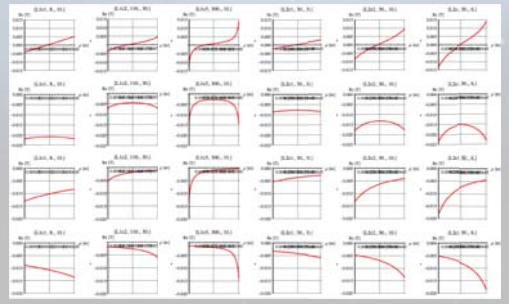
green: Bz < 0 (into page), oragne: Bz > 0 (out of page)



Positive Inner & Positive Outer

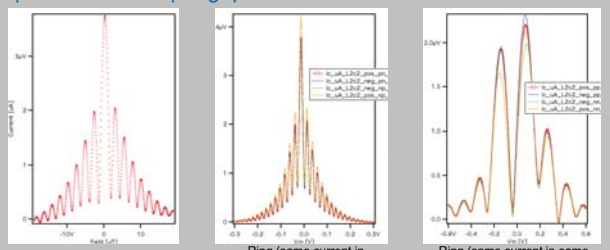
Positive Inner & Negative Outer

Magnetic field with various current config. in the rings



Measured Ic(B) using 400 turn coil and the "rings"

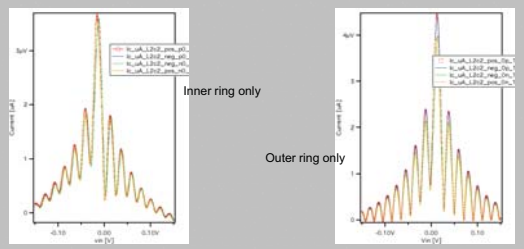
30μm TES with 10μm gap at 111 mK



400-turn coil (uniform field)

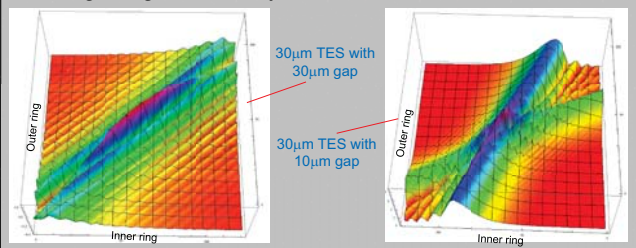
Ring (same current in opposite direction)

Ring (same current in same direction)

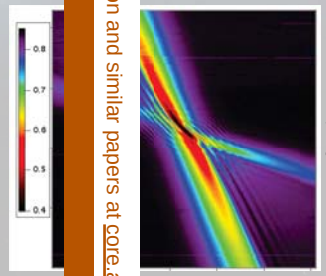


Measured Ic(B) with non-uniform field

Measurement scheme: apply sweeping currents independently in each ring using two Keithley SourceMeters



New m ement scheme for Ic(B)

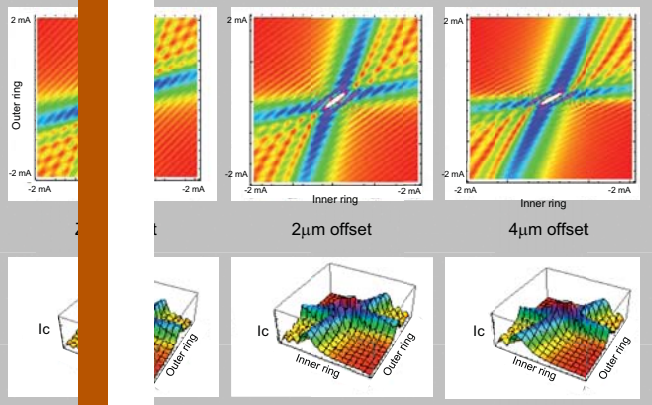


Sweep the inner ring with function generator

→ can be measured about one order of magnitude faster with more stable temperature control

Modeli B) to reproduce measured data

Simulate response of 30μm TES with 6μm gap and various offset (a l distance between the TES and the lead)



Summ d Discussion

- Criti ent of TES is a function of temperature, magnetic field TES size.
- Frau ike oscillation of critical current with uniform mag ld is a strong evidence of TESs' being a weak-link.
- We ome up with a theoretical model that is able to repr uch of the observed structure in the critical current as a n of non-uniform applied magnetic field.
- Furt k is underway to study larger L devices and also TES added normal metal structures used for noise mitig