



Do New Pnictide Superconductors Avoid the “Grain Boundary” Problem?

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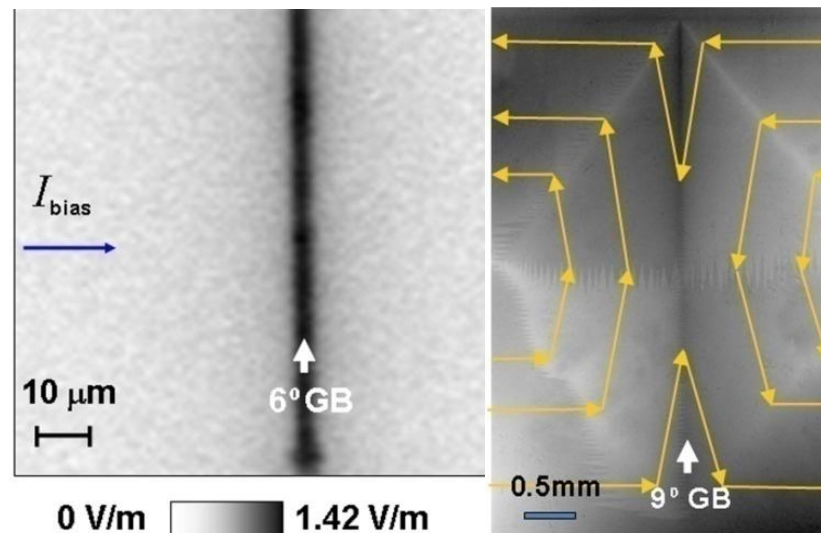
DMR-Award 0654118

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- It is well-known that grain boundaries (GB) reduce the ability for the copper-based high-temperature superconducting materials to carry a superconducting current, a big problem for future applications.
- Do the new pnictide materials avoid this “Grain Boundary” problem ?
- We grew pnictide films in collaboration with the leading thin film group of C-B Eom at the University of Wisconsin-Madison. We succeeded to make:
 - The first truly epitaxial thin pnictide films developed by novel template engineering (Lee *et al. Nature Materials* **9**, 397 (2010))
 - The first experimental demonstration of strong current blocking effect of GBs in thin film bicrystals. (Lee *et al. Appl. Phys. Lett.* **95**, 212505 (2009))
- The conclusion is that low carrier density and competing orders degrade superconductivity at GBs in pnictides, rather like they do in the cuprates. Rats.

This work was supported in part by the AFOSR.



(Left) Image of the Electric Field developed in the superconducting state of an epitaxial thin film of Co-doped BaFe_2As_2 . The dark line shows that the dissipation is all concentrated at the GB and not in the grains found on either side. The image at right is a magneto-optical image of the field induced by supercurrents flowing in the superconducting state. The superimposed current stream lines (yellow arrows) show how supercurrent is largely blocked by the depressed superconductivity of the grain boundary. These results are from a grain misalignment of only 6 degrees. The problem gets rapidly worse for larger misorientation angles, in a manner similar to that which occurs in YBCO.



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Senior mechanical engineering undergraduate student Jeremy Weiss (center) made all of the Co-doped BaAs₂Fe₂ targets used for the pulsed laser deposition (PLD) sample growth. Postdocs Chiara Tarantinti (left) and Akiyasu Yamamoto (JSPS fellow, now Assistant Professor at the University of Tokyo, right) played key roles in the characterization of the PLD grown samples. Image taken at MagLab Open House.

The search for better superconductors is a continuing thrust of forefront science. In the public mind, higher superconducting transition temperature always means a better superconductor, and more potential applications. HOWEVER, sensitivity to disorder is often most important in determining which new superconductors are best for technological applications.

Applications of the well-known copper-based high-temperature superconductors are very challenging because super-conductivity is suppressed at boundaries between crystalline grains inside the material.

This work shows that, sadly, the new pnictide superconductors suffer the same problems with grain boundaries.

Project led by Gurevich, Hellstrom and Larbalestier (FSU) in collaboration with C-B Eom (U. of Wisconsin-Madison) and X. Pan (U. of Michigan)