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Jhinhwan Lee
KAIST, South Korea

Switching iron-based superconductivity with spin current

We have explored a new mechanism for switching magnetism and superconductivity in a magnetically frustrated iron-based superconductor using spin-polarized scanning tunneling microscopy (SPSTM). Our SPSTM study on single crystal Sr_2VO_3FeAs is made up of alternating self-assembled FeAs monolayer and Sr_2VO_3 bilayers shows that a spin-polarized tunneling current can switch the FeAs-layer magnetism into a non-trivial C4 (2×2) order, which cannot be achieved by thermal excitation with unpolarized current. Our tunneling spectroscopy study shows that the induced C4 (2×2) order has characteristics of plaquette antiferromagnetic order in the Fe layer and strongly suppresses superconductivity. Also, thermal agitation beyond the bulk Fe spin ordering temperature erases the C4 state. These results suggest a new possibility of switching local superconductivity by changing the symmetry of magnetic order with spin-polarized and unpolarized tunneling currents in iron-based superconductors. We have also performed high-resolution quasiparticle interference (QPI) measurements, self-consistent BCS-theory-based QPI simulations and a detailed e-ph coupling analysis to provide direct atomic-scale proofs of enhancement of iron-based superconductivity due to the BCS mechanism based on forward-scattering interfacial phonons.

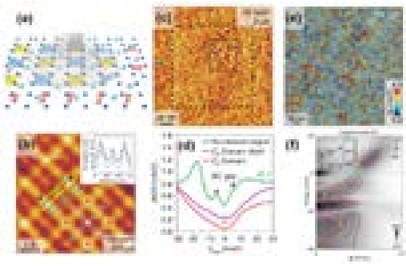

Figure-1: (a), (b) Atomic scale evidence of plaquette antiferromagnetic order induced in FeAs layer of Sr_2VO_3FeAs by injection of spin-polarized tunneling current and (c), (d) resultant local switching-off of iron-based superconductivity. (e)-(f) Quasiparticle-interference signature of enhancement of iron-based superconductivity due to C_2 defects locally enhancing e-ph coupling with the forward-scattering interfacial phonons.

Recent Publications

1. Jin-Oh Jung, Jhinhwan Lee, et al. (2017) Versatile variable temperature and magnetic field scanning probe microscope for advanced material research. *Review of Scientific Instruments;* 88: 103702.
2. Jhinhwan Lee (2017) Real-time digital signal recovery for a multi-pole low-pass transfer function system. *Review of Scientific Instruments;* 88: 085104.

Biography

Jhinhwan Lee has completed his Bachelor's degree from Seoul National University (1995). After obtaining his PhD degree from the same institution, he joined Professor J C Davis' Laboratory at Cornell University as a Postdoctoral Associate and was appointed Research Associate in 2007. He went to Korea Advanced Institute of Science and Technology as Assistant Professor and began his life-long investigations on magnetism and unconventional superconductivity. He has received Korea Physical Society Bombee Physics award in 2004 and the Albert Nelson Marquis lifetime achievement award in 2018. His works includes bandgap engineering of nanotube published in nature; scanning probe microscope for advanced material research is published as a cover paper in *Review of Scientific Instruments (*2017) and switching iron-based superconductivity using spin current published in Physical *Review Letters* with Viewpoint (2017).

jhinhwan@gmail.com