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Josephson effect studies of pairing symmetry in Fe-based superconductors

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To investigate the pairing symmetry in the recently discovered Fe-based superconductors, Josephson effect studies have been performed on two types of c-axis junctions incorporating 122-type iron pnictide superconductors: junctions between s-wave superconductors and iron pnictide superconductors [1] and junctions between electron-doped and hole-doped iron pnictide superconductors [2]. The ac Josephson effect was observed in the $I-V$ characteristics for both types of junctions under microwave irradiation. By applying external magnetic fields parallel to the junction interfaces, Fraunhofer-like patterns were obtained. Analysis based on the obtained modulation patterns suggests that the Josephson current is flowing along the c-axis direction within a typical area of 10×10 $(\mu\text{m})^2$. The presence of Josephson coupling between an s-wave superconductor and a 122-type iron pnictide superconductor along the c-axis strongly supports an s-wave symmetry in the iron pnictide superconductor. Moreover, our observed Josephson effect in the bicrystal junctions indicates that phase coherence can be established between electron-doped and hole-doped iron pnictide superconductors. Such a phase-coherent $p-n$ structure is an important component [3] for performing definitive phase-sensitive tests for the proposed $s\pm$ symmetry in Fe-based superconductors. Progress in carrying out such tests will be discussed. Recent results on systematic measurements of the energy gap using Andreev reflection spectroscopy with highly transparent contacts will also be presented. This work is supported by the NSF (DMR-0653535) and performed in collaboration with S. R. Saha, N. P. Butch, K. Kirshenbaum, J. Paglione, R. L. Greene, I. Takeuchi at UMD, and Y. S. Oh, Y. Liu, L. Q. Yan, K. H. Kim at SNU.

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