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Visualizing the vortex lattice in stoichiometric high Tc CaKFe4As4 superconductor

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Many single crystalline iron based superconductors can be understood by considering a s-wave superconducting order parameter that changes sign in two different parts of the Fermi surface. Interband scattering in such s+- superconductors is expected to produce pair-breaking close to crystalline defects, as a consequence of the sign changes of the order parameter. Unlike other superconductors, vortex lattices in single crystals of iron based superconductors are often disordered. However, it is still unknown if vortex pinning is due to pair breaking defects as a consequence of sign changing superconductivity or to substitutional disorder as in conventional superconductors. Here I will present Scanning Tunneling Microscopy studies in single crystals of stoichiometric CaKFe4As4. The superconducting critical temperature is very high, of Tc= 35 K, a value comparable to that found near optimal substitution levels in other non-stoichiometric iron based systems. I will discuss evidence for two-gap superconducting behavior and sign changing superconductivity. I will also show that the vortex lattice is hexagonal but becomes disordered after a few lattice spacings. Results of imaging individual vortices, show that the spatial variation of the superconducting order parameter within the vortex core has the same length scale for the two parts of the Fermi surface. Images of the whole vortex lattice show that disorder in the vortex positions appears because of pair breaking induced by scattering by defects.