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Optical conductivity of (Ba,K)Fe2As2: observation of a normal state pseudogap and the effect of impurity scattering in the superconducting order parameter

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We measured the detailed temperature dependence of the optical conductivity, down to 15 cm-1 (2 meV), of (Ba,K)Fe2As2 iron-pnictide superconductors in the underdoped and optimally doped regimes. In the underdoped samples we observe prominent gaps opening due to the appearance of a spin density wave (SDW) order. Below the SDW temperature but far above the superconducting transition, we observe the opening of a pseudogap. The energy scale at which this pseudogap opens is comparable to the that of the superconducting gap. A spectral weight analysis shows that this pseudogap shares the same electronic states as the superconducting condensate and suggests that it is a precursor to superconductivity. When entering the superconducting state, a decrease in the low energy optical conductivity indicates the formation of a superconducting condensate and the opening of a superconducting gap. In the optimally doped sample (Tc = 39.1 K) the optical conductivity vanishes, within experimental error, below 160 cm-1 (20 meV), indicating a fully open gap. A deeper analysis indicates that 2 superconducting gaps are required to quantitatively describe the data. The gap values agree with STM and ARPES data and qualitatively follow the expected behavior for a strongly coupled two band superconductor. The fully open gaps observed in (Ba,K)Fe2As2 contrasts to the strong residual optical conductivity measured in Ba(Fe,Co)2As2. We can reconcile this discrepancy in the framework of a s+/- gap symmetry where FeAs in-plane non magnetic impurities act as pair-breaking centers.

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