

# Optical conductivity of (Ba,K)Fe<sub>2</sub>As<sub>2</sub>: 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<sup>-1</sup> (2 meV), of (Ba,K)Fe<sub>2</sub>As<sub>2</sub> 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 (T<sub>c</sub> = 39.1 K) the optical conductivity vanishes, within experimental error, below 160 cm<sup>-1</sup> (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)Fe<sub>2</sub>As<sub>2</sub> contrasts to the strong residual optical conductivity measured in Ba(Fe,Co)<sub>2</sub>As<sub>2</sub>. We can reconcile this discrepancy in the framework of a s<sub>±</sub> gap symmetry where FeAs in-plane non magnetic impurities act as pair-breaking centers.

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