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Magnetism in CaFe2As2 and Phase Separation in Superconducting Ba0.5K0.5Fe2As2 and Sr0.5Na0.5Fe2As2 Single Crystals: A Mössbauer Study

abstract

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poster

Summary

The ternary A1-xMxFe2As2 (A=Ca, Sr, Ba and Eu; M=K and Na) were found to have similar structural, magnetic and superconducting properties with the related RFeAsO1-xFx [1]. The Ca2Fe2As undergoes a first-order high-temperature h-T tetragonal to low-temperature l-T orthorhombic phase transition at TS~170K [2]. Concomitant with the structural transition the Fe moments order in a commensurate AFM structure [3]. This compound becomes superconducting either under moderate applied pressure and or Na-doping [4,5]. The Ba0.5K0.5Fe2As2 and Sr0.5Na0.5Fe2As2 are superconductors with Tc ~37 K and ~35 K, respectively. ⊠SR measurements have shown a coexistence of superconductivity and phase separated static magnetic order in these compounds [6].
Mössbauer spectroscopy have been used to investigate the magnetic and structural phase transition of CaFe2As2 as well as the occurrence of phase separation in superconducting Ba0.5K0.5Fe2As2 and Sr0.5Na0.5Fe2As2 single crystals. A mosaic of single crystal plates, with the c axes parallel to ⊠-ray direction, were built to perform the Mössbauer transmission measurements. Room temperature measurements revealed that the main component of electric field gradient Vzz is along c axis for these ternary compounds. For the non superconducting CaFe2As2 an abrupt increase of the magnetic hyperfine field Bhf below TN~170K was observed indicating a first-order magnetic transition. Low temperature spectra fits lead to Vzz >0 with Fe moments lying in the (a,b) plane. The quadrupole splitting ⊠EQ values have a discontinuity at ~170K confirming that structural and magnetic transition occurs concomitantly. The Mössbauer spectra of Ba0.5K0.5Fe2As2 and Sr0.5Na0.5Fe2As2 have a unique crystal site for Fe at room temperature, however at 4.2K the presence of two phases is clearly seen. For Ba0.5K0.5Fe2As2 ~ 51% of Fe is in a paramagnetic state while the remaining is in a magnetic phase with small magnetic moments (~0.15⊠B). For Sr0.5Na0.5Fe2As2 only ~12% of Fe are paramagnetic, the remaining Fe are in a magnetic state with magnetic moments of the order of ~0.57⊠B.

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