Neutron Scattering Study on the Newest 245 Family of Fe-based Superconductors

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Recently a new family of metal intercalated iron selenide superconductors of Tc above 30 K has been discovered. We will present the determination of the sample composition, crystal structure and magnetic order using neutron diffraction technique. Contrary to previous belief, the materials are mostly charge balanced, instead of heavily electron doped, with the chemical formula close to $A_xFe_{2-x/2}Se_2$ and the Fe valance close to +2 [1]. In superconducting samples x $\sim$ 0.8, the Fe vacancies order into an almost perfect pattern in a five times larger unit cell and a large moment block checkerboard antiferromagnetic order is found to coexist with superconductivity [2]. This is so for all the superconductors discovered so far: A=K, Rb, Cs, (Tl,K), and (Tl,Rb) and their appropriate chemical composition is close to $A_{0.8}Fe_{1.6}Se_2$ or $A_2Fe_4Se_5$ [3]. For non-superconducting samples, the Fe vacancy order is only partial and a transport gap is present at low temperature [4]. These results demonstrate a very different kind of superconductors from all previous iron based high Tc superconductors, and a new mechanism is anticipated.

[1]P. Zavalij et al., Phys. Rev. B **83**, 132509 (2011).
[2]W. Bao et al., arXiv:1102.0830 (2011).
[3]F. Ye et al., arXiv:1102.2882 (2011).
[4]W. Bao et al., arXiv:1102.3674 (2011).

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