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Materials and Physics in Pnictide Superconductors

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Superconductivity in the pnictides has shown itself to be very interesting and attractive. Some experimental results have revealed that the superconducting mechanism could be unconventional. In this talk I will survey our recent progress of both material synthesizing and physical properties of this rich family. We have made several major contributions to the synthesizing of new pnictide superconductors. (1) Fabrication of the hole doped $\text{RE}_{1-x}\text{Sr}_x\text{FeAsO}$ samples (RE=La and Pr); (2) Fabrication of a series of new parent compounds DvFeAsF (Dv=divalent metals: Sr, Ca, Eu etc.) and many new superconductors with T_c beyond 50 K by doping electrons into the system; (3) Invention of the new material $(\text{Sr}_3\text{Sc}_2\text{O}_5)\text{Fe}_2\text{As}_2$ with rather large spacing distance between the FeAs planes. We have successfully grown the $\text{NdFeAsO}_{1-x}\text{F}_x$ and $\text{Ba}_{1-x}\text{K}_x\text{Fe}_2\text{As}_2$ single crystals. It is found that the anomalous electron scattering in the normal state cannot be simply attributed to the multiband effect. The influence given by the magnetic correlation may play an important role. Specific heat, lower critical field and point contact tunneling all indicate the unconventional superconductivity and multigap features, while the paring symmetry of the superconducting gap may be a non-trivial issue. In the 1111 phase, the superfluid density is rather low and contains probably a nodal feature. While in the 122 phase, both the superfluid density and the quasiparticle density of states is about 5-10 times higher than that in the 1111 phase. An s-wave component was found in the 122 phase. I will also report the measurements on anisotropy, critical current density, critical fields and vortex phase diagram. Small anisotropy, high upper critical field and fish-tail effect (in 122) were observed. All these suggest very good potential applications. In collaboration with Gang Mu, Zhaosheng Wang, Huiqian Luo, Huan Yang, Xiyu Zhu, Ying Jia, Yonglei Wang, Fei Han, Bing Zeng, Bing Shen, Cong Ren, Lei Shan.