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Superconductivity of the "1 1 1" type iron pnictide LiFeP

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ABSTRACT

Article history: Accepted 16 November 2009 Available online 22 December 2009 We report studies on a new iron based LiFeP superconductor. The compound takes the same structure to LiFeAs containing a "FeP" conduction layer. Superconductivity was achieved up to 6 K. The new superconductor is featured with itinerant behavior at normal state.

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1. Introduction

After the discovery of the new superconductor LaFeAsO [1] of the iron based superconductor, the superconductive transition temperature T_c was optimized to 55 K by substituting other rareearth ions for La^{3+} and F^{-} for O^{2-} . Without changing the basic structural unit, the iron pnictide layer, some new systems have also been found to be superconductors, which are AEFe₂As₂ (AE for alkali earth metal) [2] (122), AFeAs (A for alkali metal) (111) [3], and FeSe (11) [4]. The high transition temperature in these itinerant systems containing magnetic element Fe challenge the conventional BCS theory [1–8]. It is very important to discover the underlying superconducting mechanism for iron based superconductors. It will be helpful to quest the novel physics through searching for new superconductors with simple crystal structure. Here, we report a new superconductor LiFeP produced by completely substituting P for As in "1 1 1" system, which can become superconductive with T_c up to 6 K.

2. Experimental

The polycrystalline samples of nominal LiFeP were synthesized by conventional solid-state reaction. The starting materials of Li and FeP are mixed according to the nominal formula. The FeP precursors were synthesized from high-purity Fe and P powders that were sealed into an evacuated quartz tube and sintered at 800 °C for 10 h. The compounds can be synthesized using either high pressure method or traditional method. The former is sintering the mixed materials wrapped with gold foil at 1.8 GPa, 800 °C for 1 h, and the later is sintering the components sealed into a quartz tube at 800 °C for 30 h. All preparative manipulations were carried out in a glove box protected with high purity Ar.

The samples are characterized by X-ray powder diffraction with a Philips X'pert diffractometer. The resistance was measured using the standard four probe method with a PPMS system, while the DC magnetic susceptibility was measured using SQUID magnetometer (Quantum design).

3. Results and discussion

The "1 1 1" type LiFeP, the same as LiFeAs [3], crystallizes into Cu₂Sb type tetragonal layered structure with space group P4/ nmm [6], which is shown in Fig. 1. The lattice parameters obtained for LiFeP are a = 3.692 Å, c = 6.031 Å. In comparison with LiFeAs, LiFeP can be viewed as a compressed "1 1 1" phase. Moreover, hydrostatic pressure made T_c of LiFeAs decreases linearly with pressure at a rate of ~1.38 K/GPa [7]. This can explain the lower T_c of LiFeP.

Fig. 2 shows the temperature dependence of the electric conductivity of LiFeP. The normal state of LiFeP shows good metallic behavior without an abrupt change of resistivity that usually proceeds the spin density wave (SDW) as manifested for the "1 1 1 1" [5] or "1 2 2" [4] type iron based system. With the different nominal composition of Li content, samples show almost the same superconducting transition with T_c^{nset} about 6 K. This is quite similar to the LiFeAs, where the T_c seems not sensitive to the nominal Li content [3]. The first-principle calculations for LiFeAs indicated little change of density of states (DOS) or Fermi surface topology with Li content that could account for its small influence on T_c [8]. The same situation may be valid for the LiFeP case.

Fig. 3 shows the DC magnetic susceptibility for samples of LiFeP, which are measured in both zero field cooling (ZFC) and field cool-



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Fig. 1. Crystal structure of "1 1 1" type LiFeP.



Fig. 2. Temperature dependence of the electric conductivity of LiFeP.



Fig. 3. DC magnetic susceptibility for sample of nominal Li_{0.9}FeAs.

ing (FC) mode with H = 30 Oe. The large Meissner signal indicates the bulk superconducting nature of the sample.

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References

- [1] Y. Kamihara, T. Watanabe, M. Hirano, H. Hosono, J. Am. Chem. Soc. 130 (2008) 3296.
- [2] M. Rotter, M. Tegel, I. Schellenberg, W. Hermes, R. Pöttgen, D. Johrendt, Phys. Rev. B 78 (2008) 020503(R).
- [3] X.C. Wang, Q.Q. Liu, Y.X. Lv, W.B. Gao, L.X. Yang, R.C. Yu, F.Y. Li, C.Q. Jin, Solid State Commun. 148 (2008) 538.
- [4] F.-C. Hsu, J.-Y. Luo, K.-W. Yeh, T.-K. Chen, T.-W. Huang, P.-M. Wu, Y.-C. Lee, Y.-L. Huang, Y.-Y. Chu, D.-C. Yan, M.-K. Wu, Proc. Natl. Acad. Sci. USA 105 (2008) 14262.
- [5] H.H. Wen, G. Mu, L. Fang, H. Yang, X.Y. Zhu, Eur. Phys. Lett. 82 (2008) 17009.
- [6] Z. Deng, X.C. Wang, Q.Q. Liu, S.J. Zhang, Y.X. Lv, J.L. Zhu, R.C. Yu, C.Q. Jin, EPL 87 (2009) 37004.
- [7] S.J. Zhang, X.C. Wang, R. Sammynaiken, J.S. Tse, L.X. Yang, Z. Li, Q.Q. Liu, S. Desgreniers, Y. Yao, H.Z. Liu, C.Q. Jin, Phys. Rev. B 80 (2009) 014506.
- [8] D.H. Lu, M. Yi, S.-K. Mo, A.S. Erickson, J. Analytis, J.-H. Chu, D.J. Singh, Z. Hussain, T.H. Geballe, I.R. Fisher, Z.X. Shen, Nature 455 (2008) 81.