Substituting dependence of the ordered moment in BaFe2(As,P)2

S. Ibuka, K. Matan and T. J. Sato
NSL, ISSP, University of Tokyo and JST-TRIP

One major difference between conventional and high-Tc-cuprate superconductors is the proximity to a competing magnetically ordered state in the latter, and it has long been believed that magnetic fluctuations could replace the role of phonons in mediating an electronpairing interaction. This mechanism could give rise to more tightly bound Cooper pairs, elevating the transition temperature. The recent discovery of iron pnictide superconductors [1] with T_c exceeding 50 K [2] in close proximity to antiferromagnetic order reinvigorates this idea.

BaFe2As2 is one of the parent compounds of iron pnictide superconductors, which shows antiferromagnetic transition at $T_N = 140$ K. In the early reports, it was shown that the transition temperature was suppressed by carrier doping and superconductivity was induced in the proximity to the vanishing point of the magnetic transition as the case of hole doping in $(Ba,K)Fe_2As_2$ [3] and electron doping in $Ba(Fe,Co)_2As_2$ [4]. After that, a novel report [5] came in which showed the superconductivity at $T_c = 30$ K induced by isovalent substitution in $BaFe_2(As_{0.68}P_{0.32})_2$. The report has modified our common knowledge that varing the electron density is one of the essential way to break the magnetic stability. In this system, we may obtain experimental information which is kept away from the effect of carrier change and the data will become a desirable source to discuss the mechanism of the superconductivity theoretically in detail. Substituting dependency of the size of the ordered moment and the temperature development of it in the antiferromagnetic phase are basical physical quantities to study the role of magnetism in the superconductivity.

Then we made three powder samples of $BaFe_2(As_{1-x}P_x)_2$ $(x = 0.06, 0.15, 0.35)$ and have performed the magnetic elastic neutron scattering study at ISSP-GPTAS the triple-axis spectrometer. The samples were made by solid phase reaction at 1323 K for more than 72 h in an electric furnace. The data shown in Fig. 1 is a temperature dependence of the peak intensity at antiferromagnetic position $Q = (103)_{Orth}$ taken with $E_i = 14.7$ meV and the collimation of 40′-PG-40′-S-40′-PG-Open in a double-axis mode. For $x = 0.06$ and 0.15, antiferromagnetic transition was observed at $T \sim 125, 90$ K respectively. On the other hand, for $x = 0.35$, only which shows superconductivity in the three samples, intensity increase was not observed in the accuracy of this experiment. At lowest temperature ($T = 3$ K), intensity increse was not observed even in other Q positions, either. From these results, we found that the ordered moment was certainly suppressed by P substitution, and it was completely suppressed and vanished at $x = 0.35$ superconductor at all.

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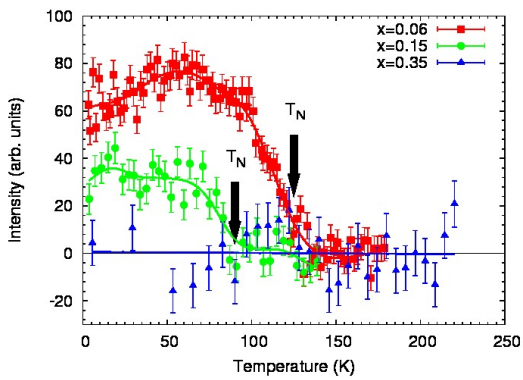

Fig. 1. Temperature dependence of magnetic intensity at Q =(103).