Strain effect on the magnetic and structural properties of Ba $(Fe_{1-x}Co_x)_2As_2$

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One of the common properties of bilayer iron pnictides (AFe_2As_2) is that they have high temperature tetragonal (C4 symmetry) paramagnetic phase which changes to low temperature orthorhombic (C2 symmetry) antiferromagnetic phase upon cooling. The structural and magnetic transitions are simultaneous for parent compounds whereas they split upon electron doping. The change from tetragonal to orthorhombic phase creates twin domains inside the crystal making it difficult to study directional dependence of physical properties (anisotropies). A number of recent experiments have shown that the application of uniaxial strain is an effective way of detwinning bilayer pnictides in order to study their inherent electronic anisotropy [1-3]. The uniaxial strain breaks C4 symmetry of tetragonal phase and gives a unique direction to the measurement. The transport measurement on detwinned crystals of parent as well as cobalt doped $BaFe_2As_2$ showed electronic anisotropy that starts well above the nominal structural transition temperature T_s. Our recent experiment on parent $BaFe_2As_2$ showed that the uniaxial strain applied along orthorhombic b axis breaks the C4 symmetry both by structural lattice distortion as well as long range spin ordering which is evident from increased structural and magnetic transition temperatures relative to strain free case. We also found that the structural and magnetic transition temperatures split from each other which were otherwise simultaneous in strain free case [1].

On the other hand, doping with cobalt in $BaFe_2As_2$ and replacing iron, the transition onset temperatures split from each other as well as move to lower temperature along with decreases in the ordered magnetic moment and orthorhombicity. Previous transport measurements on detwinned single crystals of $Ba(Fe_{1-x}Co_x)_2As_2$ showed that the electronic anisotropy is a non-monotonic function of cobalt concentration which increases at first and then decreases back to zero [2]. The anisotropy is maximum for about x = 0.03. It is also reported that there exists tricritical point at particular cobalt concentration where the magnetic transition changes from first order to second order whereas the structural transition is always second order.

This report is based on our recent experiments on series of $Ba(Fe_{1-x}Co_x)_2As_2$ samples (x = 0.015, 0.03 and 0.057) on C-5 and N-5 spectrometers at the Canadian Neutron Beam Centre. The purpose of the experiment was to study the effect of uniaxial strain on transition temperatures on cobalt doped crystals where the magnetic (T_n) and structural (T_s) transitions are already split. Our study was focused on how the spin nematic fluid that is supposed to exist in tetragonal paramagnetic phase responds to uniaxial pressure both above and below the tricritical point of x = 0.025. Our results showed that for x = 0.015 (underdoped superconductor) the splitting is unchanged; however, both T_s and T_n increase by about 8 K. For x = 0.03 which is close to tricritical point, there is no change in T_s and T_n whereas in x = 0.057 (over doped superconductor) we could not find any structural and magnetic transition. Fig. 1 shows the result of our measurement for T_s and T_n in both pressed and unpressed case as a function of Co doping. It is still not clear to us whether the effect of uniaxial pressure decreases monotonically with cobalt

concentration or there is crossover somewhere around tricritical point x = 0.025. We will try to answer this question in our next beam time looking at other samples that are close to x = 0.025.

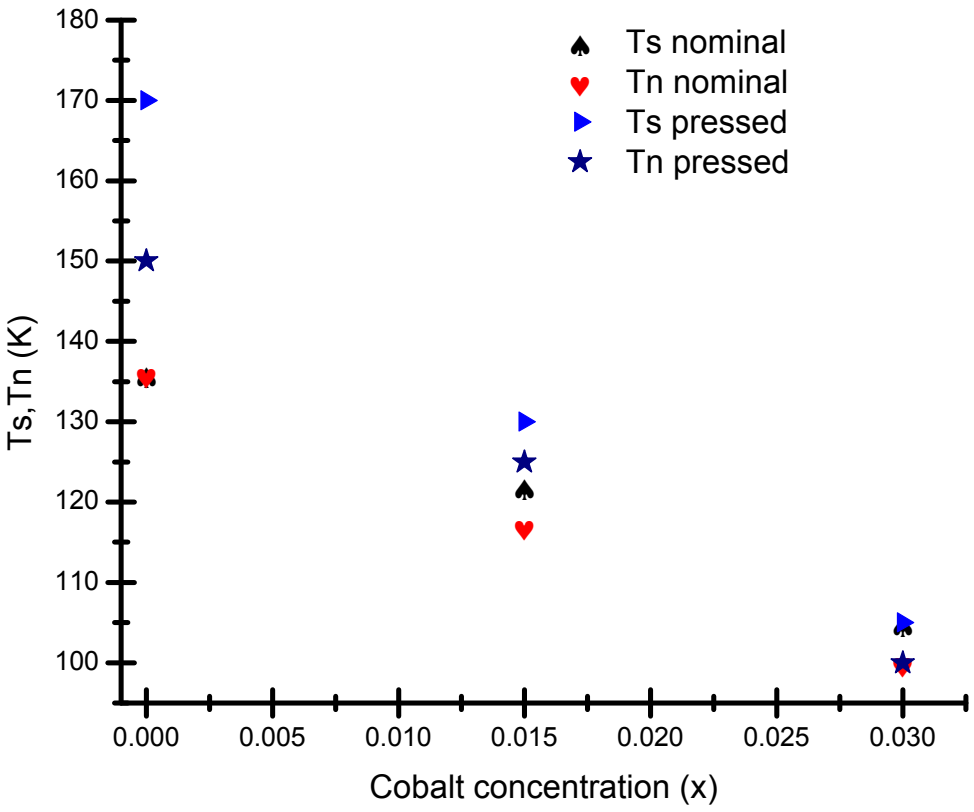

Fig. 1 Variation of T_s and T_n as function of cobalt concentration for both pressed and unpressed condition. Similar pressure of about 2 MPa was applied to each sample.

References:

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