Highlights

Superconductivity —2017

Experimental Evidences for Static Charge Density Waves in Iron Oxy-pnictides

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By means of high-resolution synchrotron X-ray powder diffraction and transmission electron microscope analysis of Mn-substituted LaFeAsO samples, it has been demonstrated the development of a static incommensurate modulated structure across the low-temperature orthorhombic phase. The incommensurate structural distortion is likely originating from a charge-density-wave (CDW) instability, a periodic modulation of the density of conduction electrons associated with a modulation of the atomic positions.

Our results indicate that the Fermi surface nesting can induce a CDW state in Fe oxy-pnictides, responsible for the structural transition observed at low temperature. Remarkably the tetragonal to orthorhombic transformation induces a rotation by 45° of the unit cell; hence the in-plane $\mathbf{k}_{nesting} = (\pi,\pi)$ calculated for the high temperature tetragonal phase is parallel to the in-plane $\mathbf{k}_{modulation} = (\delta,0)$ detected for the low-temperature orthorhombic phase by HRTEM analysis. This is the exact situation expected for a CDW state.

Our observation of a static CDW in $La(Fe_{1-x}Mn_x)AsO$ reveals the possibility of an intrinsic and widespread tendency towards charge ordering in Fe-based superconductors and discloses a new view for the phenomenology and phase diagrams of Fe based superconductors. The possible role of CDW fluctuations for the mechanism of the nematic and orthorhombic phase formation as well as their interplay with superconductivity represent new relevant subjects for both experimental and theoretical researches.

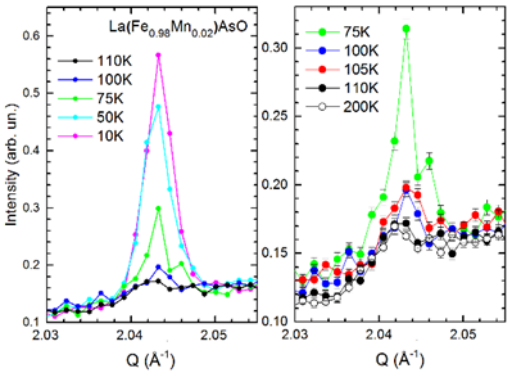

Fig.1: Thermal evolution of the 1st order satellite peak of $La(Fe_{0.98}Mn_{0.02})AsO$, marking the occurrence of the CDW state.

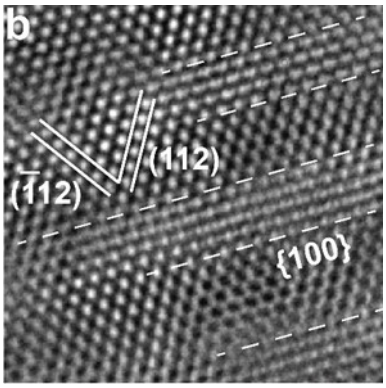

Fig.2: HRTEM image of $La(Fe_{0.98}Mn_{0.02})AsO$ phase at 94 K evidencing structural modulation.