Study on possible correlation of superconductivity with defects and superparamagnetism in undoped AFe$_2$As$_2$ with A=Ca, Sr and Ba

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Extensive studies have been carried out on the induction of bulk superconductivity in the Fe-pnictide 122 system with a $T_c$ up to 38 K through doping and/or pressure. However, non-bulk superconductivity has also been detected unexpectedly in undoped AFe$_2$As$_2$ where A = Ca, Sr, and Ba with $T_c$ = ~12K, ~22K and ~23K, respectively. The reason for the observation remains unknown. Recently, systematic investigation shows that highly anisotropic superconductivity with a $T_c$ up to 49 K and superparamagnetism occur in rare-earth doped Ca122. Further examination reveals slight deviation from the 1:2:2 stoichiometry which correlates closely with the occurrence of non-bulk superconductivity and superparamagnetism in these samples. We have therefore decided to investigate systematically the stoichiometry, defects, magnetism and superconductivity in undoped AFe$_2$As$_2$ single crystals under different synthesis conditions where A = Ca, Sr, and Ba. Results will be presented and discussed.