the Iron-based Material Growth and Its Transport Property

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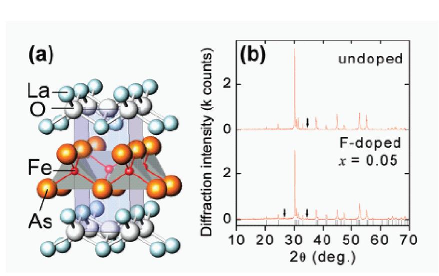
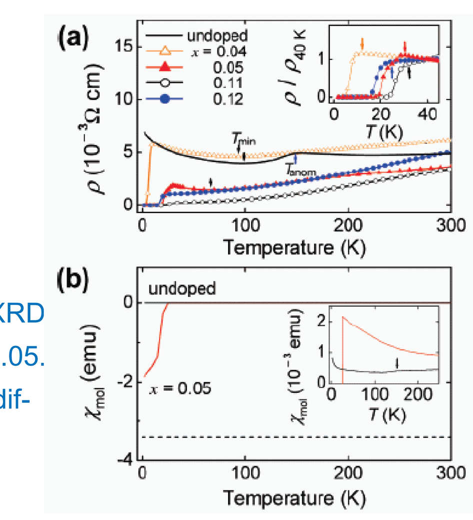
Introduction

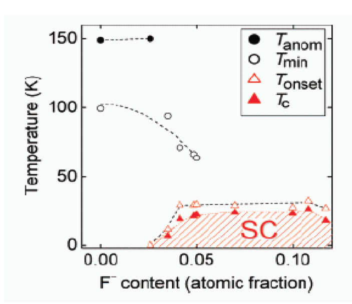
The iron-based material has been a hot topic this year since the "1111" La[O1-xFx]FeAs[1] with Tc=26K firstly discovered by the Japanese Scientists. Soon the other SC Re[O1-xFx]FeAs(Re=rare earth) with Tc up to 56K were made in series. Then the other systems "122" [Ba1-xKx]Fe2As2 and "11" α-FeSe were discovered in succession. Because the iron-based material is the second high temperature superconductor besides the cuprates, our group has also tried to reveal the superconducting mechanism behind this new material. So we began to grow the iron-based material and then tested their sturctures, compositions and transport properties.



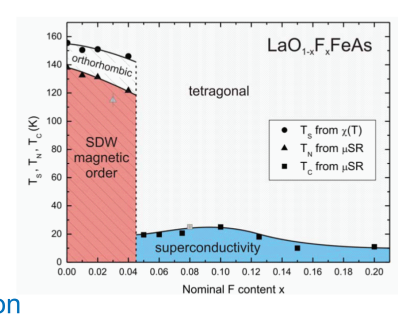
(a) Crystal structure of LaOFeAs.(b)Powder XRD patterns of LaOFeAs and La[OxFe1-x]As:x=0.05. Black bars at bottom show calculated Bragg diffraction positions of LaOFeAs. Arrows denote peaks due to impurity phase.[1]



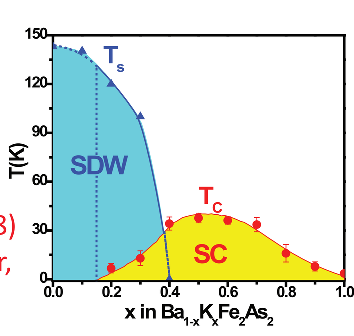
(a)Electrical resistivity versus temperature for undoped and La[O1-xFx]FeAs: x=0.04, 0.05, 0.11, and 0.12. Arrows show onset transition temperatures. (b) Molar susceptibility versus T for undoped and La[O1-xFx]FeAs: x=0.05. The dotted line denotes perfect diamagnetism for the sample.[1]



Tc, Tonset, and Tmin in the ρ–T curves as a function of F⁻ content(x) for La[O1-xFx]FeAs. Tc is defined as the temperature where the ρ value becoms half of that at Tonset. Tanom values for the undoped and LaO0.97F0.03FeAs are also shown. Dotted curves are guides for eyes.[1]



The doping dependence of the magnetic and superconducting transition temperatures determined from the μSR experiments. Also shown are the tetragonal to orthorhombic structural transition temperatures Ts determined from resistivity measurements which show a king and subsequent strong reduction below Ts.[2]

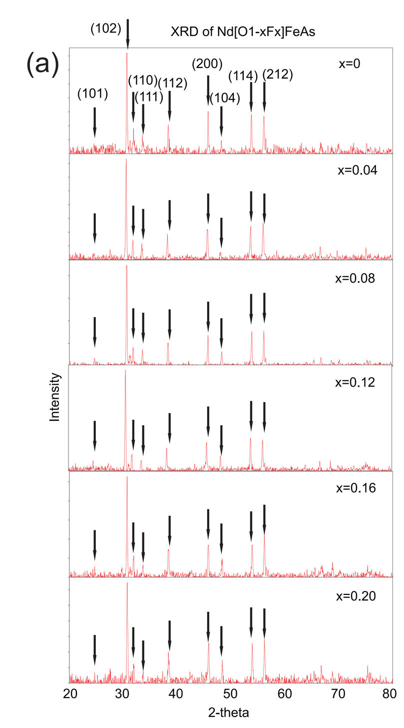


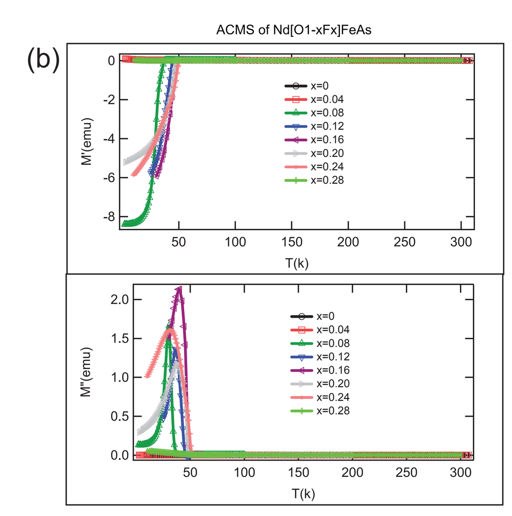
The composition-temperature phase-diagram, showing the structure, magnetic and superconducting transitions. The Ts denotes the temperature of the simultaneous structural and magnetic transition, and Tc the superconducting one.[3]

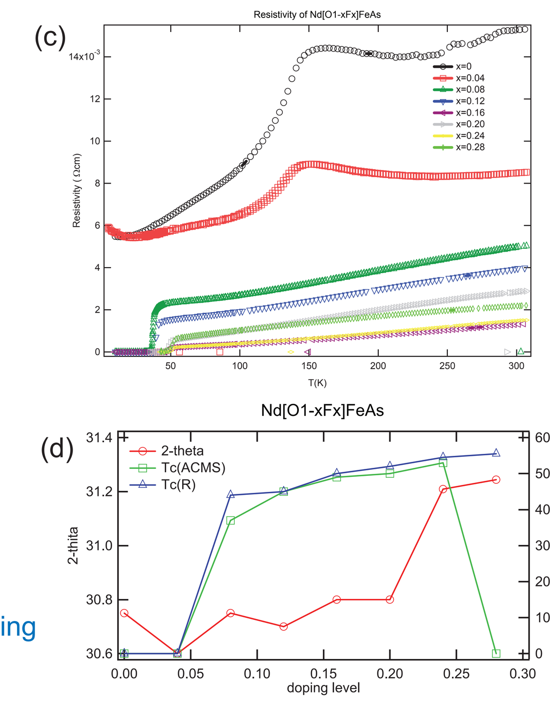
Ref 1. Y. Kamihara et al., J. Am. Chem. Soc. 130, 3296(2008)
Ref 2. H. Luetkens et al., Nature Materials Letter, 10.1038/NMAT2397
Ref 3. H. Chen et al., Europhys. Lett. 85, 17006 (2009)

the Polycrystals of the "1111" system

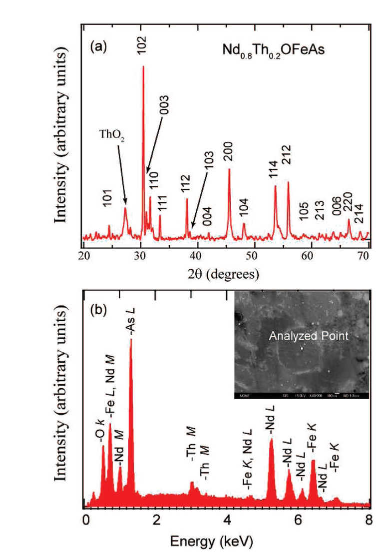
The polycrystals of the "1111" system were grown by the two step solid state reaction method. We firstly synthesized the ReAs, FeAs et al.. Then we thoroughly mixed the starting material according to their stoichiometric ratio, pressed them into laminas and annealed at 1150° C for 48 hours.



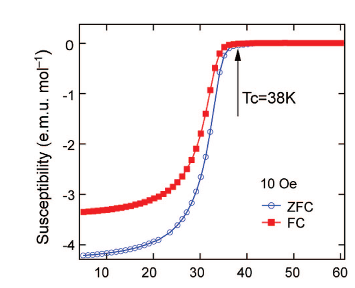




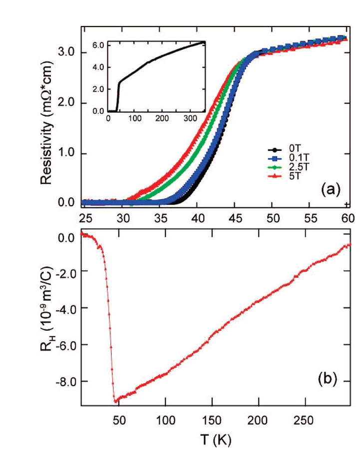
(a)the XRD, (b)ACMS data and (c)resistivity of Nd[O1-xFx]FeAs. (d)comparison of the 2-theta, Tc(ACMS) and Tc(resistivity) with the doping level x .



Powder XRD (a) and EDX data (b) of Nd0.8Th0.2OFeAs. The inset in panel b shows the scanning electron microscope picture. The white spot shows where the EDX data were taken.[4]



Temperature dependence of the magnetic susceptibility of Nd0.8Th0.2OFeAs under 10 Oe in zero-field cooling and field cooling process.[4]

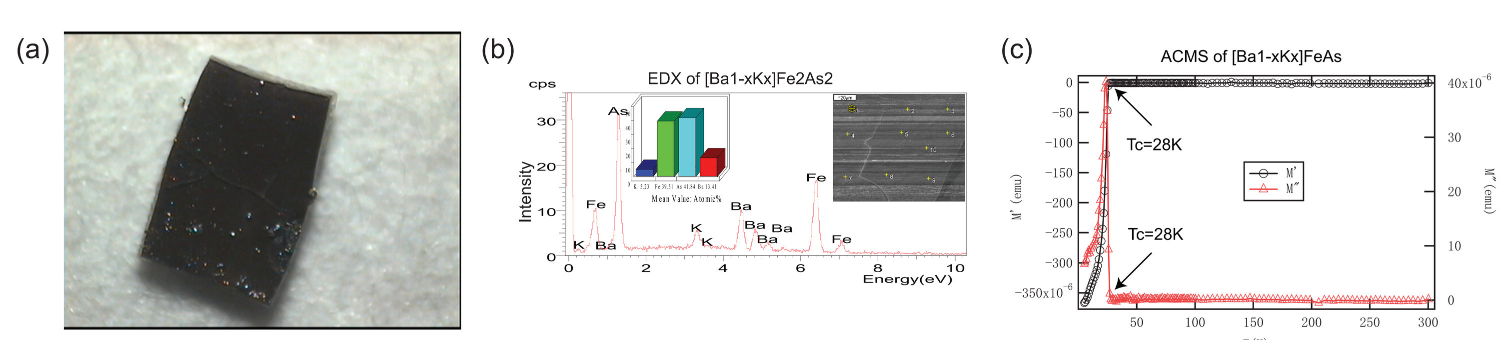


Temperature dependence of (a) the resistivity of polycrystal Nd0.8Th0.2OFeAs sample under external field and (b) Hall coefficient under an external field of 1 T.[4]

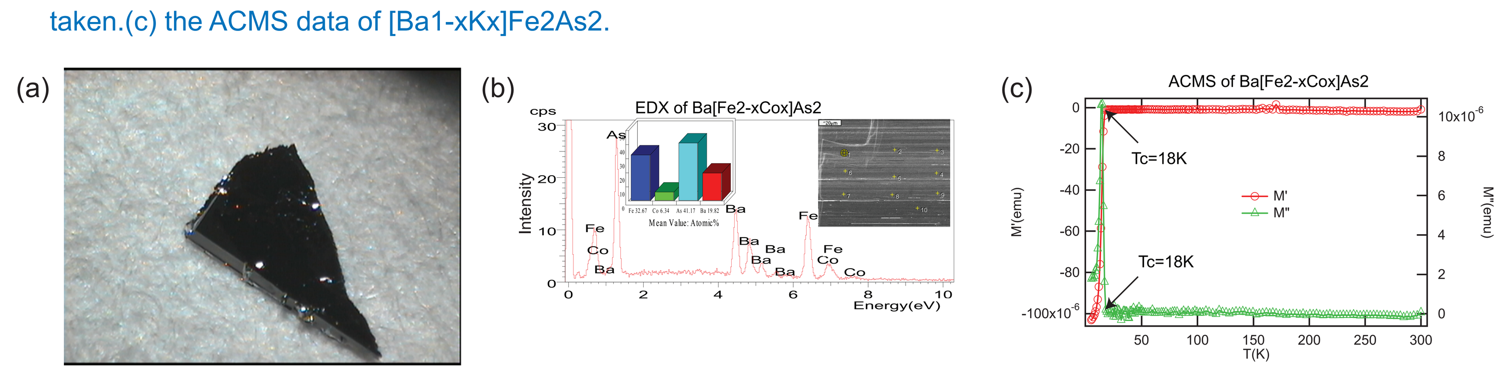
Ref 4. Min Xu, et al., Chemistry of Materials 01964h.R1 (2008).

the Single Crystals of the "122" System

We use the Tin-flux and self-flux method to grow the single crystals of the "122" system. We mixed the starting material together according to their stoichiometric ratio (sometimes we put certain material excessively to make sure its doping level, for example, Potassium(K) in [Ba1-xKx]Fe2As2), then added Tin-flux or self-flux in proportional. The samples were annealed at high temperature and then slowly cooled down.



(a)the photograph of [Ba1-xKx]Fe2As2.(b)the EDX data of [Ba1-xKx]Fe2As2. The insets show the element proportion of the sample and the scanning electron microscope picture. The white spot shows where the EDX data were taken.(c) the ACMS data of [Ba1-xKx]Fe2As2.

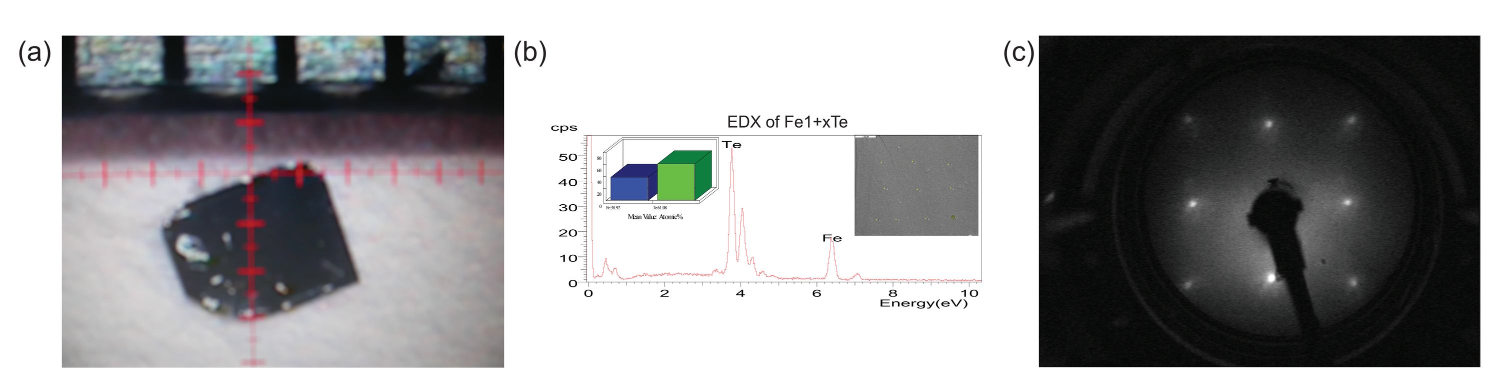


(a)the photograph of Ba[Fe2-xCox]As2. (b)the EDX data of Ba[Fe2-xCox]As2. The insets show the element proportion of the sample and the scanning electron microscope picture. The white spot shows where the EDX data were taken. (c)the ACMS data of Ba[Fe2-xCox]As2.

(a)the photograph of BaNi2As2. (b)the LEED(low energy electron diffraction) pattern of BaNi2As2. (c)the ACMS data of BaNi2As2.

the Single Crystals of the "11" system

We use the NaCl-KCl-flux method to grow the single crystals of the "11" system. We firstly synthesized the polycrystal of Fe1+xTe(Se) by the solid state reaction method. Then we thoroughly mixed the polycrystal with NaCl, KCl together in proportional. Later the samples were annealed at high temperature and then slowly cooled down. At last, we could get the samples by washing them with deionized water.



(a)the photograph of Fe1+xTe. (b)the EDX data of Fe1+xTe. The insets show the element proportion of the sample and the scanning electron microscope picture. The white spot shows where the EDX data were taken. (c)the LEED pattern of Fe1+xTe.

Summary

To summarize, we have made the polycrystals of the "1111" system, the single crystals of the "122" and "11" systems with different methods and tested their structures, compositions and transport properties. Since the new iron-based material has almost been discovered, people began to put more emphasis on the quality of the sample which mainly shows in its uniformity and purity. So our aim of the next period is to grow sample with high quality by all means.