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High pressure synthesis and transport properties of new filled skutterudite compounds RFe$_4$As$_{12}$

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Recent improvement of systematic studies for RT$_4$X$_{12}$ (R; rare earth, T; Fe, Ru, Os, X; P, As, Sb), the various novel physical properties such as superconductors, heavy fermions, and metal-insulator transition are realized. Among them, only few filled skutterudite compounds including As are studied due to the difficulty of the making samples using flux method. Recently, we have succeeded in making new filled skutterudite compounds RFe$_4$As$_{12}$ (R; light rare earth), using high pressure synthesizing method.

Polycrystalline RFe$_4$As$_{12}$ were prepared at high temperatures and high pressures using KAWAI-type cubic-anvil high-pressure apparatus (UHP-1500) in Muroran-IT. The compounds were prepared by the reaction of stoichiometric amounts of each metal and arsenic powders at around 900 °C and 4.0 GPa. The samples were characterized by powder X-ray diffraction (RIGAKU RINT RAPID II) using Co K$_\alpha$ radiation and silicon as standard.

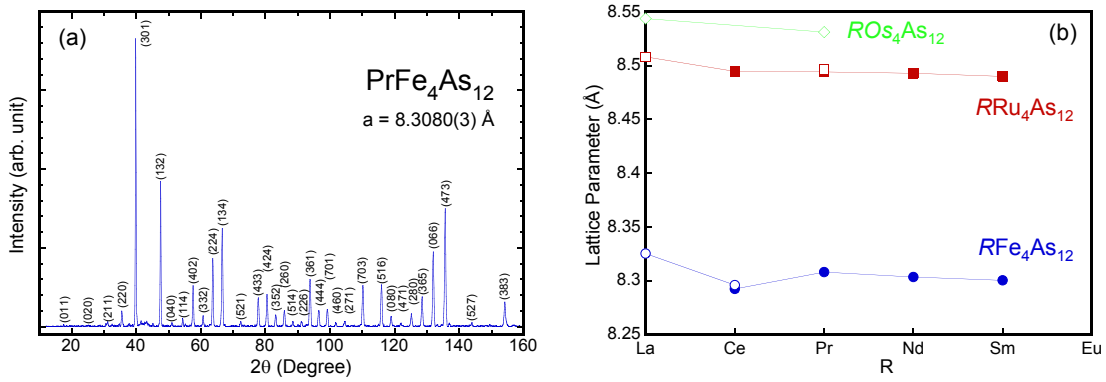

Figure 1: (a) Powder X-ray diffract pattern of PrFe$_4$As$_{12}$, and (b) rare earth dependence of lattice constant for RT$_4$As$_{12}$ (R; rare earth, T; Fe, Ru, Os). Open circles show previous report and close circles show our results.

Figure 1 (a) shows the powder x-ray diffraction pattern of PrFe$_4$As$_{12}$. A similar pattern was also observed for the other compounds. All diffraction lines of compounds prepared at high pressure are assigned by the index of the filled skutterudite structure. The lattice constants of the compounds are determined as 8.2923 Å, 8.3080 Å, 8.3034 Å, and 8.3003 Å for CeFe$_4$As$_{12}$, PrFe$_4$As$_{12}$, NdFe$_4$As$_{12}$, and SmFe$_4$As$_{12}$. Then, we plot obtained lattice constants with other As-contained filled skutterudite compounds as shown in figure 1 (b). For CeFe$_4$As$_{12}$, obtained lattice constant is in good agreement with the previous report[1]. The lattice constants systematically decrease due to the lanthanide contraction except Ce-based filled skutterudite compounds. This deviation of Ce-based filled skutterudite compounds is also observed in other compounds such as CeFe$_4$As$_{12}$, suggesting the change of the valence.

[1] D.J. Braun and W. Jeitschko; J. Solid State Chem. **32** (1980) 357.