(PS2)

Synthesis of filled Skutterudite compounds by a flux method with alkaline halide (Physical properties of compounds related to the filled Skutterudite)

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Filled Skutterudite compounds RT_4X_{12} (R = rare earth, T = Fe, Ru, Os, X = P, As, Sb) have attracted great attention due to their various physical properties such as Pr-based heavy fermion behavior, heavy fermion superconductivity, and rattling motion of R atoms in the cage of pnictogen X. Although the existence of many compounds has been known for the combination of R, T and X, all of them have not been synthesized yet. We need fine single crystals to investigate their physical properties in detail, and thus we are investigating the appropriate method to prepare large single crystals and new compounds, especially arsenides, with RbCl/LiCl flux.

By current experiments of RFe_4P_{12} synthesis with RbCl/LiCl flux, crystals can be obtained in specific conditions. According to elecron - probe microanalysis (EPMA), however, it is found that this compound does not contain Fe element, and the atomic ratio of La and P indicates semiconducting binary phosphides RP_5. We are searching for appropriate conditions.

Ternary phosphides we recently succeeded to prepare with RbCl/LiCl flux and measured magnetization are semiconductor RZn_3P_3 ($P6_3/mmc$, R = Ce, Pr, Nd, Gd). The single crystals are very thin and have a hexagonal shape. The magnetic susceptibility for R = Ce, Pr and Nd compound are paramagnetic down to 1.8 K, and each compound shows strong anisotropy originating from crystalline electric field (CEF). We calculated magnetic susceptibility of the Ce compound and compared with experimental value. For Gd compound, the magnetic susceptibility follows Curie - Weiss law above 4.5 K, and decreases below the temperture. It indicates Gd-compound orders antiferromagnetically below $T_N = 4.5$ K.

We also considered to search for the compounds related to the filled Skutterudite, and succeeded to synthesize $R_2Rh_{15}Si_7$ ($Pm3m$, R = La, Ce, Pr, Nd, Sm). The magnetic susceptibility of the Ce compound shows that the $4f$ electron is in the valence-fluctuating state, and that affects lattice constant, electrical resistivity and specific heat. For the Pr compound, the specifc heat and magnetic susceptibility show anomalies at 2 K. In addition, C/T increases below 5 K, which behavior is similar to that of $PrOs_4Sb_{12}$. We are investigating physical properties at lower temperatures.