(PS19)

Structural Analisys of $PrRu_4P_{12}$ under High-Pressure and at Low-Temperature of $PrRu_4P_{12}$

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$PrRu_4P_{12}$, which shows metal-insulator (M-I) transition at 62 K and ambient pressure [1], is very interesting, because of a drastic change of transport properties at high-pressure. With increasing pressure, the semiconductor-like electrical resistivity below the transition temperature $T_{\rm MI}$ was suppressed as pressure increases up to 8 GPa [2]. Metallic behavior was seen above 11 GPa and below 50 K. In addition, $PrRu_4P_{12}$ becomes superconducting above 12 GPa and below 1.8 K [3]. $T_{\rm MI}$ is almost independent of pressure, in contrast to the drastic change of the $R(T)$ curve. At ambient pressure, a structural transition was observed at $T_{\rm MI}$, from $Im\bar{3}$ to $Pm\bar{3}$ [4, 5]. After the metallization, an anomaly in the resistance is still observed at around 60 K, suggesting a structural change may still occur. What induces the metallization?

In order to connect these results to structural properties, we performed powder X-ray diffraction measurements using a poly-crystal under high-pressure and low-temperature with the synchrotron beam. We performed Rietveld analyses, and compared the temperature dependence of lattice parameters at 9 GPa and 13 GPa. We found a difference in behavior between the pressures. At 13 GPa, the PrP_{12} icosahedrons becomes larger at lower temperature, suggesting that the distance between the icosahedrons become shorter. Metallization may be a due to the change of position of the P atoms, which carry the conduction electrons.

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