

High-Pressure Synthesis and properties of New Lanthanide Metal Germanides

H. Fukuoka and S. Yamanaka

Department of Applied Chemistry, Graduate School of Engineering, Hiroshima University,
Higashi-Hiroshima, Hiroshima 739-8527, Japan

We have prepared new binary germanides of lanthanide metals by using high-pressure and high-temperature conditions. In La - Ge system, a new superconductor LaGe_5 was obtained by the reaction of La and Ge mixtures with La : Ge = 1 : 5 under a pressure of 5 GPa at 1200 C.[1] The structure of this compound shown in Fig 1 (a) was determined by single crystal X-ray analysis. The space group and cell parameters are listed in Table 1. The structure is composed of sp^3 -Ge buckled layers coupled by eight coordinated Ge atoms. Lanthanum atoms are situated in the Ge cages. Electrical resistivity and magnetic susceptibility measurements showed that the compound was a Type-II superconductor with a T_c of 7.0 K.

In the Ce-Ge system, two new germanides, CeGe_5 with LaGe_5 structure and CeGe_3 with the Cu_3Au structure have been obtained by high-pressure syntheses. Both compounds were metallic, but did not show superconductivity at 2 K. CeGe_3 showed ferromagnetic property with the Curie temperature of 5.0 K.

In Lu-Ge system, a new superconducting germanide, $\text{LuGe}_{3-\delta}$ was obtained. The lattice constants and preparation condition are listed in Table 1. The $\text{LuGe}_{3-\delta}$ had a layered structure composed of Ge layers, between which one dimensional Ge zigzag chains and Lu ions are situated as illustrated in Fig. 1(b). This compound showed superconductivity at 4 K.

Table 1 Crystallographic data and preparation conditions of new germanides

	structure type	S.G.	lattice constants (Å)	conditions
LaGe_5	LaGe_5	$Immm$	$a = 4.0290(6), b = 6.307(1), c = 9.978(2)$	5 GPa 1200 °C
CeGe_5	LaGe_5	$Immm$	$a = 4.000(1), b = 6.188(2), c = 9.854(1)$	5 GPa 1200 °C
CeGe_3	Cu_3Au	$Fm\bar{3}m$	$a = 4.3547(6)$	5 GPa 1600 °C
$\text{LuGe}_{3-\delta}$	YGe_3	$Cmcm$	$a = 3.973(2), b = 20.362(6), c = 3.869(1)$	5 GPa 1200 °C

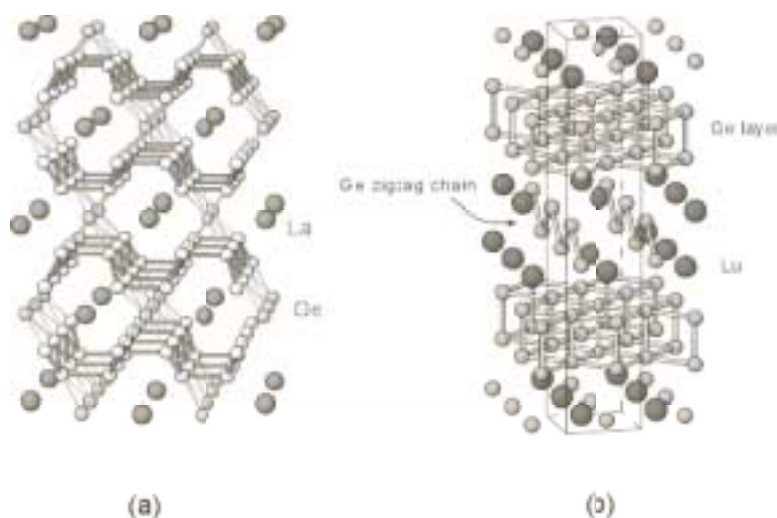


Figure 1: Crystal structures of (a) LaGe_5 and $\text{LuGe}_{3-\delta}$.

[1] H. Fukuoka and S. Yamanaka, Phys. Rev. B **67** (2003) 094501.