

Synthesis and Properties of Type II Ge clathrate film on Sapphire Substrate

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Type II clathrates M_xIV_{136} ($0 \leq x \leq 24$) are formed by atomic cage structures based on group IV elements such as Si or Ge. The cages include guest metallic atoms (M), such as alkali or alkaline earth elements which act as the donor. Therefore, M_xIV_{136} shows metallic- or n-type-conduction. In our laboratory, we have developed a preparation method for a thin film of type II Ge clathrate Na_xGe_{136} on sapphire substrates [1,2]. Recently, we reported a new synthesis method of Na_xGe_{136} film using a vacuum process [3], and an attempt at Al doping to realize p-type conduction [4]. In this paper, we present the recent progress of our investigation on the optical and electrical properties of Na_xGe_{136} and $Na_x(Al_yGe_{1-y})_{136}$ films.

Na_xGe_{136} and $Na_x(Al_yGe_{1-y})_{136}$ films were prepared on sapphire substrates. Firstly, we deposited Ge films or Al-Ge composite films on the sapphire substrates by sputtering technique. The films were placed inside the chamber of a portable vacuum evaporation and annealing system (pVEAS), in which Na deposition and lamp annealing were successively or simultaneously conducted in a high vacuum under various conditions. The annealing duration and temperature were 8~40 h and 300-320°C, respectively. The prepared samples were studied by XRD, SEM-EDX, Raman, UV-vis-IR

spectroscopy, and Hall measurements. Figure 1 shows XRD patterns and photo images of type II Ge clathrate films with and without Al inclusion. Al-5 and Al-0 correspond to Al/Ge compositions of 5/100 and 0/100, respectively. The XRD pattern of sample Al-5 shows no obvious elemental Al peak, but line broadening due to Al inclusion. The differences of the Ge clathrate with and without Al

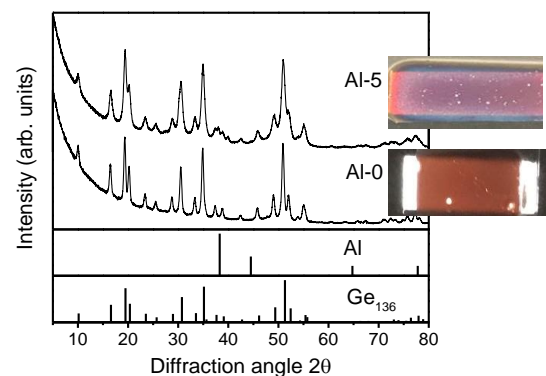


Figure 1. XRD patterns of type II Ge clathrate doped with and without Al inclusion.

will be discussed in my presentation.

References

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