**Area:** Thin-Film Compound Semiconductor PV

**FABRICATION OF INP THIN FILM BY PHOSPIDATION**

Yuming Yang, Ryoji Katsube, Shigeru Nakatsuka, Yoshitaro Nose

Kyoto University, Japan

yang.yuming.28e@st.kyoto-u.ac.jp

**Introduction**

The photovoltaic application of indium phosphide InP has been investigated for the last few decades. InP films are generally prepared by conventional growth methods such as molecular beam epitaxy (MBE). We here adopted a phosphidation method to InP thin film fabrication, which was proved to be reliable for an industrialized process like CIGS.

P source and surface morphology are significant in the phosphidation. In our previous works [1], ZnSnP$_3$ thin films for solar cells were successfully obtained by phosphidation of Zn-Sn precursor, where Sn/Sn$_4$P$_3$ material was used as P source to control the vapor pressure of P. Sn/Sn$_4$P$_3$ material was adopted to InP preparation. On the other hand, the dewetting and agglomeration of In precursor should be controlled for the uniform and smooth layer. Recently, Thin Film-Vapor Liquid Solid (TF-VLS) method was proposed as a feasible way to prepare uniform thin film of InP [2]. The main feature of this method is that a SiO$_x$ cap layer was deposited on the precursor before the phosphidation to prevent dewetting.

In this work, we thus tried to establish a process for the preparation of InP thin films by combination of cap layer and our technique of controlling phosphorus vapor.

**Experimental procedure**

Mo film was deposited on soda-lime-glass substrate by sputtering. The In precursor film with the thickness of 2-3μm was deposited by evaporation. For some samples, SiO$_x$ thin film was deposited on In precursor as a cap layer by RF sputtering. Meanwhile, the phosphorus source was prepared in the following procedure. Chemically-etched Sn and red phosphorus were weighed with the mole ratio of 7:3 and the total weight of about 2.2g. These ingredients were sealed in an evacuated quartz ampoule below the pressure of 6$\times$10$^{-3}$ Pa. The sealed ampoule was heat-treated and Sn/Sn$_4$P$_3$ P source was obtained. In precursor and Sn/Sn$_4$P$_3$ P source material were sealed in a new ampoule and the ampoule was set in a two-zone furnace for phosphidation. The phosphidation duration was 30 min and the temperatures for the precursor and the P source material were controlled at 500°C and 500°C respectively, where the partial pressure of P was about 2$\times$10$^{-7}$ Pa from thermodynamic data[3]. After phosphidation, the samples were cooled down in the furnace.

**Result and Discussion**

Figure 1 shows surface morphology of the sample observed by SEM. The surface of In precursor before phosphidation was relatively smooth. The morphology in the film with SiO$_x$ cap layer was preserved even after phosphidation, while the cluster structure was found in the thin film without cap layer. Moreover, the mapping of the thin film with cap layer suggested the formation of uniform InP layer in this area. The experimental results conclude that our process is effective to obtain InP films with the smooth surface. In the presentation, other results under various phosphidation conditions will be also discussed.

![Figure 1. SEM images of thin films a) before and after phosphidation b) without SiO$_x$ cap layer and c) with SiO$_x$ cap layer. d) – g) each elemental mapping of the area shown in c).](image)

**Reference**

