Formation of B-doped $BaSi_2$ films by RF sputtering on a heated glass substrate

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Introduction

Orthorhombic barium disilicide ($BaSi_2$) is considered a candidate material for thin-film solar cells since it consists of abundant chemical elements of Si and Ba, its band gap is reported to be approximately 1.3 eV which matches the solar spectrum, and its optical absorption coefficient exceeds 10^4 cm^{-1} at 1.5 eV [1-3]. These studies were performed on $BaSi_2$ epitaxial films grown on silicon substrate by molecular beam epitaxy (MBE). Another attractive method to grow thin films is sputtering because of its high deposition rate and large area deposition. Recently, we have deposited polycrystalline $BaSi_2$ films on glass substrate by sputtering crystalline $BaSi_2$ target at 470 ºC [4]. The basic structure of solar cell is *p*-*n* junction and thus, controlling the conductivity of $BaSi_2$ by impurity doping is required. We have achieved *n*- and *p*-type $BaSi_2$ films with carrier concentration larger than 10^{19} cm^{-3} by Sb and B doping, respectively, using MBE method [5,6]. However, there are still no reports on the formation of impurity-doped $BaSi_2$ film by sputtering. In this study, the formation of B-doped $BaSi_2$ film by sputtering and its resistivity are investigated.

Experimental procedure

The films were prepared by RF magnetron sputtering (Sanyu Electron SVC-700RF) using a polycrystalline $BaSi_2$ target as the sputtering source. Chunks of Boron (B) were stick to $BaSi_2$ target using carbon tape for the doping. B concentration is controlled by the number of B chunk stick to the target. We prepared B-doped $BaSi_2$ films using one, two, and three B chunks for low-, medium- and high-doped ones, respectively. 10×10-mm^2 alkali-free glass substrates were used in the experiment. The RF power was set at 100 W, the flow rate of Ar was 12 sccm, the vacuum level was set at about 0.2 Pa during sputtering, the sputtering temperature was 430 ºC and the deposition time was 30 min. Approximately 1-μm thick films were deposited on heated substrates. The crystalline quality of the samples was characterized by θ-2θ XRD. Four-probe method was employed to measure the resistivity of the films at room temperature.

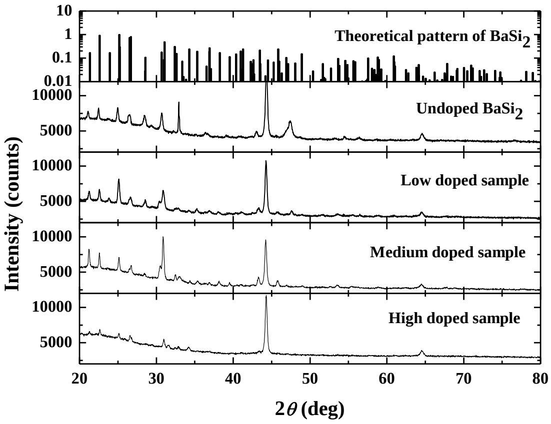

Fig. 1 θ-2θ XRD patterns of B-doped $BaSi_2$ films.

Results and discussion

Figure 1 shows θ-2θ XRD patterns of films sputtered on alkali-free glass at 430 ºC. The XRD pattern at the top shows the theoretical patterns of orthorhombic $BaSi_2$. Relatively strong peaks of $BaSi_2$ can be seen for all the samples, meaning that $BaSi_2$ were formed. Figure 2 shows the resistivity for samples with different B concentrations. The resistivity was decreased with the number of B chunk, indicating that doped B atoms worked as acceptor impurities as in B-doped $BaSi_2$ films by MBE [6].

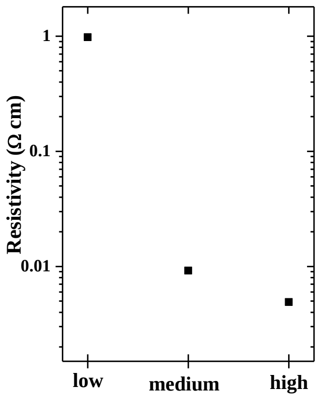

Fig. 2 Resistivity of B-doped $BaSi_2$ films.

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