Characterization of p-BaSi2/n-Si solar cells using Boron-doped p-BaSi2 on textured n-Si (001) grown by molecular beam epitaxy

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[Introduction]

Barium disilicide (BaSi2) has attractive features for solar cell application such as a suitable band 1), a large minority-carrier lifetime (τ ~ 10 μs) 2) and a large minority-carrier diffusion length (L ~ 10 μm) 3). Power conversion efficiency (η) was expected to be larger than 25% only in a 2-μm-thick BaSi2 pn junction diode 4). In our previous work, it was demonstrated that a-axis of BaSi2 was oriented normal to the (111)-oriented texture on the Si(001) substrate and light trapping took place 5). To ensure how thickness and hole concentration of boron(B)-doped p-BaSi2 influence the performance of p-BaSi2/n-Si hetero-junction solar cell, in this study, we attempted to grow a series of B-doped p-BaSi2 with different thickness and hole concentration on textured Si (001).

[Experiment]

First, a 5-nm-thick BaSi2 layer was grown to control the crystal orientation of BaSi2 over layers by reactive deposition epitaxy process. Second, approximately 20-, 50-, 75-, and 100-mm-thick B-doped BaSi2 layers were grown by molecular beam epitaxy (MBE) with various sets of B K-cell temperature (Tb) and substrate temperature (Ts). (Ts, Tb) were set at (1230°C, 600 °C); (1230 °C, 650 °C), and (1300 °C, 650 °C), respectively, and the hole concentration (p) was found to be 2.0×10^18, 4.6×10^18, and 3.6×10^18 cm^3, respectively. Then, a 3-mm-thick a-Si layer was prepared over the BaSi2 layers to prevent oxidation of BaSi2. After that, ITO electrode with a diameter of 1 mm and thickness of 80 nm was sputtered on the front side. 150 nm Al was sputtered at the back. Afterwards, J-V characteristics and photoreception were measured.

[Results & Discussions]

Figure 1 shows J-V curves of a series of samples measured under AM1.5 illumination. p was 3.6×10^18 cm^3. As the p-BaSi2 film increases from 20 to 75 nm, the solar cell performance was improved. The conversion efficiency (η) increases from 0.17% to 4.52% and the open-circuit voltage was increased from 0.04 to 0.30 V. For further increase in p-BaSi2 layer thickness up to 125 nm, however, the η goes down to 3.18% and the short-circuit current density decreases from 27.6 to 21.2 mA/cm^2.

Figure 2 shows the EQE spectra of the samples of various p-BaSi2 thicknesses. With increasing the layer thickness, the EQE decreases especially in the short wavelength range, meaning that the contribution of photogenerated carriers in the p-BaSi2 becomes small.

[Acknowledgments]

This work was financially supported in part by JST-CREST, JSPS (15H20237).

[Reference]