

INVESTIGATION ON BORON-DOPED P-BASi₂/N-Si HETERO-JUNCTION SOLAR CELLS ON A TEXTURED SI(001) SUBSTRATE

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[Introduction] Barium disilicide (BaSi₂) has attractive features for solar cell application such as a suitable band gap, a large minority-carrier lifetime ($\tau \sim 10 \mu\text{s}$) and a large minority-carrier diffusion length ($L \sim 10 \mu\text{m}$). 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 thicknesses and hole concentrations on texturized Si (001) with {111} facets.

[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-nm-thick B-doped p-BaSi₂ layers were grown by molecular beam epitaxy (MBE) with various sets of B K-cell temperature (T_B) and substrate temperature (T_S). (T_B, T_S) was chosen at (1230 °C, 600 °C) for samples A, (1230 °C, 650 °C) for samples B, and (1300 °C, 650 °C) for samples C, and the hole concentration (p) were found to be 2.0×10^{18} , 4.6×10^{18} , and $3.6 \times 10^{18} \text{ cm}^{-3}$, respectively. Then, a 3-nm-thick a-Si layer was prepared over the BaSi₂ layers to prevent oxidation of BaSi₂. After that, ITO and Al were sputtered as electrodes.

[Results] Fig. 1 shows the θ - 2θ scan XRD patterns obtained at $\chi = 54.7^\circ$. It is hard to observe any diffraction peaks of BaSi₂ at $d = 20 \text{ nm}$, however, diffraction peaks of only (100)-oriented BaSi₂ planes, such as (200), (400) and (600) planes were obtained when d was 50 nm and above, suggesting the successful growth of highly a -axis-oriented BaSi₂ epitaxial films. Fig. 2 shows the J - V curves under AM1.5 illumination and internal quantum efficiency (IQE) spectra for various d values in samples A, B, and C. The η showed a maximum of 4.62% at $d = 75 \text{ nm}$ for sample C.

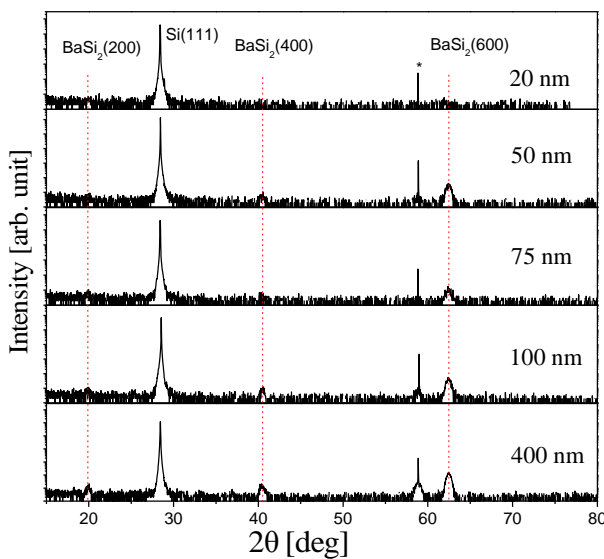


Figure 1: θ - 2θ XRD patterns for B-doped p-BaSi₂ films (samples A) with different layer thickness

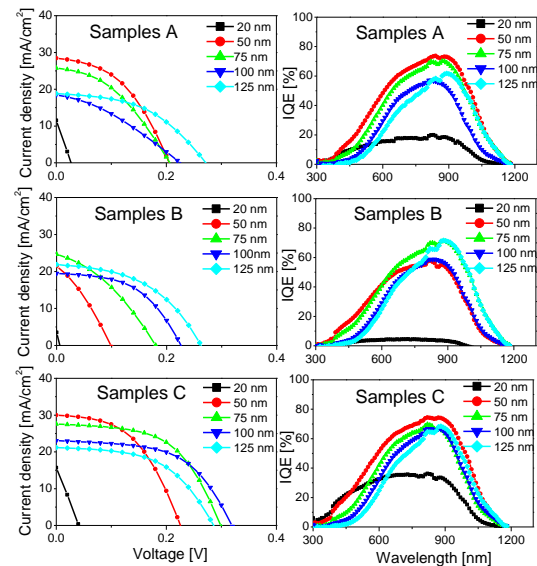


Figure 2: J - V curves under AM1.5 illumination and IQE spectra