Possibility of fabricating n-$BaSi_2$/p type multicrystalline Si (p-mc-Si) heterojunction solar cells

[1]Univ. Tsukuba, [2]NIMS
°Y. Li[1], R. Takabe[1], T. Deng[1], Z. Xu[1], K. Toko[1], T. Sekiguchi[2], T. Suemasu[1]
E-mail: bk201520388@s.bk.tsukuba.ac.jp

Introduction

Properties explored in epitaxial $BaSi_2$ such as a large absorption coefficient ($\alpha=3\times10^4$ cm^{-1}@1.5 eV) and a large minority-carrier lifetime (~10 μs) have shown the potential of $BaSi_2$ as a new candidate material for thin-film solar [1, 2]. In our recent work, we have successfully fabricated p-$BaSi_2$/n-Si heterojunction solar cells with conversion efficiency reaching 9.0% [3]. However, the dependence on epitaxial $BaSi_2$ may limit the possibility of solar cell mass production. Therefore, it is also significant to prove the possibility of fabricating solar cell with non-epitaxial $BaSi_2$. In this study, we have grown non-epitaxial $BaSi_2$ on mc-Si substrates, aiming to fabricate n-$BaSi_2$/p-mc-Si heterojunction solar cells and evaluate their properties.

Experiment

We adopted p-type mc-Si substrates with small and randomly oriented Si grains. 20 nm (Sample A), 50 nm (Sample B), 240 nm (Sample C) $BaSi_2$ were grown on those substrates by MBE method. 8 nm, 13 nm, 26 nm α-Si were capped on the surface of each sample for passivation, respectively. The growth of non-epitaxial n-$BaSi_2$ was confirmed by X-ray diffraction (XRD) in each sample. ITO/n-$BaSi_2$ /p-mc-Si/Al structure was used for solar cell characteristic measurement.

Results & Discussions

Figure 1 shows the external quantum efficiency (EQE) spectra for all the samples with no bias voltages. This result demonstrates that the n-$BaSi_2$/p-mc-Si heterointerface does not hinder the transport of photogenerated carriers. Sample A with 20 nm $BaSi_2$ shows the largest EQE among those samples. This may be due to the fact that the thinner non-epitaxial $BaSi_2$ has lesser defects than that of the thicker ones. Table 1 shows the solar cell parameters of those samples measured under AM 1.5 illumination. In spite of the difference in $BaSi_2$ thickness, conversion efficiency has been confirmed in all the samples. This result shows the possibility of fabricating n-$BaSi_2$/p-mc-Si heterojunction solar cells. Sample C, capped with 26 nm α-Si, shows the largest R_S, resulting in the lowest η, 0.52%. Therefore, there are also many other approaches to improve η, e.g., optimize the thickness of passivation layers.

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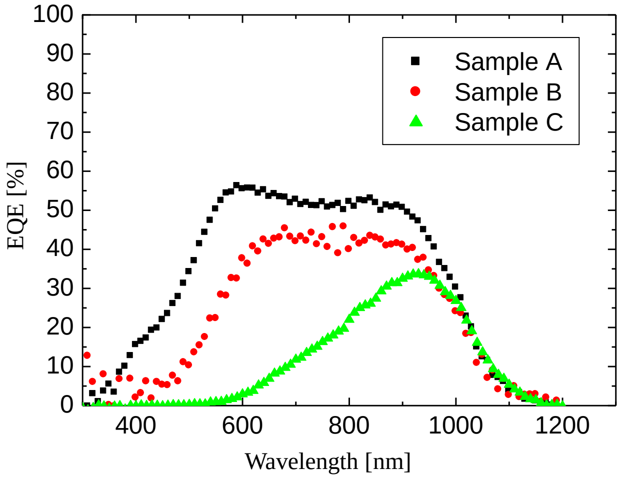

Fig 1 EQE spectra for samples A, B and C under 0 bias voltage.

	Sample A	*Sample B*	*Sample C*
η	1.59%	0.99%	0.52%
V_{OC} (V)	0.15	0.12	0.10
J_{SC} (mA/cm2)	22.5	18.0	13.3
FF	0.48	0.45	0.39
R_S (Ω)	270	251	526
R_{SH} (Ω)	7330	5106	2819

Table 1 Solar cell parameters for samples A, B and C are specified.