PHOTORESPONSE PROPERTIES OF EVAPORATED $BaSi_2$ FILMS GROWN ON MODIFIED SUBSTRATES FOR THIN-FILM SOLAR CELLS

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1. Introduction

Barium disilicide ($BaSi_2$) semiconductor has been an attractive material for thin-film solar cell application thanks to its properties, which are appropriate band gap of 1.3 eV, high absorption coefficient (~3×10^4 cm^{-1} at 1.5 eV), long minority carrier lifetime (~10 μs), and abundant-element components. Thermal evaporation (TE) is a suitable method to fabricate $BaSi_2$ on large-scale area. Using this method, $BaSi_2$ was successfully grown on various flat substrates such as Si, Ge, glass, and CaF_2. Surface modification of the Si substrate before growing $BaSi_2$ would improve absorptance by light trapping, and give impact on photoresponse properties.

2. Experimental

Firstly, n-Si (111) (ρ < 0.02 Ωcm) substrates were modified by metal-assisted chemical etching method to form hillocks on the surface. Then, they were cleaned in 5% HF for 1 min prior to growing 300 nm $BaSi_2$ films by TE method at substrate temperature of 500 °C. For comparison, $BaSi_2$ films were also grown on flat substrates.

In order to investigate the vertical photocurrent, 80-nm-thick indium tin oxide (ITO) and 200-nm-thick Al were deposited on the surface of $BaSi_2$ film and the backside of Si substrate, respectively. The photocurrent was measured by a lock-in technique using a 450 W xenon and 400 W halogen lamps with a monochromator to produce monochromatic light with a constant power of 50 μW/cm^2.

3. Results and discussion

Figure 1 shows the photoresponse properties of ITO/$BaSi_2$/n-Si (modified and flat)/Al structures under forward and reverse bias voltages of 2 V. The photoresponsivity can be observed clearly for $BaSi_2$/modified Si whereas $BaSi_2$/flat Si is very weak and almost the same as noise level. This suggests that the crystalline quality and/or interface property of $BaSi_2$/modified Si is better than that of $BaSi_2$/flat Si thanks to the increase in interface area and reduction of film stress when evaporating $BaSi_2$ at high temperature. The result is confirmed by Raman spectra analysis and excess carrier lifetime measurement. Moreover, the photocurrent is generated by the light absorption and electron-hole pairs separation by electric field. The observed photoresponsivity of $BaSi_2$/modified Si also demonstrates the effect of substrate modification on absorption improvement by light trapping, which is confirmed by optical properties measurement. The onset of photocurrent is at photon energy of 1.29 eV, which is supposed as the band-gap value of $BaSi_2$ evaporated on Si substrate.

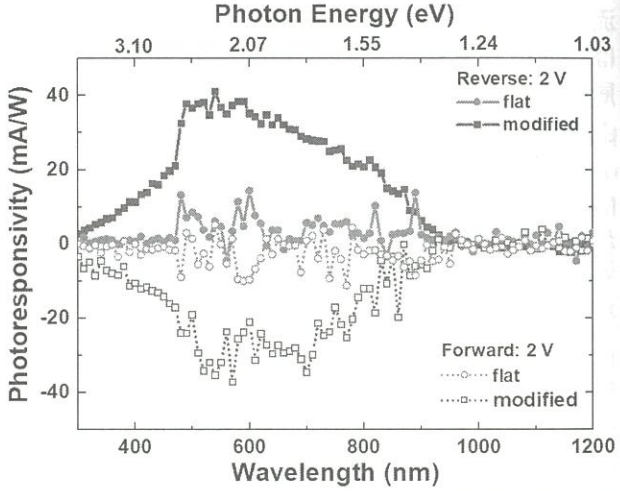

Fig. 1 Photoresponse spectra of ITO/$BaSi_2$/n-Si (modified and flat)/Al structures under forward and reverse bias voltages of 2 V.

4. Conclusion

We have shown photoresponse properties of evaporated $BaSi_2$ films on modified and flat Si substrates. The results showed that the film grown on the former have better properties than that on the latter.

Acknowledgements:

We would like to acknowledge Venture Business Laboratory, Nagoya University for the financial support during this work.

References:

T. Suemasu and N. Usami 2017 J. Phys. D: Appl. Phys. **50** 023001 and references therein.