Growth of Crystalline $BaSi_2$ Thin Films by Vacuum Evaporation on Poly-Crystalline Silicon Fabricated by Aluminum Induced Crystallization

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We attempt to realize single-phase crystalline $BaSi_2$ thin films on glass substrate by utilizing poly-Si layers fabricated by Aluminum Induced Crystallization (AIC) for practical reasons. Vacuum evaporation method was chosen to deposit $BaSi_2$ due to its simplicity and large deposition area. Since lumps of $BaSi_2$ with 99% purity were used as source material, the content of the vapor during evaporation process is time-dependent: initial vapor is Ba rich, while the latter is Si rich. In spite of this fact, our previous studies revealed that single phase $BaSi_2$ can be achieved on Si (111) substrates by solid-state reaction of Ba-rich layer with the Si substrate [1]. In this study, poly-Si fabricated by AIC on glass substrate is employed as Si supply layers to form single-phase $BaSi_2$. Since AIC proceeds under nearly equilibrium conditions, p-type Al doping of Si can be expected [2]. Thus upon deposition of $BaSi_2$, p-type $BaSi_2$ is also conceivable.

The samples were made as follows, 50-nm-thick Al layers were deposited on the top of SiO_2 glass substrate. The Al layers were then exposed to ambient air for 2 minutes to form native oxide layers before 65-nm-thick amorphous Si is deposited. The samples were then annealed at 475-525^{o}C in dry Ar ambient atmosphere. After removing Al layers by HF and Secco etching, about 500-nm-thick $BaSi_2$ were then deposited inside vacuum evaporation chamber at different substrate temperatures by resistive heating of $BaSi_2$ lumps on tungsten boat.

The grain orientations of the Si supply layers grown by AIC at different annealing temperatures are shown in Fig. 1. Large grained Si layer with preferred orientation of (111) is achieved at annealing temperature of 475 ^{o}C. However, the grain size becomes smaller and (001)-oriented regions grow at higher temperature. Raman spectra of the grown $BaSi_2$ at different substrate temperatures are shown in Fig. 2. The samples grown at substrate temperature of 400 ^{o}C and above show 5 characteristic peaks of $BaSi_2$ which represent $[Si_4]^{4-}$ anions vibration modes in $BaSi_2$ phase. No other peaks were observed, which might indicates that the grown $BaSi_2$ is single phase. Also the peaks intensities are increased at higher temperatures, showing enhancement of crystal quality at high substrate temperature. Moreover, the electrical properties of the grown $BaSi_2$ will be further investigated.

According to our results, $BaSi_2$ was successfully grown on poly-Si layer fabricated by AIC method. The absence of peaks other than $BaSi_2$ peaks on Raman spectra might indicates that the grown $BaSi_2$ is single phase.

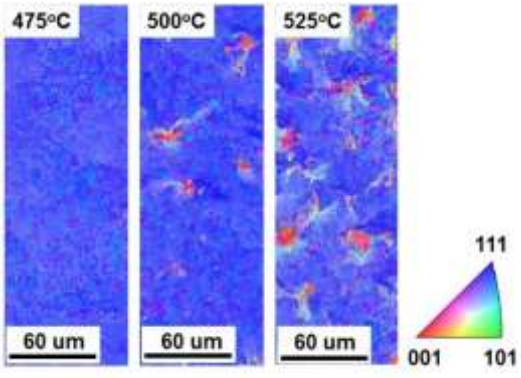

Figure 1. Crystal orientation of AIC-Si

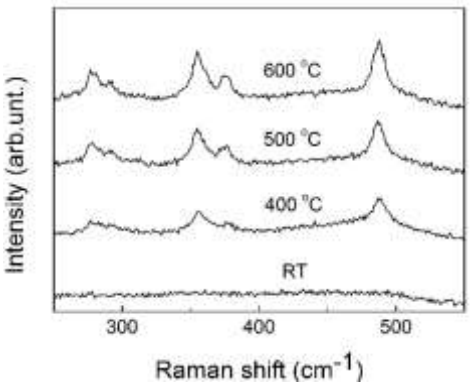

Figure 2. Raman spectra of $BaSi_2$ on AIC-Si

Reference

[1] Y. Nakagawa, K.O. Hara, T. Suemasu, and N. Usami, *Jpn. J. Appl. Phys*. **54**, 08KC03 (2015).
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