Solid Phase Epitaxy of Si Film on poly-Si Seed Layer formed by Aluminum-induced Crystallization

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Fabrication of Si solar cells on foreign substrate gained interest recently in order to reduce solar cell cost productions [1]. By using aluminum-induced crystallization (AIC) technique, it is possible to form poly-Si layer on foreign substrate with large grain size and preferential crystal orientation. However, the poly-Si formed by AIC has a limitation in thickness (< 300nm) due to the solubility limit of Si atoms in Al. Therefore, the thicker layer formation after AIC process is required. In order to do that, we have applied solid phase epitaxy (SPE) technique to transfer AIC poly-Si layer template into the thicker poly-Si film.

AIC poly-Si layers were formed by annealing quartz/Al/a-Si stack layers with certain Al thickness and annealing time. Air exposure was done to form permeable layer Al_2O_3 before a-Si layer deposition. After the formation of AIC poly-Si is successfully obtained, 1μm thick a-Si was deposited by RF-sputtering. Finally, the sample was annealed by rapid thermal annealing system (RTA) to induce the epitaxial growth.

Orientation and grain size of AIC poly-Si have measured by electron back scattering diffraction (EBSD). Highly preferential (111) orientation (80%) and large grain size (av. 8 μm) obtained in 100 nm Al layer thickness when annealed at 425°C as shown in Figure 1. This can be explained that the nucleation site is Al/quartz substrate interface and the lowest interfacial energy is (111) direction [2]. After SPE process, Raman measurements were performed. From Figure 2, crystal fraction increases and the full width at hall maximum (FWHM) decreases with increasing the annealing temperature. This result indicates the requirement of high temperature SPE to force the epitaxial growth event. In addition, x-ray diffraction spectra show strong Si (111) peaks and small Si (220), and (511) peaks, showing that SPE film has (111) preferential orientation as well as AIC poly-Si samples.

Refs: [1] O. Nast, et al., J. App. Phys. 88 (2000)124; [2] M. Kurosawa, et al., J. App. Phys. 116, (2014)

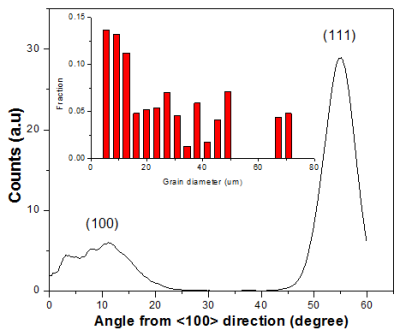

Figure 1. Crystal orientation and grain size of AIC poly-Si.

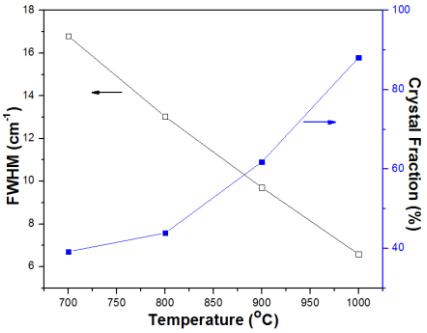

Figure 2. Crystal fraction and FWHM of SPE film.

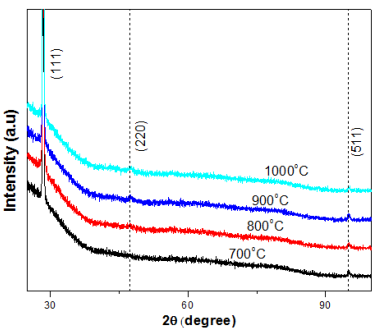

Figure 3. XRD patterns of SPE films at various annealing temperature.