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Surface and interfacial behavior during the crystallization of a-Si:H films deposited by DC-Saddle Field CVD; An *in-situ* Synchrotron X-ray Scattering study

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The crystallization process of amorphous silicon has been intensively studied due to the fundamental interest and physical application. Although the nature of relaxation, and defect annihilation of a-Si:H has been revealed, the continuous evolution of surface and interface(a-Si/Si substrate) during the crystallization process has not been systematically investigated yet. We have studied the annealing process of a-Si:H thin films by in-situ Synchrotron X-ray Scattering.

In our study, hydrogen-terminated Si wafers were prepared. Hydrogenated amorphous Si thin films investigated were grown on Si(100) substrate by DC saddle-field plasma enhanced CVD at 250℃. The films were deposited using pure SiH_4 gas, at 50mTorr, with mass flow of 5sccm. The a-Si:H films of various thickness were prepared. The in-situ synchrotron x-ray scattering studies were carried out at 5C2 K-JIST/KUMHO beamline at Pohang Light Source (PLS). A series of x-ray scattering data were obtained during real time annealing of the amorphous films. The fully crystallized Si films were also studied by AFM after completion of crystallization.

From the x-ray reflectivity and the theta rocking curves at low angle, we conclude that the surface of 2μm-thick amorphous Si film became relatively rough at 300℃, and very rough at above 600℃. The surface of a 1100Å-thick amorphous Si film, however, stayed smooth both in air and high vacuum(10^{-6}torr) during annealing cycle. The AFM results also show that the surface roughness of the crystallized Si films increased roughness with thickness. With crystal truncation rod analysis, we found that the interfacial(a-Si/Si substrate) roughness showed a similar behavior as the surface. The 2μm-thick amorphous Si film became polycrystalline solid in both air and high vacuum(10-6torr). A 1100Å-thick amorphous Si film was transformed to epitaxial solid at 10^{-6}torr. while it was polycrystalline Si in air.