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Effects of Cluster Eliminating Filter on Extremely Thin a-Si:H Films Deposited by SiH_4 Multi-Hollow Discharges

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Hydrogenated amorphous silicon (a-Si:H) nanoparticles below 10 nm in size (clusters) are formed in CVD plasmas for a-Si:H film deposition and some of them are incorporated into a-Si:H films, leading to light induced degradation of the films [1]. Recently, highly stable a-Si:H films have been deposited by suppressing incorporation of clusters using a cluster eliminating filter together with a multi-hollow discharge plasma CVD reactor [2, 3]. Here we studied effects of cluster eliminating filter on extremely thin a-Si:H films deposited by SiH_4 multi-hollow discharges.

Deposition experiments were carried out by setting high resistivity Si substrates in the upstream region from the electrode in the multi-hollow discharge plasma CVD reactor. A cluster eliminating filter was set between the electrode and substrates. SiH_4 was fed from the bottom of the chamber at 126 sccm, then flew thorough the hollows. The total pressure was 0.12 Torr. High frequency discharge voltage of 120 MHz was applied to the powered electrode. The discharge power was 20 W. The substrate temperature was set at 180 °C. Hydrogen concentration in films was measured by Fourier transform infrared spectroscopy (FTIR).

Figure 1 shows film thickness dependence of hydrogen concentration associated with SiH_2 bonds C_{SiH2} in films. C_{SiH2} of films deposited with and without the cluster eliminating filter exponentially increases with decreasing the film thickness. These two lines have nearly the same value at 17 nm in thickness. These results suggest that SiH_2 bonds in films below this thickness are formed mainly due to surface reactions. Therefore surface reactions should be controlled for further reduction of Si-H_2 bond density.

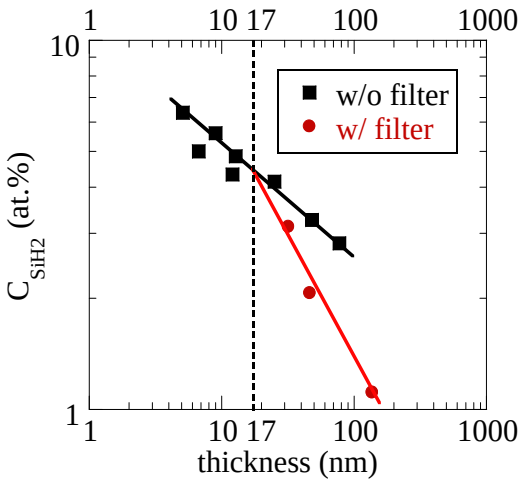

Fig. 1. Film thickness dependence of hydrogen concentration associated with SiH_2 bonds in films.

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