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Effects of substrate temperature on SiH_2/SiH bond density ratio of a-Si:H films fabricated by plasma CVD

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Thin film hydrogenated amorphous silicon (a-Si:H) solar cells have several advantages over other solar cells, such as their thin and flexible features with a relatively low cost. The solar cells are promising to be a power source for the "Internet of Things" technology. One of important issues for a-Si:H thin film solar cells is suppression of light-induced degradation. Light-induced degradation tends to be reduced by lowering the density of Si-H_2 bonds in a-Si:H films [1,2]. We succeeded in reducing Si-H_2 bonds incorporation by a multi-hollow discharge plasma CVD method together with a cluster-eliminating filter. Here, we have studied effects of substrate temperature on SiH_2/SiH bond density ratio of a-Si:H films using Raman spectroscopy.

We deposited undoped a-Si:H films on 2.5 cm x 5 cm on Si substrate by the multi-hollow discharge plasma CVD method [3,4]. SiH_4 gas was fed at 84 sccm. The total pressure was 0.08 Torr. 110 MHz discharge voltage of 300 Vpp was applied to the powered electrode. The substrate temperature was kept at 170, 200, 220 and 250°C. Raman spectroscopy was carried out using Green laser light (λ = 532nm). We set a focus position to a surface of a-Si:H films and measured seven irradiation positions per sample [5].

Figures 1 shows the I_{SiH2}/I_{SiH} as a parameter of the substrate temperature. I_{SiH2}/I_{SiH} decreases 0.109 to 0.069 with increasing the substrate temperature from 170°C to 250°C. This is probably because the longer surface diffusion of SiH_3 radicals on the growing surface and the higher hydrogen subtraction reaction rate for the higher substrate temperature. The results indicate that tuning the substrate temperature is the key to reduction of Si-H_2 bonds in films.

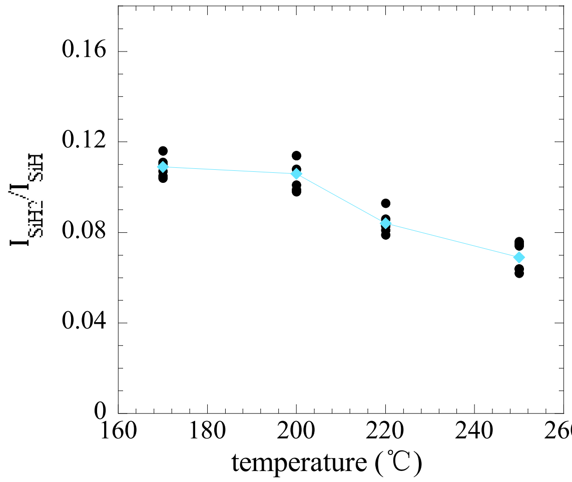

Fig. 1. Dependence of I_{SiH2}/I_{SiH} on subsrate temperature.

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