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With the rapid development of Internet of Things (IoT) technology, energy supply for the IoT devices is an important issue. To overcome the issue, hydrogenated amorphous silicon (a-Si:H) thin film solar cells have been attracted attention due to their thin and flexible features. 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-H₂ bonds in a-Si:H films [1,2]. A-Si:H films are deposited with SiH₄ plasma in which a-Si:H nanoparticles in the size range below 10 nm (clusters) are generated. Clusters have a high density of Si-H₂ bonds and their incorporation into films leads to Si-H₂ bonds in films [3]. We succeeded in detecting Si-H₂ bonds in solar cells by Raman spectroscopy and found that high density Si-H₂ bonds exist at the P/I interface. Here, we have studied effects of SiH₄ gas flow rate on spatial distribution of SiH₂/SiH bond density ratio of a-Si:H films using microscopic FTIR.

We deposited undoped a-Si:H films (I-layer) on B-doped Si films (P-layer) by a multi-hollow discharge plasma CVD method [4]. Pure SiH₄ was fed at 56, 147 sccm. The total pressure was 0.08 Torr. High frequency discharge voltage of 110 MHz was applied to the powered electrode. The discharge power was 20 W. The substrate temperature was 170 °C. The thickness of I-layer was 20 nm. Microscopic FTIR was carried out with FTIR spectrometer (IRT-7200).

Figures 1 shows the spatial distribution of the SiH₂/SiH bond density ratio as a parameter of the SiH₄ gas flow rate. The spatial aperture size was 50 μ m × 50 μ m, and a total of 900 points were measured in 30 rows and 30 columns (1.5 mm × 1.5 mm). As shown in Fig. 1, the ratio of SiH₂/SiH bonds decreases with increasing the gas velocity from 10 m/s to 26.5 m/s. In addition, the in-plane



Figure 1. Spatial distribution of SiH₂/SiH bond density ratio of a-Si:H films; (a)56sccm (10 m/s), (b)147sccm (26.5 m/s).

uniformity becomes better for the higher gas velocity. The high gas velocity eliminates contribution of higher order silane to film growth. The results indicate that the gas velocity is one of the key parameters for controlling the SiH₂/SiH bond density ratio.

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References

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