Spatial distribution of SiH_2/SiH bond density ratio in a-Si:H solar cells fabricated by plasma CVD

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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-H_2 bonds in a-Si:H films [1,2]. A-Si:H films are deposited with SiH_4 plasma in which a-Si:H nanoparticles in the size range below 10 nm (clusters) are generated. Clusters have a high density of Si-H_2 bonds and their incorporation into films leads to Si-H_2 bonds in films [3]. We succeeded in detecting Si-H_2 bonds in solar cells by Raman spectroscopy and found that high density Si-H_2 bonds exist at the P/I interface. Here, we have studied effects of SiH_4 gas flow rate on spatial distribution of SiH_2/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 SiH_4 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 SiH_2/SiH bond density ratio as a parameter of the SiH_4 gas flow rate. The spatial aperture size was 50 μm × 50 μm, 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 SiH_2/SiH bonds decreases with increasing the gas velocity from 10 m/s to 26.5 m/s. In addition, the in-plane 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 SiH_2/SiH bond density ratio.

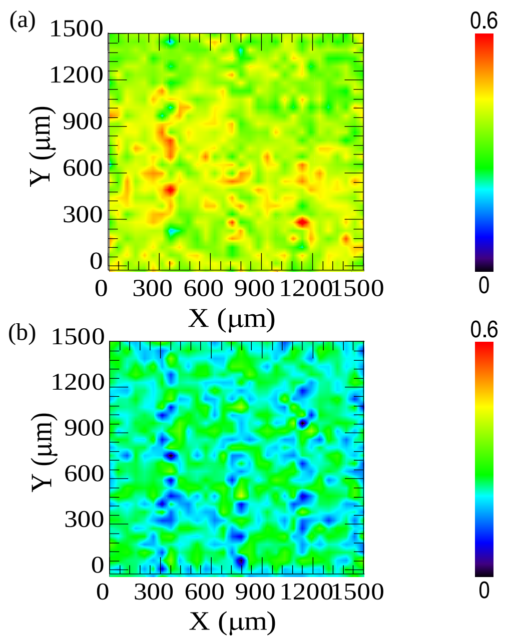

Figure 1. Spatial distribution of SiH_2/SiH bond density ratio of a-Si:H films; (a)56sccm (10 m/s), (b)147sccm (26.5 m/s).

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References

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