Topic number 14

Suppression of Si-H_2 bond formation at P/I interface in a-Si:H solar cells deposited by multi-hollow discharge plasma CVD

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Light induced degradation is the most important issue of hydrogenated amorphous silicon solar cells. A-Si:H films of a lower Si-H_2 bond density show less light-induced degradation. We have revealed existence of high-density Si-H_2 bonds within 60nm from P/I interface by Raman spectroscopy. These Si-H_2 bonds are originated from surface reactions of SiH_3; because the other origin, namely, cluster incorporation is considerably suppressed by a multi-hollow discharge plasma CVD (MHDPCVD) method. Substrate temperature dependence of I_{SiH2}/I_{SiH} shows the fine tuning the substrate temperature during initial stage of I-layer deposition is effective to suppress Si-H_2 bond formation at P/I interface.

1. Introduction

Light-induced degradation is the most important issue of hydrogenated amorphous silicon (a-Si:H) solar cells. By Raman spectroscopy, we have succeeded in detecting Si-H_2 bonds in cells, which are responsible for the light-induced degradation [1]. Here we have measured the hydrogen content ratio I_{SiH2}/I_{SiH} associated with Si-H_2 and Si-H bonds at P/I interface to identify high density region of Si-H_2 bonds and to suppress Si-H_2 bonds.

2. Experimental

Non-doped a-Si:H films (I-layer) were deposited on B-doped Si films (P-layer) with a MHDPCVD reactor [2, 3]. Pure SiH_4 was fed to the reactor at 84 sccm. The total pressure was 0.08 Torr. The discharge frequency and power were 110 MHz and 20 W, respectively. The substrate temperature was 170, 200, and 220 °C. The deposition rate was 0.0214 nm/s. Raman spectroscopy was carried out using HeNe laser light (λ= 632.8 nm). The penetration depth of HeNe laser light was more than 500 nm.

3. Results and discussion

Figure 1 shows dependence of I_{SiH2}/I_{SiH} on thickness of I-layer. I_{SiH2}/I_{SiH} decreases with increasing the thickness from 10 to 60 nm and it becomes constant for the thickness above 60 nm, indicating high density Si-H_2 bonds exist at P/I interface. These Si-H_2 bonds are originated from surface reactions of SiH_3; because the other origin, namely, cluster incorporation is considerably suppressed by the MHDPCVD method. To realize higher stability, suppressing Si-H_2 bond formation at P/I interface is important.

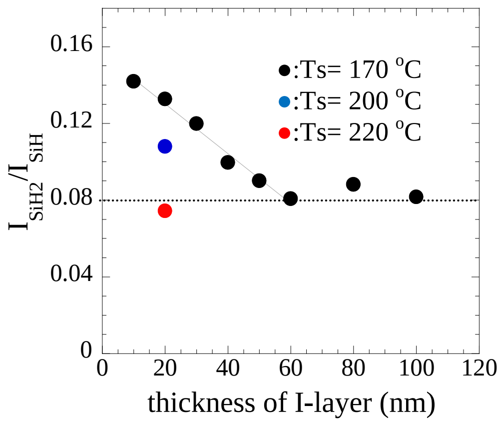

Fig. 1. Dependence of I_{SiH2}/I_{SiH} on thickness of I-layer and substrate temperature.

To realize such suppression, we have examined effects of substrate temperature on I_{SiH2}/I_{SiH}. I_{SiH2}/I_{SiH} decreases with increasing the substrate temperature from 170 °C to 220 °C. A precise turning the substrate temperature together with the deposition rate is effective to suppress Si-H_2 bond formation at P/I interface.

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4. References

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