対向ターゲットスパッタ法による a-Si:H (i)パッシベーション膜の製膜における極薄 SiO_x 層挿入の効果

Effect of ultra-thin SiO_x insertion on a-Si:H (i) passivation layer deposited by facing target sputtering

東工大工学院 [1]

(M2)ファリス アキラ ビン モハマド ズルキフリ [1], (M1)白取優大 [1], 中田 和吉 [1], 宮島 晋介 [1]

School of Engineering, Tokyo Tech.[1]

Faris Akira Bin Mohd Zulkifly[1], Shiratori Yuta[1], Kazuyoshi Nakada[1], Shinsuke Miyajima[1]

E-mail: farisakira.b.ab@m.titech.ac.jp

[Introduction] Silicon heterojunction solar cells (SHJ) are known for their high efficiency, which is realized by excellent surface passivation by introducing hydrogenated intrinsic amorphous silicon [a-Si:H (i)]. Generally, high quality a-Si:H (i) has been deposited by chemical vapour deposition using SiH_4 as the main source gas. To reduce the fabrication cost of the solar cells by avoiding the usage of the explosive SiH_4 gas, we introduced facing target sputtering (FTS) method as an alternative fabrication process for a-Si:H (i). Recently, we deposited high quality of a-Si:H (i) with effective carrier lifetime (τ_{eff}) beyond 2 ms by optimizing the amount of RF power. From our TEM results, we confirmed the presence of epitaxial growth in the a-Si:H (i) layer. In this study, we introduced hydrogen peroxide treatment on the silicon wafer which was reported to be effective in reducing the epitaxial growth for the deposition of a-Si:H by Cat-CVD method.[1]

[Procedure] N-type 280 μm FZ (100) mono-crystalline silicon wafers with resistivity of 3 Ω cm were used in this study. Before the deposition of a-Si:H (i), HF treatment was done to eliminate the native oxide on the Si-wafer. Then, SiO_x layer with a thickness around 1 nm were formed by dipping the wafer in 4% of H_2O_2 for 30 s at room temperature. The deposition of a-Si:H (i) by FTS was conducted under 0.2 Pa in room temperature. After the deposition of a-Si:H (i) layer, annealing treatment in forming gas (FG) ambient was applied in the range of 150–450°C. Effective minority carrier lifetime was measured before and after the annealing treatment by quasi steady-state photo-conductance (QSSPC) method.

[Results] Fig. 1 shows the relationship between minority carrier lifetime of a Si-wafer passivated by approximately 10-nm-thick a-Si:H (i) and RF power during the deposition. In most cases, passivation layers with the SiO_x layer showed higher lifetime, indicating that H_2O_2 treatment improves the passivation effect of thin a-Si:H (i) layers deposited by FTS method.

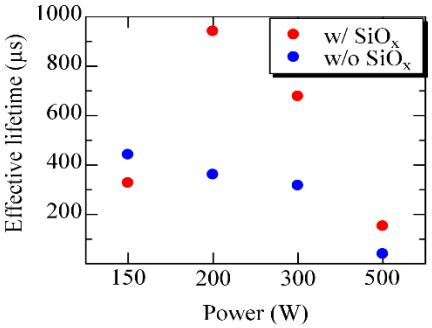

Fig. 1 Effective lifetime after annealing treatment in different RF power amount

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[Reference] [1] T. Oikawa et al., Current Applied Physics **15**, 1168 (2015).
[2] Akira Faris et al., 77th JSAP Autumn Meeting, 15p-P13-10, (2016, Sep.).