課題番号　　:F-18-WS-0029
利用形態　　:機器利用
Program Title (English)　:Analysis of the passivation layer on Si surface by using ellipsometry
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キーワード／Keyword　: Si oxide layer, surface passivation, refractive index, Shape/morphology observation, analysis

1. 概要(Summary)

Surface passivation of Si substrate was established well for the photovoltaic performance enhancement of the conventional bulk Si cells.[1] Pristine Si usually has high concentration non-saturated dangling bonds at the surface that causes high local carrier recombination rates in solar cells.[2] Here, we passivated the n-Si substrate surface with a thin oxide layer by a quick annealing process in vacuum (1 min, 500-550 °C, <5×10^{-4} Pa), and analyzed the oxide layer by spectroscopic ellipsometry.

2. 実験(Experimental)

【利用した主な装置】

高性能分光膜厚 測定装置

【実験方法】

At first, two parameters, amplitude component (ψ) and phase difference (Δ) were measured by the ellipsometry. Then the thickness (d) and refractive index (n) of the oxide layer could be calculated from the ψ and Δ by the Si oxide models. Each sample was measured and calculated three times.

3. 結果と考察(Results and Discussion)

Fig. 1a and 1b show the relationship between the thickness, refractive index and the passivation conditions. After etching in HF for 30 s, the oxide layer had thickness and refractive index of around 0.5 nm and 1.458, respectively. The thickness of oxide layer increased to around 1 nm as the annealing time and temperature increased. The refractive index was higher for the layer with annealing (1.469) than without annealing (1.458), showing the higher density for the oxide layer formed by annealing than for the native oxide layer on HF-treated Si surface.

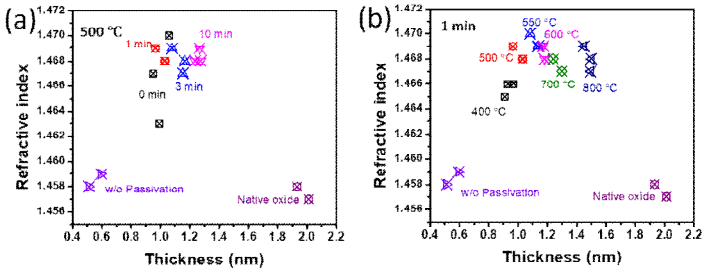

Fig. 1. The spectroscopic ellipsometry analysis of the oxide passivation layer on Si surface formed by annealing in vacuum (a) at 500 °C for 0–10 min and (b) at 400–800 °C for 1 min. "w/o Passivation" shows the cell with n-Si substrates after etching in HF.

4. その他・特記事項(Others)

・参考文献

1. T. D. Lee, et al., Renew. Sust. Energ. Rev. 2017, 70, 1286-1297.
2. Z. Y. Zhang, et al., J. Phys. Chem. C 2012, 116 (1), 893-900.

5. 論文・学会発表(Publication/Presentation)

(1) Rongbin Xie and Suguru Noda, AiMES 2018 (Americas International Meeting on Electrochemistry and Solid-State Science), D02-721, Cancun, Mexico, October 2, 2018.
(2) Rongbin Xie, Naoya Ishijima, and Suguru Noda, Monash-Waseda Joint Workshop on "Energy and Nanomaterials", Waseda Univ., Tokyo, Japan, Nov. 13, 2018 (poster).

6. 関連特許(Patent)

No.