Nano holes on micro pyramids: modulated surface texturing with neutral beam for the application of optical trapping in Si Solar cells

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Introduction: Silicon is a stable, eco-friendly, abundant and occupy the present PV market share more than 85%, and our research mainly focus on to reduce the production cost by developing high efficiency, thin (<100 m) light weight PERC bifacial type Si solar modules in large scale for mass production. Si is high refractive index (n = 3.4) and indirect bandgap material, more than 30% of incident light is reflected from the front surface and needs more thick Si (1000 µm) to absorb transmitted light. We propose making nano holes on micro pyramids will reduce the surface reflections to minimum and increase the optical absorption through increasing the path lengths of transmitted light inside Si.

Experiments: CZ p-Si (100) with thickness of 180 µm and resistivity of 1-5 ohm-cm wafers were used to form micro pyramids by wet etching. The mixture of Cl_2, SF_6 and O_2 neutral beam [1] were used to make holes on micro pyramids, to determine the etch profile use the cross-sectional view by using FE-SEM. Anti-reflection properties were measured using UV-Vis spectrometer which contains the integrated sphere.

Results and Discussions: Wet etching was performed to generate micro pyramids with a size of 5 to 6 microns and as shown in Fig. 1(a), which decrease the surface reflectance 20 to 9 % in the wavelength range from 400 to 1020 nm shown in Fig. 1 (b). We utilize the concept of multiple reflection in nano holes on the surface of micro pyramids will reduce the reflectance below 9%. Mask less texturing was performed to make the nano holes using Cl_2, SF_6, and O_2 neutral beams (NB) is to generate small to big hole on the surface of micro pyramids and as shown in Fig 1(b). The measured reflectance spectrum of NB modified samples not decrease much due to partial etch out of the micro pyramids, we are optimizing the gas chemistry to get best anti-reflective modulated surface texture for photovoltaic device.

Ref: [1]. S. Samukawa et al., J. Vac. Sci. Technol. A 20, 1566 (2002).

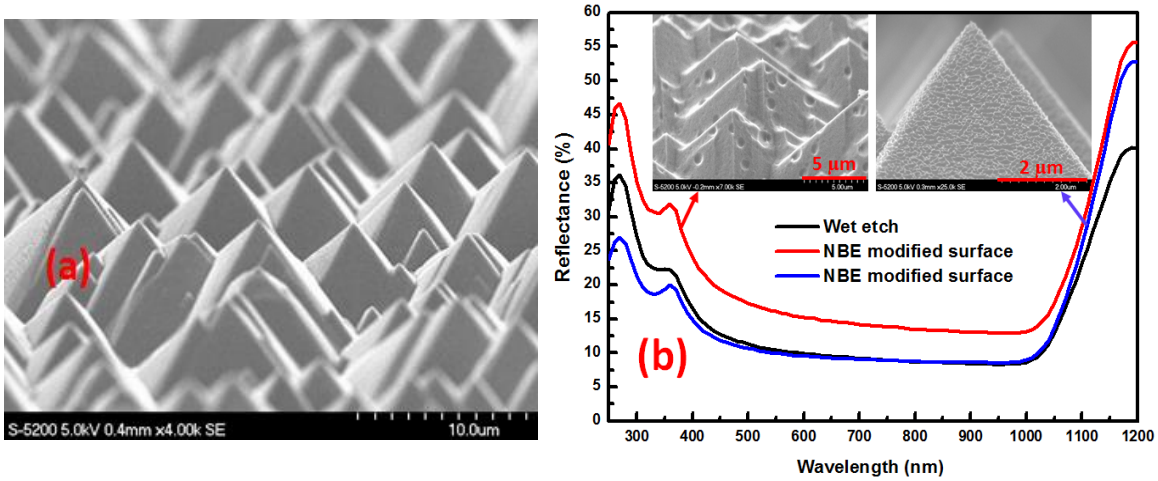

Fig. 1. (a) Wet etch pyramids. (b) Reflectance spectrum of wet and NBE modulated surfaces.

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