Si solar cells with nanodot structures formed by Nd:YAG laser pulses at 266 nm

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The formation of nanostructures on the surface of materials can provide new functions such as water repellency, antibacterial and non-reflective properties. In the case of Si solar cells, pyramid structures of 1 to 10 μm are formed on the surface to reduce reflectance [1]. If nanostructures of 1 μm or less can be formed on the pyramidal structure surface of silicon solar cells, it is expected that the reflectance in the solar spectral region of 500 nm or less can be reduced [2]. Furthermore, if nanodot structures with dimensions of about 5 nm can be fabricated, it will be possible to further increase the band gap energy, which corresponds to the spectral sensitivity of Si solar cells. In this study, we report that when the surface of a silicon solar cell is irradiated with a laser fluence below the melting threshold using Nd:YAG laser pulses at 266 nm, nanodot structures are formed on the pyramidal structure surfaces of the Si solar cells. Nanodot structures were prepared using the fourth harmonic (λ=266 nm, τ=7ns, repetition frequency=10 Hz) of a Nd:YAG laser (Quanta-Ray Pro-350-10, Spectra Physics). The laser pulse was focused on the solar cell with a cylindrical lens of f = 300 mm.

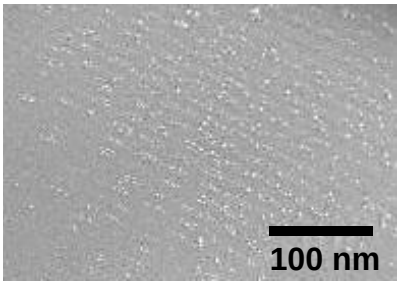

Fig. 1 SEM image of nanodot structures formed on the surface of Si solar. cell.

The number of laser pulses used for nanodot structure formation was 1500. Laser irradiation was carried out in air. The experimentally measured melting threshold fluence F_{th} was 0.51 J/cm^2. The crystallinity and the surface morphology of the Si solar cells irradiated with the laser were evaluated using a micro-Raman spectrometer (NRS-3300, JASCO) and observed by FE-SEM (S4700, Hitachi), respectively. Figure 1 shows SEM image of the Si solar cell after the laser irradiation at F = 0.2 F_{th}. It was found that nanodot structures with a averaged size of 20 nm were formed on the surface.

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