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Fabrication of Microwire Arrays for Enhanced Light Trapping Efficiency Using Deep Reactive Ion Etching

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Silicon microwire array is one of the promising platforms as a means for developing highly efficient solar cells thanks to the enhanced light trapping efficiency. Among the various fabrication methods of microstructures, deep reactive ion etching (DRIE) process has been extensively used in fabrication of high aspect ratio microwire arrays. In this presentation, we show precisely controlled Si microwire arrays by tuning the DRIE process conditions. A periodic microdisk arrays were patterned on 4-inch Si wafer (p-type, 1～10 Ωcm) using photolithography. After developing the pattern, 150-nm-thick Al was deposited and lifted-off to leave Al microdisk arrays on the starting Si wafer. Periodic Al microdisk arrays (diameter of 2 μm and periodic distance of 2 μm) were used as an etch mask. A DRIE process (Tegal 200) is used for anisotropic deep silicon etching at room temperature. During the process, SF_6 and C_4F_8 gases were used for the etching and surface passivation, respectively. The length and shape of microwire arrays were controlled by etching time and SF_6/C_4F_8 ratio. By adjusting SF_6/C_4F_8 gas ratio, the shape of Si microwire can be controlled, resulting in the formation of tapered or vertical microwires. After DRIE process, the residual polymer and etching damage on the surface of the microwires were removed using piranha solution (H_2SO_4 : H_2O_2=4 : 1) followed by thermal oxidation (900°C, 40 min). The oxide layer formed through the thermal oxidation was etched by diluted hydrofluoric acid (1 wt% HF). The surface morphology of a Si microwire arrays was characterized by field-emission scanning electron microscopy (FE-SEM, Hitachi S-4800). Optical reflection measurements were performed over 300～1100 nm wavelengths using a UV-Vis/NIR spectrophotometer (Cary 5000, Agilent) in which a 60 mm integrating sphere (Labsphere) is equipped to account for total light (diffuse and specular) reflected from the samples. The total reflection by the microwire arrays sample was reduced from 20 % to 10 % of the incident light over the visible region when the length of the microwire was increased from 10 μm to 30 μm.

Keywords: Si micro wire, radial junction, Deep Reactive Ion Etch, silicon solar cell