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Hole and Pillar Patterned Si Absorbers for Solar Cells

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Si is a dominant solar material, which is the second most abundant element in the earth giving a benefit in the aspect in cost with low toxicity. However, the inherent limit of Si has an indirect band gap of 1.1 eV resulting in the limited optical absorption. Therefore, a critical issue has been raised to increase the utilization of the incident light into the Si absorber. The enhancement of light absorption is a crucial to improve the performances and thus relieves the cost burden of Si photovoltaics. For the optical aspect, an efficient design of a front surface, where the incident light comes in, has been intensively investigated to improve the performance of photon absorption. Lambertian light trapping can be attained when the light active surface is ideally rough to increase the optical length by about 50 compared to a planar substrate. This suggests that an efficient design may reduce thickness of the Si absorber from the conventional 100～300 μm to less than 3 μm. Theoretically, a hole-array structure satisfies an equivalent efficiency of c-Si with only one-twelfth mass and one-sixth thickness. Various approaches have been applied to improve the incident light utilization in a Si absorber using textured structures, periodic gratings, photonic crystals, and nanorod arrays. We have designed hole and pillar structured Si absorbers. Four-different Si absorbers have been simultaneously fabricated on an identical Si wafer with hole arrays or pillar arrays at a fixed depth of 2 μm. We have found that the significant enhanced solar cell performances both for the hole arrayed and pillar arrayed Si absorbers compared to that of a planar Si wafer resulting from the effective improvement in the quantum efficiencies.

Keywords: Hole arrays, Pillar arrays, Si absorbers, Solar cells