Silicon nanopyramid texture fabricated by one-step solution process and its application to silicon heterojunction solar cells

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A novel method to fabricate crystalline silicon (c-Si) nanometer-sized pyramid (nanopyramid) texture with low etching margin using one-step solution process is reported. Recently, thin (<120 μm) c-Si solar cells have attracted much attention as a promising way to significantly cut down the production cost of the solar cell modules [1-3]. Compared to the conventional micron-sized Si pyramids, the nanopyramid texture is advantageous particularly for thin c-Si solar cells in minimizing the etching margin. At the same time, a smaller pyramid size allows to narrow the screen-printed Ag fingers, which in turn improves the J_{sc} of solar cells and reduces the Ag consumption [4]. Furthermore, Si nanopyramid texture is expected to be suited to perovskite/Si tandem cells [5], as it offers the potential of conformal deposition of perovskite top cell on top of the textured Si surface by means of low-cost solution-based deposition techniques.

In this contribution, we propose a new methodology of fabricating Si nanopyramid texture featuring both excellent anti-reflection performance and relatively low etching margin using an $AgNO_3$-assisted alkaline solution. After cleaning processes with acetone and deionized water, the planar Si wafer was textured by dipping in a mixed solution, which contains KOH: Pure EtchTK81(Hayashi Pure Chemicals Ltd., surfactant) and acid solution of HF: $AgNO_3$, for 15 min at 70°C. The texture size can be tuned by changing the concentration of HF: $AgNO_3$ solution. Figures 1a and 1b show the top-view and cross-sectional SEM images, respectively, showing that Si nanopyramids with a height of 300-500 nm were successfully formed on the Si surface. The etching margin of this structure was 3.4 μm. An even lower optical reflection is realized in comparison with the reference micron-sized pyramid texture (Fig. 2). Si heterojunction solar cells with Si nanopyramid textures were fabricated, demonstrating higher J_{sc} and efficiency compared with the cells with the conventional micron-sized Si pyramids.

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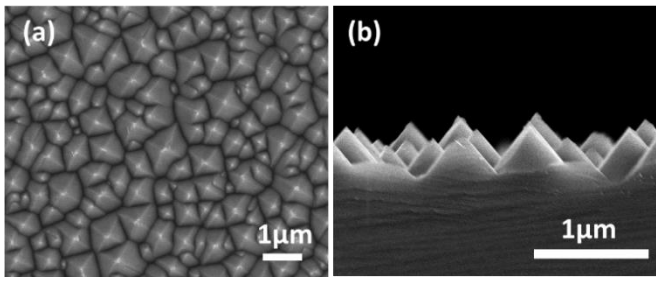

Fig. 1. Si nanopyramids etched by $AgNO_3$-assisted alkaline solution (a) top view and (b) cross-sectional view.

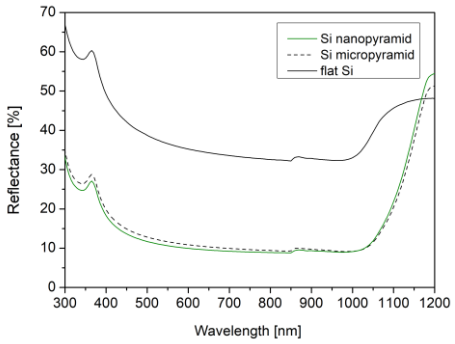

Fig. 2. Optical reflectance of the textured Si wafers with nano/micropyramids and flat Si wafer .

References

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