Towards Efficient and Flexible Silicon Based Thin Film Solar Cells

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In this presentation, I will discuss two efforts towards cost-efficient Si-based thin film solar cells (TFSCs). First, we report a ***shrinking and growing*** procedure to reduce the grain boundary density without modifying the deposition conditions of poly-Si. The key idea is to etch the as-deposited planar poly-Si thin-film to form poly-Si pillars with diameters smaller than the initial grain sizes, and these pillars are subsequently used as the seeds for the epitaxial growth of the Si absorber layer (Figure 1). As such, the final Si micropillars are either single crystalline or polycrystalline with much smaller grain boundary density. In addition, we incorporated the radial p-n junction configuration into the micropillar array so that the grain boundary recombination losses were further reduced by shortening the charge-carrier collection distances. As a result, the maximum efficiency of the micropillar poly-Si TFSCs is 6.4% that is about 1.5 times higher than that of the control planar cells without going through the shrinking and growing procedure.

Second, we report a new ***peel-and-stick*** process that circumvents these fabrication challenges by peeling off the fully fabricated TFSCs from the original Si wafer and attaching TFSCs to virtually any substrates, such as plastics, paper, and cell phones (Figure 2). We demonstrates the peel-and-stick process with a model system, hydrogenated amorphous silicon (a-Si:H) TFSCs, for which the 7.5% efficiency is unchanged by the peel-and-stick process. The peeled-off TFSCs also exhibit excellent mechanical flexibility due to their thin thickness. The new peel-and-stick process enables further reduction of the cost and weight for TFSCs and endows TFSCs with flexibility and attachability to greatly broaden their application areas. We believe that the peel-and-stick process can be applied to thin film electronics as well.

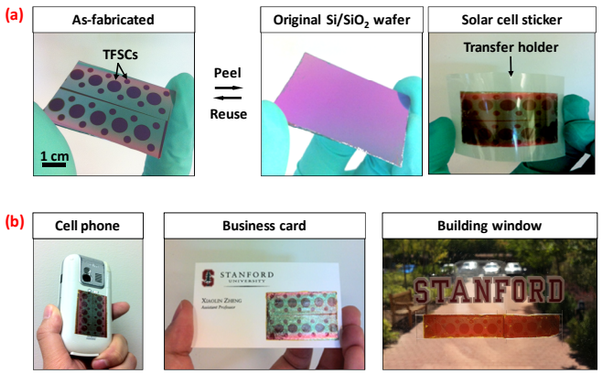

Figure 2: Thin film solar cells (TFSCs) at different stages of the peel-and-stick process. (a) As-fabricated TFSCs on the original Ni coated Si/SiO2 wafer (left). The donor Si/SiO2 wafer is clean and reusable after the peeling-off step (middle). The TFSCs are held by a temporary transfer holder (right). (b) TFSCs on cell phone (left), business card (middle), and building window (right).

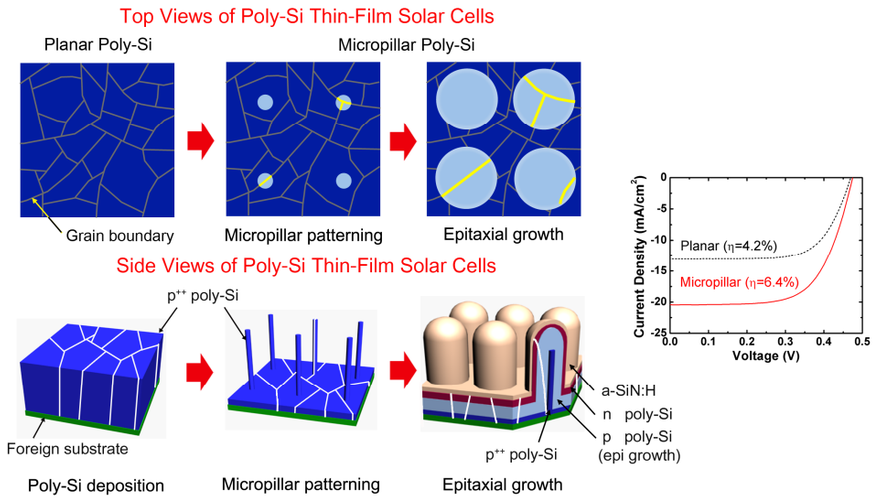

Figure 1: Schematic of the shrinking and growing process for reducing grain boundary density for thin film solar cells.