FUNCAPSOLAR
FUNCTIONAL ENCAPSULATION FOR SOLAR CELLS

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The photovoltaic (PV) industry has high impact and growth due to demand for cleaner energy worldwide. Development of new material solutions and photonic concepts are necessary for improving durability, performance, and cost.

This project investigates nanostructured PDMS as a potential functional encapsulant of planar Silicon solar cells. Single cell efficiencies in current c-Si PV technology, are typically around 20%. Such high efficiency cells require appropriate surface texturing for reducing reflection. Texturing is achieved through a basic etching obtaining random pyramids. This texturization is on one hand angle sensitive and on the other difficult to produce on multicrystalline Si substrates. In addition, the assembly of PV cells for producing a module invariably requires an encapsulant material which ideally has high transparency in the solar spectrum, environment tolerance [temperature and moisture], and low dielectric constant. The last property also serves in providing refractive index matching from air to the semiconductor solar cell. EVA is most commonly used but requires UV blocking which prevents utilization of this part of the spectrum for solar cells.

In this project we propose the use of PDMS – a promising material with all the good "traditional" properties as an encapsulant but with nanostructuring to reduce the overall reflection in all the range of wavelengths (the solar spectrum) and in a large range of angles.

Summary of Results and Achievements: Nano-structuring has to be compatible with high throughput, ease of fabrication and cost-effectiveness. Pattern generation approaches such as colloidal lithography and nano-imprint lithography (NIL) were investigated for nanostructuring. Colloidal lithography using self-assembly of silica particles (dispersed by spin coating on oxygen plasma treated surfaces) provided reasonable surface coverage, with close packed hexagonal arrangement obtained in patches of maximum 1 mm sq areas. In comparison, NIL provided nanopatterning on 3" wafer scale. The process for nanostructuring PDMS was developed. In separate works, planar Si solar cells were fabricated with Voc: 0.6 V and current density of 28 mA/cm2. These cells were used to test the use of nanostructured PDMS as anti-reflectors to increase the external quantum efficiency. The preliminary measurements indicated the feasibility and showed that the nanostructuring affects the cell performance but requires more effort to optimize the structure for improved performance.