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Anti-reflective Coating for PV Applications

TCO Nanorods: a light trapping surface

Problem Statement:

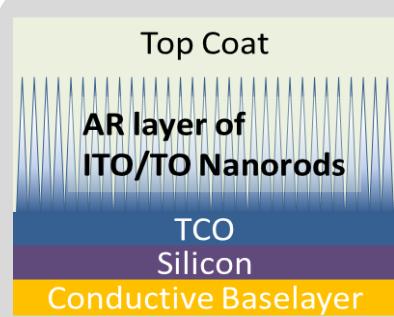
Photovoltaic (PV) panel efficiency can be dramatically increased by maximizing the number of incident photons that strike the light absorbing material (e.g. single crystal silicon). In a current PV stack, several sequential losses occur that reduce the number of photons that reach the light absorbing material. For instance, each interfacial layer on top of silicon reflects photons prematurely. We propose a simplified PV stack using transparent conducting oxide (TCO) nanorods to minimize interfacial layers, trap and channel photons, and increase PV efficiency.

Approach:

Nanoscale high aspect ratio features are known to trap incident light. Photons are trapped and reflections are suppressed over a wide range of incident light angles. Indium-doped Tin Oxide (ITO), an industry standard transparent conducting oxide material, is a critical component to photovoltaic modules. ITO is applied as a film to the top of the silicon wafer and conducts electrons from the silicon surface without blocking incident light. Sandia is developing low-temperature one dimensional crystalline growth of ITO/tin oxide or AZO/Zinc oxide nanorods nucleated over traditional PV surfaces. The surface modification results in a new high aspect ratio antireflective coating. The nanorod surface traps and channels photons and reduces the number of interfacial layers of different materials that cause reflections. The reduced number of layers also decreases the likelihood of delamination failures.

Impact:

Reducing reflections could increase the efficiency of a PV panel by 6%, according to literature estimates of losses. This would correspond to a commensurate improvement in panel efficiency.



Sandia-developed nanorod ITO layers trap photons, decrease reflection, and increase PV efficiency by up to 6%.

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