ZnO-ITO multilayered structure on Si substrate with prospective usage as antireflective covering for solar cells

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ZnO and SnO_2 are some of the most important functional oxides with direct wide band gaps (3.37 and 3.95 eV). They are widely used in electronics as transpared electrodes, materials for optoelectronic devices and solar sells [1]. As is known, nearly 40% of incident light is reflected back in silicon wafers in the 550 nm wavelength region. This causes a significant loss in solar cell efficiency. Capturing of incident light is an essential requirement for high-performance solar cells. Photocurrent in solar cells can be increased by fabricating of antireflective coatings, which are beneficial in transmitting maximum light in such a way that minimal light is reflected from the air–substrate interface. Theoretical modelling of the antireflective thin films, such as ZnO [2], unlocks new options for production of wideband-tunable antireflective coatings that can be applicable in high-performance photovoltaic applications.

This study uses a silicon wafer as the substrate, on which the multilayered structure is formed. This structure includes a 500-nm thick ITO (Indium tin oxide) film, ZnO films with variable thickness and ZnO nanorods of various radii on the top. This kind of coating can enhance solar cell productivity at omnidirectional angles because there is a gradual declination of the refractive index. The multilayered structure were designed and tested using Lumerical FDTD (Finite-difference time-domain) simulations [3], and this reduced it reflectance to <0.5% in the 400-700 nm wavelength range. Optimization results indicate that ZnO nanorods with r = 35 nm on a 70-nm ZnO uniform film on the top of ITO thick film has reflectance of 0.0004-0.5% in the visible region. Lumerical FDTD helps and permits the operator to define an appropriate design using different inorganic materials applicable to various supporting substrates and illuminants [3]. This software is a reliable simulation tool that can operate in varying environmental conditions.

References

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