Optimization of a broadband and omnidirectional anti-reflection layer for Cu_2ZnSnS_4 solar cells

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Abstract

Anti-reflection coatings (ARCs) play an important role in the performance of optoelectronic devices because of their ability to minimize Fresnel reflection loss at the interface between air and semiconductor materials [1-2]. In this article, a study is presented of aluminum-doped zinc oxide (AZO) sub-wavelength grating (SWG) nanostructures for broadband and omni-directional anti-reflection coatings (ARCs) on Cu_2ZnSnS_4 (CZTS) solar cells using the rigorous coupled-wave analysis (RCWA) method. Various SWG nanostructures of different shapes and periodic AZO on CZTS solar cells are discussed in detail. The optimized reflectance decreased from 9.9% to 1.67%, and efficiency increased from 12.56% to 13.74%, accordingly. The omni-directional and broadband antireflections of the AZO SWG nanostructures are also investigated. This considerable enhancement in light harvesting is attributed to the linearly graded effective refractive index profile from the air to the device surface.

References

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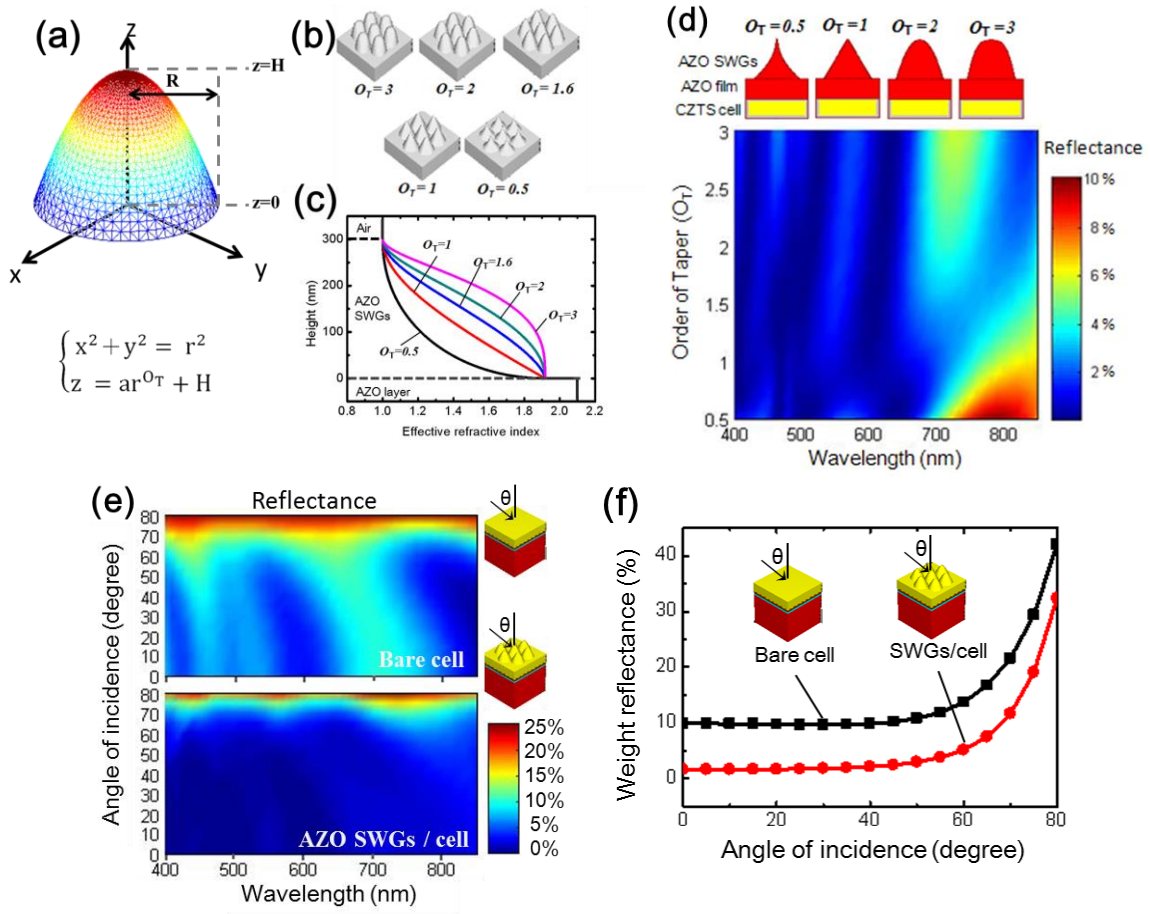
[2] J. Zhu, Z. F. Yu, G. F. Burkhard, C. M. Hsu, S. T. Connor, Y. Q. Xu, Q. Wang, M. McGehee, S. H. Fan, and Y. Cui, Nano Lett. **9**, (2009) 279–282.

Figures



(a) The geometry of AZO SWGs expressed by the equation of the parabola-shaped, (b) the geometries of AZO SWGs at O_T = 3, 2, 1.6, 1 and 0.5, (c) calculated effective refractive index profiles of the AZO SWGs with R=150 nm and H=300 nm at O_T = 3, 1.6, 2, 1 and 0.5. (d) Contour plots of the calculated reflectance variation as a function of wavelength at different OT for AZO SWG nanostructures on CZTS solar cell. (e) The simulation angular reflectance spectra for solar cell with (top) bare and (bottom) with AZO SWGs solar cells. (f) The weighted reflectance of the cells.