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Dual-wide-band absorber of truncated-cone structure, based on metamaterial

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Artificially-engineered materials, whose electromagnetic properties are not available in nature, such as negative reflective index, are called metamaterials (MMs). Although many scientists have investigated MMs for negative-reflective-index properties at the beginning, their interests have been extended to many other fields comprising perfect lenses. Among various kinds of MMs, metamaterial absorbers (MM-As) mimic the blackbody through minimizing transmission and reflection. In order to maximize absorption, the real and the imaginary parts of the permittivity and permeability of MM-As should be adjusted to possess the same impedance as that of free space. We propose a dual-wide-band and polarization-independent MM-A. It is basically a triple-layer structure made of metal/dielectric multilayered truncated cones. The multilayered truncated cones are periodically arranged and play a role of meta-atoms. We realize not only a wide-band absorption, which utilizes the fundamental magnetic resonances, but also another wide-band absorption in the high-frequency range based on the third-harmonic resonances, in both simulation and experiment. In simulation, the absorption bands with absorption higher than 90% are 3.93 – 6.05 GHz and 11.64 – 14.55 GHz, while the experimental absorption bands are in 3.88 – 6.08 GHz and 9.95 – 13.84 GHz. The physical origins of these absorption bands are elucidated. Additionally, it is also polarization-independent because of its circularly symmetric structures. Our design is scalable to smaller size for the infrared and the visible ranges. This work was supported by the ICT R&D program of MSIP/IITP, Korea (KCA-2013-005-038-001).

Keywords: Metamaterials, Wide band, Resonance, Sub-wavelength structure

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High aspect ratio Zinc Oxide nanorods for amorphous silicon thin film solar cells

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The front transparent conductive oxide (TCO) films must exhibit good transparency, low resistivity and excellent light scattering properties for high efficiency amorphous silicon (a-Si) thin film solar cells. The light trapping phenomenon is limited due to non-uniform and low aspect ratio of the textured glass [1]. We present the low cost electrochemically deposited uniform zinc oxide (ZnO) nanorods with various aspect ratios for a-Si thin film solar cells. Since the major drawback of the electrochemically deposited ZnO nanorods was the high sheet resistance and low transmittance that was overcome by depositing the RF magnetron sputtered AZO films as a seed layer with various thicknesses [2]. The length and diameters of the ZnO nanorods was controlled by varying the deposition conditions. The length of ZnO nanorods were varied from 400 nm to 2 μm while diameter was kept higher than 200 nm to obtain different aspect ratios. The uniform ZnO nanorods showed higher haze ratio as compared to the commercially available FTO films. We also observed that the scattering in the longer wavelength region was favored for the high aspect ratio of ZnO nanorods and much higher aspect ratios degraded the light scattering phenomenon. Therefore, we proposed our low cost and uniform ZnO nanorods for the high efficiency of thin film solar cells.

Keywords: Light trapping, Zinc oxide nanorods, Haze value, Aspect ratio, a-Si thin film solar cell.