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Numerical Simulation of Plasmonic Nano-antenna ZnO for Solar Cells Applications

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The consumption of energy is growing abruptly, and it is directly proportional with world population growth in over the world. The high efficiency solar cells are always looking for how to management the light effectively. Nowdays, the material production for high efficiency solar cells has been a keystone factor in the development of innovative electrical devices. So, the fabrication, characterization and numerical analysis of ZnO nanoantenas for high efficiency solar cells applications are very important, because it is in the group II–VI metal oxide semiconductor with a wide direct band gap [1]. The modern electronics, nanophotonics, plasmonics and energy conversion applications are using semiconductor nanostructures. In the case, nanophotonics and plasmonics where optical nanoantennas are growing the interest because these can be found application in high efficiency solar cells. In the case of ZnO films, it has a high electrical conductivity and a high optical gain at ambient temperature. In consequence by these properties, ZnO thin films have found numerous potential applications in solar cells. A new concept of trapping light is the use of plasmonics, the electronic response of free electrons to light interacting with metal nanostructures. Therefore, the interest in plasmonics for photovoltaics has increased considerably since about a decade and is explored from different perspectives such as enhanced scattering, local field enhancement, and wave guiding [2-3].

In this work the effects of plasmonics were explored by numerical simulation of the photocurrents in a nanoscale solar cell using a thin film ZnO. The methodology was explored by the solar cell functions as nanolens, focusing incoming light directly on the nanoantenna. We found that plasmonics and geometric optics affect the nanostructured solar cell performance, depending strongly on light incidence angle, the intensity and polarization. It is important, because with these phenomena can increase the efficiency significantly. This provides valuable insight in solar cell processes in which novel concepts such as plasmonics, elongated nanostructures, and nano-lenses are used. The SEM photos of the samples surfaces of ZnO thin films are showed in Figure 1. Here, we can see the typical scanning electron microscopy images of ZnO grown on glass substrate, the inserts are for higher magnification to show the cross-sectional view for hexagonal structures. The results using different light transmission for different polarizations at the solar cell surface leading to the observed difference in photocurrent. The cross sections of the light absorption in the ZnO nanoantenna is shown in Figure 2. Side and top view cross sections at normal and 30° incidence show that most of the light is absorbed in the central region of the nanostructured solar cell.

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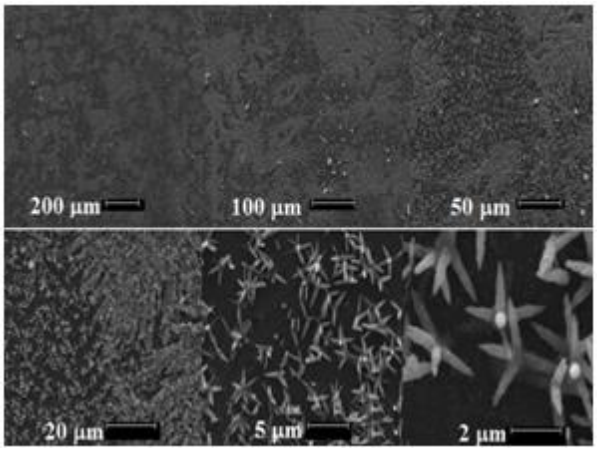

Figure 1. SEM photos of the samples surfaces of ZnO thin films.

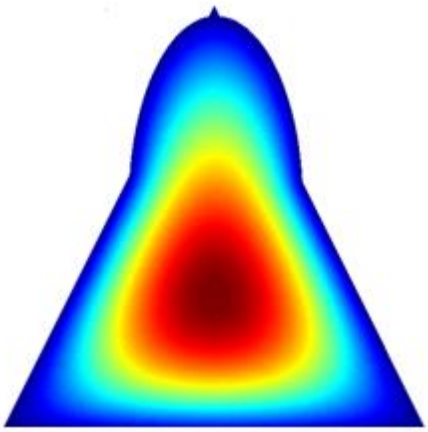

Figure 2. View perpendicular to plane of incidence of the time-integrated photo-absorption in the ZnO nanoantenna.

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