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The properties of Al-doped ZnO thin films sputtered from aerogel nanopowder targets for solar cells applications

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Abstract:

Zinc oxide (ZnO) is an interesting wide band gap semiconductor material with a direct band gap of 3.3 eV and a high exciton binding energy of 60 meV at room temperature. Thin films of this oxide have many remarkable characteristics and have attracting much attention recently, due to its broad range of applications as transparent conductive oxide (TCO) in electrodes, solar cells and photovoltaic devices. ZnO thin films doped with group-III elements such as aluminum, boron, gallium and indium, have been used as transparent and conducting films. Aluminum doped zinc oxide (AZO) is considered to be an outmost important material due to its high conductivity, good transparency, lower cost, resource availability and non toxicity.

In this work, AZO thin films were deposited by rf-magnetron sputtering on glass and silicon substrates at room temperature using aluminium (3 at%) doped nanocrystalline powder. The nanoparticles of ~30 nm size were synthesized by a sol–gel method using supercritical drying in ethyl alcohol. The obtained AZO film with a thickness of about 0.4 µm was polycrystalline with an hexagonal wurtzite structure and preferentially orientated in the (002) crystallographic direction. Transmission electron microscopy (TEM) and scanning electron microscopy (SEM) were used to study the film morphology. The obtained AZO film has a typical columnar structure. The films are highly transparent in the visible wavelength region with a transmittance higher than 90% and an electrical resistivity down to 10^{-3} Ω.cm at room temperature. We have reported the presence of an interesting photovoltaic effect in In_2O_3:SnO_2/(n)AZO/Si(p) heterostructure. Electron-beam induced current (EBIC) measurements were carried out to visualize the p-n junction in our heterostructure and the I(V) characterizations in dark and under illumination were also investigated.