# Linear and nonlinear optical investigations of nano-scale Si-doped ZnO thin films: spectroscopic approach

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## Abstract

Pure and Si-doped ZnO (SZO) thin films at different concentration of Si (1.9 and 2.4 wt%) were deposited on highly cleaned glass substrate by radio frequency (DC/RF) magnetron sputtering. The morphological and structural investigations have been performed by atomic force electron microscope (AFM) and X-ray diffraction (XRD). The X-ray photoelectron spectroscopy was employed to study the composition and the change in the chemical state of Si-doped ZnO thin films. The optical observations like transmittance, energy band gap, extinction coefficient, refractive index, dielectric loss of pure and Si-doped ZnO thin films have been calculated. The linear optical susceptibility, nonlinear refractive index, and nonlinear optical susceptibility were also studied by the spectroscopic approach rather than conventional Z-scan method. The energy gap of Si-doped ZnO thin films was found to increase as compared to pure ZnO thin films. The crystallinity of the ZnO thin films was effected by the Si doping. The O1s spectra in pure and Si-doped ZnO revealed the bound between O-2 and Zn+2 ions and reduction in the surface oxygen with the Si doping. The chemical state analysis of Si 2p showed the conversation of Si to SiOx and SiO2. The increase in the first-order linear optical susceptibility chi((1)) and third-order nonlinear optical susceptibility chi((3)) was observed with the Si doping. The nonlinear studies gave some details about the applications of metal oxides in nonlinear optical devices. In short, this study showed that Si doping through sputtering has effected on the structural, surface and optical properties of ZnO thin films which could be quite useful for advanced applications such as metal-oxide-based optical devices.

## Keywords

**KeyWords Plus:** CHEMICAL-VAPOR-DEPOSITION; ELECTRICAL-PROPERTIES; SPRAY-PYROLYSIS; TEMPERATURE; NANOPARTICLES; CHALCOGENIDES; OXIDES; COPPER

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