



Research Article

Composition and Temperature Dependence of Electronic and Optical Properties in Manganese Doped Tin Dioxide Films on Quartz Substrates Prepared by Pulsed Laser Deposition

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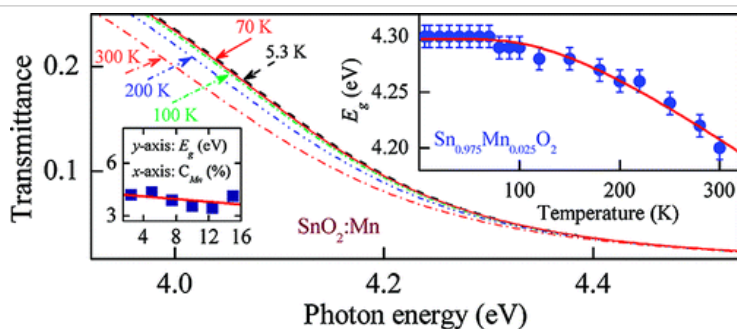
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Abstract



Manganese-doped tin dioxide ($\text{SnO}_2\text{:Mn}$) films (grain size of about 16 nm) with different composition x from 2.5 to 15% have been grown on quartz substrates by pulsed laser deposition. X-ray diffraction analysis show that the films are polycrystalline and an impurity phase appears until the x is up to 15%. The optical functions in the photon energy range of 0.5–6.5 eV have been extracted by fitting the transmittance spectra at room temperature with the Adachi's dielectric function model (Adachi, S., *Phys. Rev. B* 1987, 35, 7454). The refractive index generally decreases with the doping composition except for the film doped with 15% Mn because of the variation in crystalline formation and electronic energy band structure. Because of the repelling effect of 2p–3d hybridization and its perturbation on O 2p-like bands, the optical band gap linearly decreases and can be well expressed by $(4.26 - 3.8x)$ eV. The transmittance spectra of the film doped with 2.5% Mn at the temperature varied from 5.3 to 300 K have been recorded and a redshift trend of the absorption edge with increasing



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the temperature can be observed. The results indicate that the dielectric functions decrease with the temperature at the photon energies above the fundamental band gap. Moreover, the optical band gap is shrunk from 4.30 to 4.20 eV with increasing the temperature because of the modification of the electron–phonon interactions. The band gap narrowing coefficient of the SnO₂:Mn film with 2.5% Mn is estimated to be about -5.74×10^{-4} eV/K at room temperature.

Keywords: **SnO₂:Mn; optical properties; temperature dependence; pulsed laser deposition**

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