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Interconnection of charge neutrality level with electronic structure and p-d hybridization and its modification upon electronic excitation

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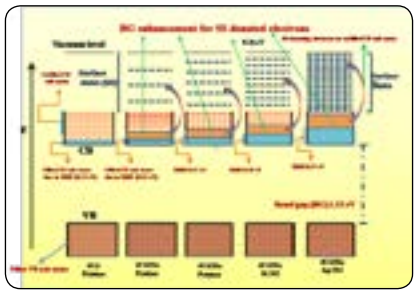
Undoped and tin doped cadmium oxide (CdO) based thin films are irradiated by 84 MeV Si^{6+} and 120 MeV Ag^{9+} ions. In the present work the charge nutrality level (CNL) in highly conducting CdO thin films is demonstarted by the observed variation in the band gap upon annealing and doping. The increase in crystallite size with tin doping is a signature of decrease of CdO stoichiometry by substitutional replacement of Cd with Sn. Each Cd^{2+} ions are substituted by Sn^{2+} ions with reduction of Sn^{4+} via creating oxygen vacancies in the lattice which also enhnaces the carrier concentration in the tin doped thin film. The band gap enhancement cannot be explained by Burstein Moss Shift (BMS) only but can be explained by formation of charge neutrality level (CNL). The level of local CNL resides at the branch point of virtual gap states (ViGS) generation of which is the consequence of tin doping in CdO lattice. Further investigations using soft X-ray absorption spectroscopy (SXAS) at oxygen K and cadmium M edge and the analysis of the spectral features has revealed an evidence of p-d interaction between O 2p and Cd 4d orbitals. After irradiation, the thin films exhibit an unusual band gap enhancement via generation of oxygen vacancies due to huge electronic energy deposition inside the lattice by Ag and Si ions. The observed band gap enhancement has been substantiated by a schematic block diagram.



Recent Publications

1. Arkaprava Das et al. (2017) Virtual gap states induced modifications in charge neutrality level in cadmium oxide thin films. Materials Research Express. 4(4):045901.
2. Arkaprava Das et al. (2016) Electronic structure modification and Fermi level shifting in niobium doped anatase titanium dioxide thin films: a comparative study of NEXAFS, work function and stiffening of phonons. Physical Chemistry Chemical Physics. 18(5):36183627.
3. Arkaprava Das et al. (2016) Micro-Raman and electronic structure study on kinetics of electronic excitations induced monoclinic to tetragonal phase transition in zirconium oxide films. RSC Advances. 6(106):104425-104432.
4. Subodh K Gautam et al. (2016) Carrier transport mechanism of highly-sensitive niobium doped titanium dioxide/p-Si heterojunction photodiode under illuminations by solar simulated light. Journal of Applied Physics. 120:214502.
5. Rakesh C Ramola et al. Study of phase transformation induced by electronic excitation in pure and yttrium doped ZrO_2 thin films. Material Research Express. 4(9):096401.

Biography

Arkaprava Das is a senior research scholar in Inter University Accelerator centre, New Delhi, India and has his research work focused on the development of undoped and doped cadmium oxide (CdO) thin films and their nanocomposites (NCs) for studying various phase transformation phenomenon besides the scope of their potential applications.

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