

ABSTRACT

Nanoparticles of less than 100 nm have improved properties in comparison to the bulk properties of the same material. This makes them more appealing and recently, they have attracted a lot of research attention. Titanate are materials based on ilmenite structure with formula MTiO_3 . Titanates are applicable in areas like photocatalysis, environmental purification and gas sensors, in optical and storage devices and high effect solar cells among others. This is due to their promising electrical, optical and magnetic properties that are tunable through doping amongst other methods. The fabrication of any electronic device depends on electrical and optical properties of a material. Doping can improve such properties. NiTiO_3 possesses low quantum efficiency and high electron-hole recombination. To overcome these two, $\text{Cu}_0\text{Ni}_1\text{TiO}_3$, for $x = 0$ and copper-doped nickel titanates nanoparticles ($\text{Cu}_x\text{Ni}_{1-x}\text{TiO}_3$ ($x = 0.3, 0.5, 0.7$)) were successfully synthesized via sol-gel method and calcined at 600 °C for 3 hours to obtain the final product. The studies of various properties of the synthesized samples were through XRF, XRD, FTIR, Kelvin probe and UV-Vis analysis. The XRD spectra analysis for the $\text{Cu}_x\text{Ni}_{1-x}\text{TiO}_3$ revealed the micro strain to be 0.0019, 0.001, -0.0028, -0.0017, the dislocation density as $80.160 \times 10^{-3} \text{Å}^{-2}$, $165.919 \times 10^{-3} \text{Å}^{-2}$, $305.241 \times 10^{-3} \text{Å}^{-2}$, $144.2442 \times 10^{-3} \text{Å}^{-2}$ and the packing factor of synthesized samples as 84.88, 101.96, 91.79 and 82.26 for $x = 0, 0.3, 0.5, 0.7$ respectively. FTIR analysis indicated frequencies $501\text{-}504 \text{ cm}^{-1}$, $401\text{-}492 \text{ cm}^{-1}$ and $703\text{-}704 \text{ cm}^{-1}$ attributed to O-Ti-O and Ti-O stretching vibrations, octahedral metal-oxygen bond and tetrahedral vibration bonds for $\text{Cu}_x\text{Ni}_{1-x}\text{TiO}_3$ ($x = 0, 0.3, 0.5, 0.7$) respectively. The band gap energy of the synthesized $x = 0$ sample as studied via UV-Vis was 4.2024 eV. The energy band gaps for the copper-doped nickel titanate were 4.1953 eV, 4.2024 eV and 4.2969 eV for $x = 0.3, 0.5, 0.7$ respectively. The Kelvin's probe analysis for the doped samples, revealed line scan work function in the range of 5.0321 eV- 5.3855 eV for $x = 0.3, 0.5, 0.7$ and 4.9707 eV for $x = 0$. The point scan analysis showed work function of 5.098 eV for $x = 0$ and a range of 4.908 eV - 5.366 eV for $x = 0.3, 0.5, 0.7$ samples. The samples for $x = 0, 0.3, 0.5$ showed a negative contact potential difference while sample for $x = 0.7$ showed positive contact potential difference. Copper dopant had an effect on the structural, optical and electronic properties of nickel titanate.