Hydrothermal improvement for 3R-CuFeO2 delafossite growth by control of mineralizer and reaction atmosphere

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Abstract

Delafossite CuFeO2 oxides were grown inside a hydrothermal reactor using Cu2O and FeOOH as precursors and NaOH as mineralizer. During this work the effect of the NaOH mineralizer and the reaction atmosphere was studied by varying the amount of NaOH used in the hydrothermal synthesis and by changing the reactor atmosphere from room air to high purity nitrogen. The oxides obtained were analyzed with Raman Spectroscopy, Fourier Transform Infrared Spectroscopy (FT-IR), X-ray diffraction (XRD), X-ray Photoelectron spectroscopy (XPS), Field Emission Scanning Electron Microscopy (FESEM) and Energy Dispersive X-ray Spectroscopy (EDS), in order to obtain their morphological, chemical and structural characteristics. It was found that increasing the amount of mineralizer from 0.4 g up to 1.02 g improves considerably the hydrothermal reaction efficiency obtaining a resulting oxide with 93% of 3R-CuFeO2 phase and a subsequent decrease of the 2H-CuFeO2 phase. Moreover, using the same hydrothermal route it was shown possible to obtain high purity CuFeO2 compounds using small amounts of NaOH (0.4 g) if the reaction is performed under a non-oxidative atmosphere injecting pure nitrogen gas to the hydrothermal reactor where an increase of 3R-CuFeO2 phase from 36% to 94% was obtained. Finally, direct band gap of the semiconducting oxides were estimated using Tauc method from UV–vis spectra obtained by Diffuse Reflectance spectroscopy..

Keywords

Delafossite, Hydrothermal synthesis, Surface characterization, Semiconductor band gap.