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Synthesis and characterization of $ZnWO_4$ ceramic powder

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Abstract

Zinc tungstate ($ZnWO_4$) ceramic powder has been synthesized by a solid-state reaction method. A broad and intense blue emission at 472 nm has been measured from it with an excitation at 297 nm. Structural properties of this $ZnWO_4$ ceramic powder have been analyzed by carrying out the XRD, SEM, EDAX and FTIR spectral measurements. Besides these studies, dielectric properties in the frequency range of 200 Hz to 3 MHz at 300 K have also been carried out and all the obtained results are reported here.

Keywords: A. Powders: solid-state reaction; B. Spectroscopy; C. Dielectric properties

1. Introduction

It has been known that the tungstate-based inorganic materials have potential applications in various fields, such as photoluminescence, microwave devices, fiber optical communications and as scintillator materials [1–4]. These materials are considered to be novel, technically and commercially important because they posses different encouraging properties such as high chemical stability, high refractive index, high X-ray absorption coefficient and also their displaying efficiency in outputs [5–7]. As a wide direct band gap semiconductor, ZnO has recently been gaining more attention due to its extensive applications in a variety of fields [8–10]. Keeping these advantages in view, we have made an attempt here to prepare $ZnWO_4$ ceramic powder by a solid-state reaction method to characterize its spectral and dielectric properties systematically.

2. Experimental studies

Zinc tungstate ($ZnWO_4$) ceramic powder was prepared by a solid-state reaction method. Commercially available laboratory reagent chemicals of ZnO, WO_3 (in 99.9% purity) were used as starting materials. These two chemicals were weighed appropriately based on the stoichiometric composition and later on these chemical mixtures were powdered by using acetone as a wetting organic liquid in an agate mortar for 2 h. The mixture was then transferred into a porcelain crucible and later on sintered in an electrical muffle furnace at 1000 °C for about 5 h. The structure of the synthesized ceramic powder was characterized on a XRD 3003TT Seifert diffractometer with CuKα radiation (λ = 1.5406 Å) at 40 kV and 20 mA and the 2θ value was varied between 20° and 80° range. The morphology of the ceramic powder was examined on a JEOL JSM 840A Scanning Electron Microscope. The ceramic powders were gold coated using a sputter coater polaron SC7610 system. The elemental identification of the synthesized ceramic powder was obtained from the EDAX attachment of the SEM system. FTIR spectrum of the sample was recorded on a Nicolet IR-200 spectrometer using a KBr pellet technique in the range of 4000–400 cm^{-1}. Dielectric profiles of $ZnWO_4$ ceramic powder measured in the frequency range of 200 Hz to 3 MHz at 300 K on a Hioki 3532-50 LCR meter. Both the excitation and emission spectra of the sample were carried out on a Jobin Yvon Fluorolog-3 Fluorimeter with a Xe-arc lamp (450 W) as the source of excitation.

3. Results and discussion

An XRD profile of $ZnWO_4$ ceramic powder has been presented in Fig. 1 revealing that it is in *monoclinic* nature and most of the observed peaks have been indexed to the pure phase of *monoclinic wolframite* using the JCPDS Card No: 15-0774.

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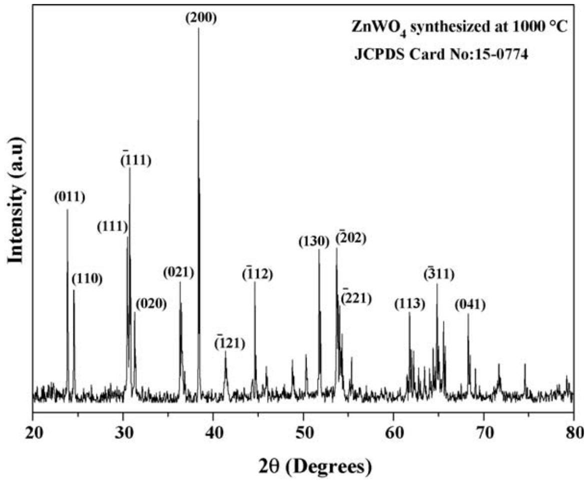

Fig. 1. XRD profile of $ZnWO_4$ ceramic powder.

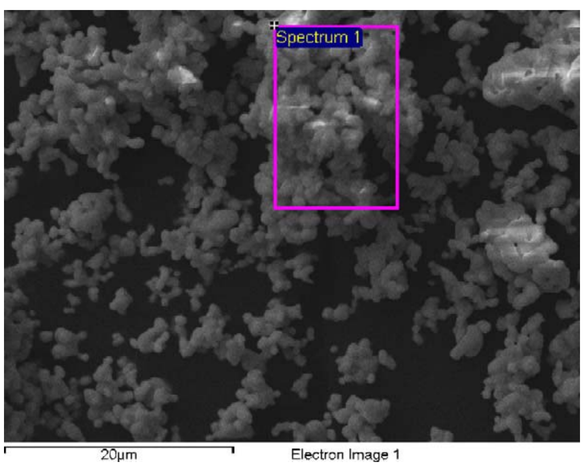

Fig. 2. SEM image of $ZnWO_4$ ceramic powder.

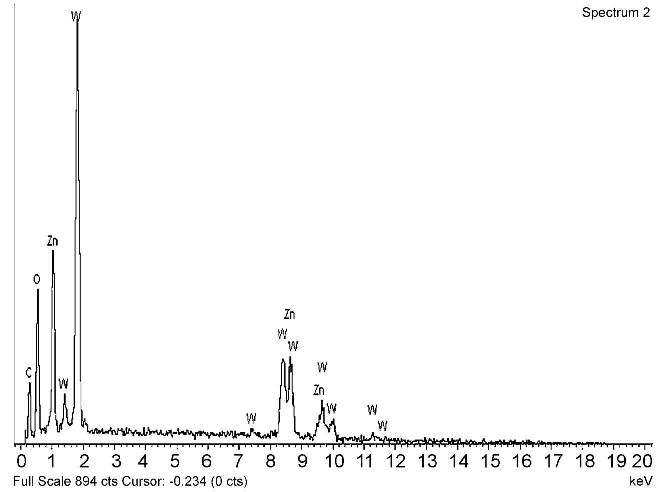

Fig. 3. EDAX profile of $ZnWO_4$ ceramic powder.

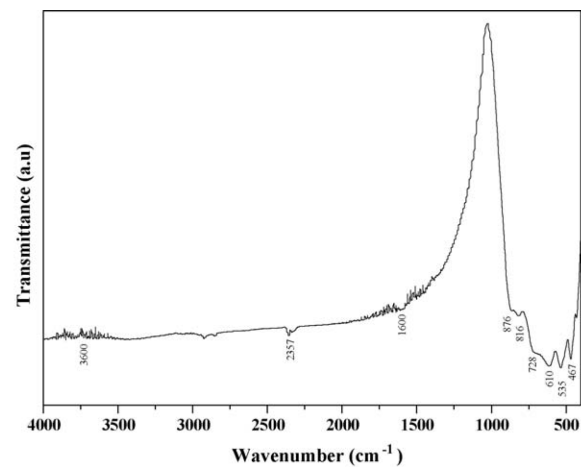

Fig. 4. FTIR spectrum of $ZnWO_4$ ceramic powder.

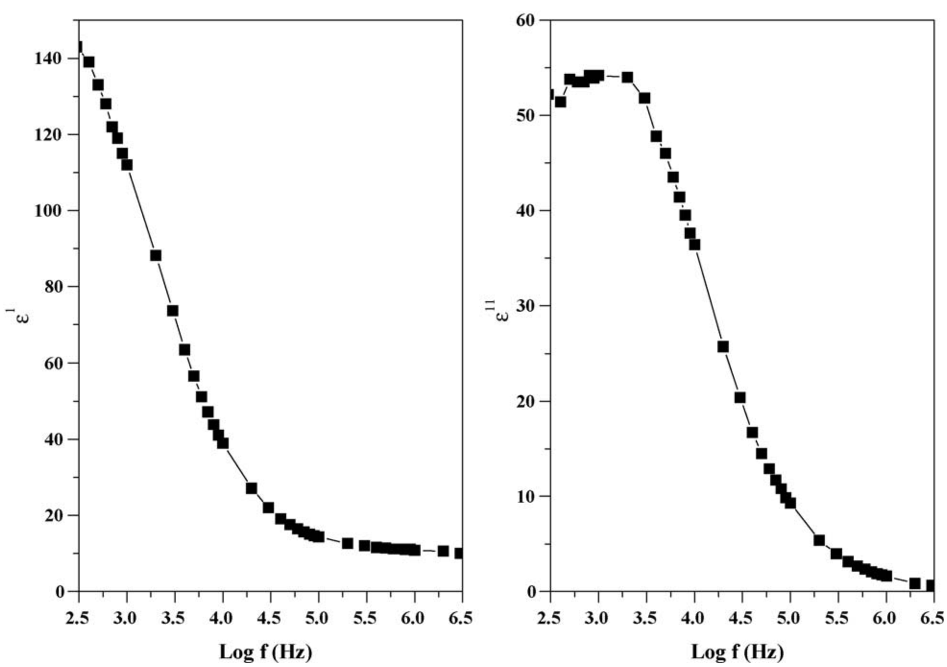

Fig. 5. Variation of dielectric constant (ε') and dielectric loss (ε'') of $ZnWO_4$ ceramic powder with respect to frequency at room temperature.