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Effect of phase transformation on optical and dielectric properties of pulsed laser deposited $ZnTiO_3$ thin films

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ABSTRACT

Zinc titanate ($ZnTiO_3$) ceramics were prepared by conventional solid state reaction method using ZnO and TiO_2 in a molar ratio of 1:1 with optimized parameters. It was found that the sample sintered at 800 °C for 12 h exhibit single hexagonal phase of $ZnTiO_3$. $ZnTiO_3$ thin film have been deposited on ITO coated glass substrate using pulsed laser deposition (PLD) technique employing a KrF laser source ($\lambda = 248$ nm). In present work, the effect of substrate temperature, which leads to transformation of hexagonal phase to cubic phase, has been studied. The XRD pattern revealed that pure hexagonal phase of $ZnTiO_3$ appear upto 400 °C and more increment in substrate temperature leads to transformation of hexagonal phase to cubic phase. We have observed the blue shift in absorption edge at lower temperature. When the substrate temperature increases from 300 to 400 °C the band gap decreases due to strong hexagonal phase, but more increment in substrate temperature increases the band gap causes by change of phase from hexagonal to cubic. The dielectric constant of $ZnTiO_3$ thin film increases as the substrate temperature increases due to the enhancement in crystallinity and improved morphology.

1. Introduction

ZnO is a wide band-gap semiconductor with outstanding optical and electrical properties [1,2] and TiO_2 is one of the most important semiconductors with high photocatalytic activity, being non-toxic, stable in aqueous solution, and relatively inexpensive [3,4]. ZnO and TiO_2 have attracted much interest on either single material [5,6] or ZnO–TiO_2 composites [7,8]. Dulin and Rase [9] reported that three compounds exist in the ZnO–TiO_2 system, including $ZnTiO_3$ (hexagonal and cubic), Zn_2TiO_4 (cubic), and $Zn_2Ti_3O_8$ (cubic). Among these compounds the stable formation of $ZnTiO_3$ phase was known to be complicated, mainly due to the decomposition of $ZnTiO_3$ into Zn_2TiO_4 and rutile TiO_2 at about 945 °C.

With the recent progress of microwave applications, including mobile telephones and satellite communication system, the development of high-quality microwave dielectrics has been intensified so that they can be used as dielectric resonators, capacitors, and filters. $ZnTiO_3$ is an attractive material for applications in microwave dielectrics [10–13]. $ZnTiO_3$ has also been regarded as a good candidate for low-temperature cofired ceramics (LTCCs) due to its relatively low sintering temperature and

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