Available online at www.sciencedirect.com

ScienceDirect

materialstoday: PROCEEDINGS

Materials Today: Proceedings 2 (2015) 5251 – 5255

International Conference on Solid State Physics 2013 (ICSSP'13)

Room temperature ferromagnetism and nickel addition effects in titanium dioxide

M. Hassan[a]*, S. Riaz[b], S. Naseem[b]

[a] *Material growth Laboratory, Department of Physics, University of the Punjab, Lahore*
[b] *Centre of Excellence for Solid State Physics, University of the Punjab, Lahore*

Abstract

Un-doped and Ni doped TiO_2 samples were fabricated using solid state reaction technique. The composition was adjusted according to the molecular weights. The samples were calcined and sintered in a digital furnace. The Nickel content x_{Ni} in host TiO_2 lattice was adjusted as $x_{Ni} = 0.00$ and 0.02. X-ray diffraction (XRD) revealed rutile phase for both TiO_2 samples. The phase segregation took place at $x_{Ni} = 0.02$ with the formation of NiO, and Ni_2O_3. Crystallite size, calculated from Scherer's formula, decreased with the increase of Ni content. Scanning Electron Microscopy (SEM) depicted porosity, inhomogeneous grain distribution. The Vibrating Sample Magnetometer (VSM) showed the room temperature (RT) ferromagnetic in both samples.

Selection and Peer-review under responsibility of the Committee Members of International Conference on Solid State Physics 2013 (ICSSP'13)

Keywords: DMS; XRD; Rutile; TiO_2; Solid state reaction; Ferromagnetism

* Corresponding author. Tel.: +92-429-9231243.
E-mail address: Mahmud.physics@pu.edu.pk

2214-7853
Selection and Peer-review under responsibility of the Committee Members of International Conference on Solid State Physics 2013 (ICSSP'13)
doi:10.1016/j.matpr.2015.11.031

1. Introduction

A variety of materials are being investigated for spintronics applications, where efficient control of the spin of electrons in addition to their charge is required [1]. The diluted magnetic semiconductors (DMS) in which non-magnetic semiconductors like Si, Ge, GaAs, etc., are diluted with magnetic impurity atoms, but T_C is below room temperature RT. The oxide based semiconductors have been devoted considerable attention due to the prediction of ferromagnetism above RT for Mn doped ZnO [2]. The RT ferromagnetism has been reported for many oxide based semiconductors such as TiO_2, ZnO, SnO and [3, 4, 5]. However, results from different reports about the real origin of RT ferromagnetism, particularly for thin films, are quite confusing. Therefore, investigations of bulk samples are important.

Titanium dioxide (TiO_2) has diverse applications [6, 7] and different growth techniques have been employed to grow TiO_2 [8, 9]. TiO_2 appears in the rutile and anatase phase, and both have the tetragonal structure, while another brookite phase has orthorhombic structure. However, only anatase and rutile phases are more stable and have been extensively studied [10]. According to the best of our knowledge, the Ni addition in TiO_2 lattice by solid state reaction method does not exist. In this work, we have prepared bulk samples of un-doped and Ni doped TiO_2, to realize room temperature ferromagnetism and to find a correlation between structural and ferromagnetic behaviors.

2. Experimental

The analytical grade TiO_2 and NiO powders were used to fabricate un-doped and Ni doped TiO_2 using solid state reaction method. The composition was adjusted according to the molecular weights the powders. The precursor powders weighed by a digital balance, were mixed thoroughly by grinding in a mortar and pestle for 60 minutes. The samples were calcined in air in a digital Nabertherm furnace at 600°C for 6 hours. The powders samples were again grinded for 15 minutes. The pellets of 1 cm diameter were prepared under a pressure of 3 ton. The pellets were sintered in air at 1100°C for 8 hours. The sequence of steps is shown in the form of a flowchart in figure 1. The samples were characterized by x-ray diffraction (XRD), scanning electron microscopy (SEM) and vibrating sample magnetometer (VSM).

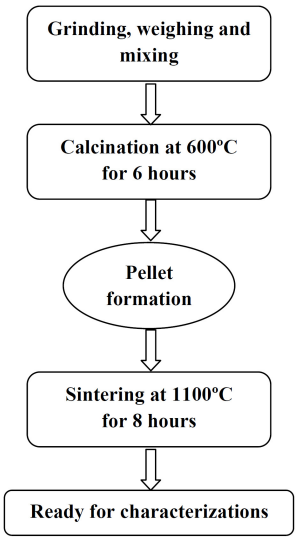

Fig. 1. Flow chart of the steps carried out during synthesis of TiO_2 using solid state reaction method.