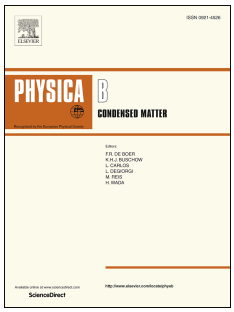
Accepted Manuscript



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PII: S0921-4526(18)30010-3

DOI: 10.1016/j.physb.2018.01.009

Reference: PHYSB 310656

To appear in: *Physica B: Physics of Condensed Matter*

Received Date: 21 September 2017

Revised Date: 8 December 2017

Accepted Date: 5 January 2018

Please cite this article as: T. Ali, A. Ahmed, M. Naseem siddique, P. Tripathi, Enhanced dielectric properties of Fe-substituted TiO_2 nanoparticles, *Physica B: Physics of Condensed Matter* (2018), doi: 10.1016/j.physb.2018.01.009.

Enhanced Dielectric Properties of Fe-Substituted TiO_2 Nanoparticles

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Abstract

We report the structural and dielectric properties $Ti_{1-x}Fe_xO_2$ ($0.00<x<0.10$) nanoparticles (NPs) synthesized by sol-gel method. The synthesized material has been characterized by soft X-ray absorption spectroscopy (SXAS) in order to investigate the fine structure and electronic valence state. SXAS analysis reveals a mixed valence state of Fe with dominating Fe^{3+}. The dielectric properties were studied by the use of LCR impedance spectroscopy. The dielectric constants, dielectric loss and A.C. conductivity have been determined as a function of frequency and composition of iron. At higher frequencies, the materials exhibited high AC Conductivity and low dielectric constant. The above theory could be explained by 'Maxwell Wagner Model' and may provide a new insight to fabricate nanomaterials having possible electrical application.

Introduction

In recent years metal oxide nanomaterials have attracted great attention due to their remarkable unusual chemical and physical properties with respect to the bulk materials. Among all reported metal oxide nanomaterials TiO_2 captured enormous attention owing to its impact in photocatalytic, optical and electrical application [1-5]. Moreover, TiO_2 has numerous advantages like high dielectric constant, large surface area, high chemical stability and low cost. However, in spite of high dielectric constant; the ionic and atomic polarization of TiO_2 cannot offer optimal dielectric or polarization properties; therefore surface modification is recommended to study how the metal doped surface structures change the polarization and conductivity. On the other hand, pure TiO_2 suffers a problem of large band gap and low quantum yield. In order to solve these problems several efforts have been done by adding transition metal as a dopants into an anatase TiO_2 [6, 9]. Our previous work has already showed that Fe^{3+} ion were successfully incorporated into the lattice of TiO_2 [1], because Fe^{3+} ion share identical ionic radius to Ti^{4+} and half-filled *d*-electronic configuration. The TiO_2 NPs exist in the two common crystal structures such as anatase and rutile. In these phases the dielectric properties depend on the nature of polarization, interfaces, grain scale, defects, and doping element. Anatase are metastable at all temperatures