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### Enhanced Dielectric Properties of Fe-Substituted TiO<sub>2</sub> 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<sup>3+</sup>. 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

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