**Effect of Iron Doping on Structural and Magnetic Properties of Titania Nanostructures**

**Pegah M. Hosseinpour**
Advisor: **Dr. Laura H. Lewis, Chem. E. Dept., NEU**
Co-Advisor: **Dr. Latika Menon, Physics Dept., NEU**

**ABSTRACT:**

Titania nanotube arrays doped with transition metals are semiconductors with potential simultaneous magnetic, semiconducting and catalytic properties. Clarification of the interactions between the ferromagnetic dopant concentration, crystal structure and band structure is necessary to investigate this potential multifunctionality. Iron is selected as the dopant of choice due to its strong ferromagnetic properties and a possible enhancement of photocatalytic character and functionality of titania. The goal of this study is to develop iron-doped (< 1 at%) titania nanotubes and obtain a fundamental understanding of their morphological, structural and magnetic properties as functions of composition, processing and post-processing conditions. This goal will be accomplished by fabrication of standard pure titania nanotube and iron-doped titania nanotube arrays, both subjected to systematic thermal treatment and associated examination of the morphological, structural and magnetic character. Besides, studies of pure and iron-doped bulk and nanoparticulate forms of titania will highlight the effects of nanostructuring on the materials' properties. In this manner increased fundamental understanding of the relationships between structure and function of titania nanotubes will be obtained.

Electrochemical synthesis of pure and Fe-doped titania nanotube arrays is followed by annealing under different purging gases (vacuum, $N_2$, $O_2$ Ar) and temperatures. Information concerning the structural stability, crystallization character and

transport properties are obtained by morphological (scanning and transmission electron microscopy (SEM, TEM)), structural (x-ray diffractometry (XRD)) and magnetic (superconducting quantum interference device (SQUID)) probes.

Initial studies confirm attainment of uniform pure titania and Fe-doped titania nanotube arrays with an average pore diameter of ~100 nm and 10-40 μm long depending on duration of anodization (2-6 hrs). Based on preliminary results, shorter tube length and being on the titanium substrate (*vs* free standing nanotube arrays) lead to higher thermal stability. Besides, magnetic measurements established that oxygen deficient environment enhances ferromagnetism while it deteriorates the nanotubular structure. Analysis of magnetic data reveals that the magnetic susceptibility may be decomposed into Curie-Weiss and Pauli paramagnetic components indicating the presence of two types of magnetic phases. Further studies will focus on deeper understanding of the relationships between the structural, compositional, electronic and optical properties of the Fe-doped titania nanotube arrays.