3.7.1 Number of Collaborative activities per year for research/ faculty exchange/ student exchange/ internship/ on –the-job training/ project work

Collaborating Agency:

Dr. A. T. Ravichandran Associate Professor Department of Physics

National College(Autonomous) Tiruchirapalli

Dr. K. RAVICHANDRAN
Associate Professor
Materials Science Research Laboratory
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Date: 21.08.2016

LINKAGE

For the year 2016-2017

Between

1. Dr. K. Ravichandran, Associate Professor PG & Research Department of Physics A.V.V.M Sri Pushpam College (Autonomous), Poondi – 613 503.	&	2. Dr. A. T. Ravichandran Associate Professor PG & Research Department of Physics National College (Autonomous) Tiruchirapalli – 620 001.

Considering the significance of the noble cause for the student community, we have come forward to collaborate with each other to exchange research knowledge, expertise, laboratory and library facilities to the process of scientific research and education in the field of materials science. The parties (mentioned above as 1. & 2.) have had preliminary discussion in this matter and have ascertained areas of broad consensus. The parties now therefore agreed to enter in writing these avenues of consensus, under a flexible linkage, and this project aims to fill the gap between knowledge demand and subject expertise related to the mentioned field.

Joint Responsibilities

- Sharing oflaboratory facilities, library resources, database etc.,
- Joint Publication of research articles, books, magazines, bulletins etc.,
- Jointly organizing conferences, seminars, symposia and workshops.
- Submitting joint proposals for research funding from agencies like UGC, CSIR, DST and TNSCST.

J. Ravi	[signature]
Dr. K. Ravichandran	Dr. A. T. Ravichandran
Dr. K. RAVICHANDRAN *Assistant Professor of Physics* *AVVM Sri Pushpam College (Autonomous)* *Poondi-613 503, Thanjavur (Dt).*	Dr. A.T. RAVICHANDRAN, Ph.D., Associate Professor PG & Research Department of Physics National College (Autonomous) Tiruchirappalli 620 001.

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CrossMark

Effect of Co doped material on the structural, optical and magnetic properties of Cu_2O thin films by SILAR technique

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Abstract Undoped and Co doped Cu_2O ($Cu_{2-x}Co_xO$; x = 0, 1, 2, 5 and 10) thin films were deposited onto glass substrates using successive ionic layer adsorption and reaction technique. The variation in the concentration of Co shows significant impact on the film properties, where as doped with 10 wt% of Co exhibited major property improvements when compared with other films. The prepared films were characterized for their structural, morphological, optical and magnetic properties. X-ray diffraction analysis of the films revealed the crystalline growth of $Cu_{2-x}Co_xO$ films. The substitution of Cu^{2+} by Co^{2+} ions has led to a single phase cubic structure highly oriented along (111) plane. Optical studies (photoluminescence and UV–vis–NIR) of the films exhibit the quality of the films with the increase of dopant. The stretching vibrations of Cu–O and O–Cu–O have been confirmed by Fourier transform infrared spectroscopy. The morphological study done by a field emission scanning electron microscope has shown as increase of particle size with increase in the dopant concentration. High resolution of transition electron microscope and particle analyzer verified the nano-size and shape of the films. The presence of copper in the structure of thin film was confirmed by energy dispersive X-ray spectrometer. Magnetic measurements showed that undoped and minimum doped (1 and 2 wt%) films exhibit diamagnetic behavior and at the maximum (10 wt%) Co doping level, the films exhibit ferromagnetic properties. Current verses voltage studies showed the ohmic nature of the films.

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1 Introduction

Metal oxide materials have received great attention for their physical and chemical properties. Copper oxide thin film is a p-type semiconducting metal oxide material and it exhibits direct band-gap (~1.3 to 2.1 eV) [1]. Copper oxide exists, in two forms of cupric oxide (or) copper monoxide (CuO) and Cuprous oxide (Cu_2O) [2]. Cu_2O materials are especially useful in the field of Photovoltaic devices and light emitting diodes [3]. Because of the copper ore (Cu_2O), the active layer is widely available as naturally occurring minerals. Cu_2O is the parent compound of many p-type transparent conducting oxides (TCOs) such as Cu_XO_2 delafossites (X = Co, Fe, Zn, Al, KCL, Cr, etc.) [4]. The magnetic property of the Cu_2O material can be enhanced with doping of Co and Fe without affecting the semiconductivity. Generally, metal doping materials are making radical changes in electrical, optical, morphologies and magnetic properties of copper oxide thin films [5]. Over the past decade, 1D and 2D nanostructures have been discussed for their unique optical, electrical and mechanical properties [6]. In recent years, tremendous effort has been dedicated to converting 1D and 2D nanostructures

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Uniform and Well-Dispersed ZnO:Fe Nanoparticles with High Photoluminescence and Antibacterial Properties Prepared by Soft Chemical Route

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Abstract Fe doped ZnO nanoparticles were synthesized using simple soft chemical route by varying the Fe doping level (5, 10 and 15 at.%). The obtained samples were characterized for their structural, optical, surface morphological and antibacterial properties. XRD profiles confirmed that the synthesized material is nanocrystalline ZnO with hexagonal wurtzite structure. The XRD studies reveal that the crystalline size of Fe doped ZnO nanoparticles are range from 56 to 24 nm. The size of the particle decreases gradually as Fe content is increased. The surface morphological studies confirmed the nanosize of the obtained particles. The FESEM and TEM images show that the particle size reduces after doping. The EDAX profiles confirmed the presence of expected elements in the final product. The Photoluminescence studies showed the occurrence of energy transition from ZnO to dopant site. The antibacterial activity of Fe doped ZnO nanoparticles against *Staphylococcus aureus* (Gram-positive) were found to be significantly higher than that against the *Bacillus subtilis* (Gram-positive) micro-organism.

Keywords Nanoparticles · ZnO · Soft chemical route · TEM · Photoluminescence and antibacterial activity

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1 Introduction

The transparent host matrix has recently generated increasing interest as advanced technological materials because of their unique optical, mechanical, electronic and structural [1–4] properties of composite metal nanoparticles. Such nanomaterials can be used as promising materials for novel functional applications in optoelectronics, medicine and magnetic [5–7] etc. ZnO with a wide energy band-gap (3.37 eV) in bulk is one of the II–VI semiconductor materials, making it attractive for the nano-electronic and photonic applications [8]. Recent studies have demonstrated that specially formulated metal oxide nanoparticles have good antibacterial activity [9, 10] antimicrobial formulations compressing nanoparticles could be effective bacterial materials [11, 12]. Interestingly, ZnO nanoparticles (NPs) are reported several studies on non-toxic to human cells [13], this aspect necessitated their usage as antibacterial agents noxious to micro-organisms and hold good biocompatibility to human cells [14]. Investigations of antibacterial nanomaterials, mostly ZnO NPs, would enhance the research area of nanomaterials, and the mechanism behind nanostructured materials.

The properties of nanostructured ZnO can be tailored by doping selective elements like Al, Mg, Mn, F, Zr, Ag, and Ni [15–21]. Iron doped ZnO nanoparticles synthesized by Jagannatha Reddy et al., suggested that the optical properties of the material were modified due to the dopant iron Fe^{3+}, which created new additional levels nearer to the absorption edges. Many reports have been proposed to synthesize nanostructured ZnO is using well-established methods like hydrothermal, wet chemical, soft chemical route, polyol method, microwave irradiation method [21–26], etc. Of these methods, soft chemical synthesis route offers several advantages. It's very fascinated, simple, facile and