INNOVATIVE

IMAGINATIVE

RESEARCH MANUAL OF

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FORWARD

This is the RESEARCH WORK CARIIED BY Me and my students. In it you will find short summaries of the project work carried out during the various academic years. The project topics that the students have chosen to work on are mainly Nanotechnology, Optics and Photonics, Spectroscopy and Medical Physics, Thermodynamics Social issues like water energy and nano technology. So I highlight me and my individual students achievements done to motivate research in our Institute as well as benefit to the society.

Dr Vandana B Patil
Asst Professor
Physics DYPIEMR

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****RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2012-13****

Photoluminescence and photoelectrochemical properties of nanocrystalline ZnO thin films synthesized by spray pyrolysis technique.

A simple and inexpensive spray pyrolysis technique (SPT) was employed for the synthesis of nanocrystalline zinc oxide (ZnO) thin films onto soda lime glass and tin doped indium oxide (ITO) coated glass substrates at different substrate temperatures ranging from 300 ◦C to 500 ◦C. The synthesized films were polycrystalline, with a (0 0 2) preferential growth along c-axis. SEM micrographs revealed the uniform distribution of spherical grains of about 80–90 nm size. The films were transparent with average visible transmittance of 85% having band gap energy 3.25 eV. All the samples exhibit room temperature photoluminescence (PL). A strong ultraviolet (UV) emission at 398 nm with weak green emission centered at 520 nm confirmed the less defect density in the samples. Moreover, the samples are photoelectrochemically active and exhibit the highest photocurrent of 60 A, a photovoltage of 280 mV and 0.23 fill factor (FF) for the Zn450 films in 0.5 M Na2SO4 electrolyte, when illuminated under UV light.

This work is published in the scoups indexed journal,

Applied Surface Science 257 (2011) 10789–10794

Superhydrophobic zinc oxide (ZnO) coatings were synthesized by a simple and cost-effective spray pyrolysis technique (SPT) via seed assisted growth onto the glass substrates at 723 K from an aqueous zinc acetate precursor solution. Initially, the ZnO seeds were synthesized from an aqueous 0.4 M zinc acetate solution onto the glass substrates at 723 K. For the seed assisted growth of ZnO, the solution concentrations (0.1 M to 0.4 M) were used and its effect on structural, morphological, optical and wettability properties of ZnO thin films was investigated. The synthesized films were found to be polycrystalline, with preferential growth along c-axis. Scanning electron microscopy (SEM) images show the uniform distribution of spherical grains of about 60–80 nm grain size. After seed assisted growth, film surface becomes very rough. The films were specular and transmittance of thin films decreases as the concentration of the precursor solution increases.

The optical absorption spectrum shows a sharp absorption band-edge at 381 nm, corresponding to optical gap energy (Eg) of 3.25 eV. All samples are superhydrophobic in nature. The Zn4 sample shows the superhydrophobicity with highest value of the contact angle (CA) i.e. 165°. Such a superhydrophobic coatings can be useful in the anti-snow, anti-fog and self cleaning surfaces.

This work is published in the scoups indexed journal,

Surface & Coatings Technology 206 (2011) 1336–1341

****RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2013-14****

Oxalic acid induced hydrothermal synthesis of single crystalline tungsten oxide nanorods.

One-dimensional single-crystalline tungsten oxide nanorods have been synthesized by the hydrothermal technique. The controlled morphology of tungsten oxide was obtained by using sodium tungstate and oxalic acid as an organic inducer. The reaction was carried out at 170 °C for 24, 48 and 72 h. The obtained tungsten oxides were investigated by using XRD, SEM and HRTEM techniques. In order to understand the role of organic inducer on the shape, size and phase formation of WO_3 was prepared with and without organic inducer. On heating of sodium tungstate without organic inducer for 72 h at 170 °C in the hydrothermal unit we obtain nanoparticles of monoclinic WO_3, however, on addition of oxalic acid a single phase hexagonal WO_3 with distinct nanorods was formed. On addition of oxalic acid a systematic emergence of nanorod-like morphology was obtained with incrementing reaction times from 24 h to 48 h. The 72 h reaction generates self-assembled 20–30 nm diameter and 4–5 μm long h-WO_3 bundles of nanorods. The XRD studies show hexagonal structure of tungsten oxide, while SAED reveals its single crystalline nature. The photoluminescence (PL) emission spectrum shows a characteristic blue emission peak at 3 eV (410 nm). Raman spectra provide the evidence of hexagonal structure with stretching vibrations (830 cm^{-1}) for 72 h of heating at 170 °C.

This work is published in the scoups indexed journal,

Journal of Alloys and Compounds
Volume 590, 25 March 2014, Pages 283-288

RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2014-15

Hydrothermally synthesized tungsten trioxide nanorods as NO_2 gas sensors

One-dimensional single-crystalline h-WO_3 nanorods have been synthesized by using a facile hydrothermal technique. Crystal structure, morphology evolution and thermal stability of the products are characterized by using X-ray Diffraction pattern, Scanning Electron Micrographs, Photoluminescence reflectance spectrum; UV–vis diffused reflectance spectral analysis and Raman techniques. The evolution and distribution of WO_3 nanorods strongly depend on hydrothermal reaction temperature and time of reaction. Hydrothermal reaction temperature of 170 1C for 48 h ensures the formation of well-defined agglomerated WO_3 nanorods. Gas response measurements reveal that WO_3 sensor operating at 250 1C exhibits highest sensitivity towards NO_2 with low cross sensitivity towards LPG, acetone and ammonia gas, which makes this material a competitive candidate for NO_2 sensing applications. A possible adsorption and reaction model is proposed to illustrate formation of one dimensional nanostructure and gas sensing mechanism.

Ceramics International 41 (2015) 3845–3852

****RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2015-16****

Effect of annealing on the properties of CTAB assisted lead tungstate

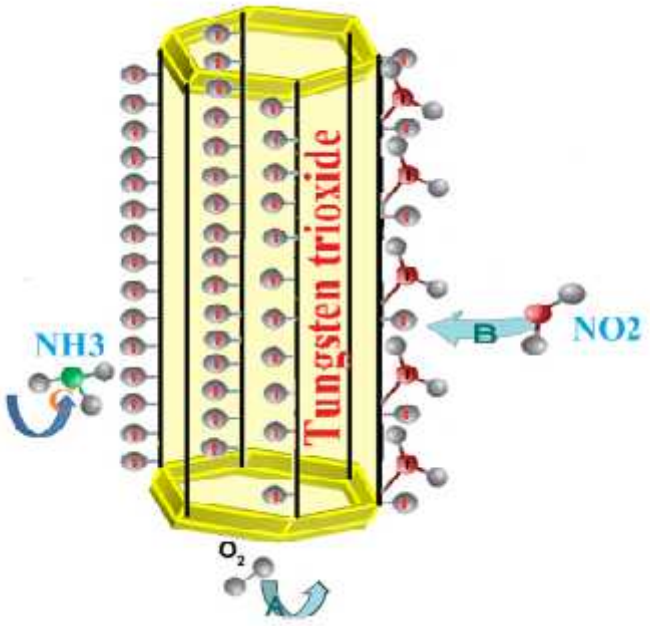
The popcorn shaped lead tungstate were synthesized at room temperature using precipitation method with cetyltrimethyl ammonium bromide (CTAB). The grown samples were further annealed at 550 °C and used for investigations of their structural, morphological and optical studies by using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). XRD and SEM results revealed that the lattice distortions of PbWO4 reduced significantly when annealing temperature increased to 550 °C and these results were supported by Photoluminescence (PL) and Raman spectroscopic studies.

Materials Letters 181 (2016) 350–353

****RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2016-17****

Enhanced NO_2 response of hydrothermally grown Ti doped WO_3 nanostructures

Titanium doped WO3 (Ti doped WO3) nanostructures were synthesized by hydrothermal synthesis by the controlled hydrolysis of Na2WO4 using oxalic acid and Titanium tetrachloride. Prepared samples were characterized by X-ray powder diffraction (XRD), scanning electronic microscopy (SEM), and transmission electron microscopy (TEM). As-synthesized pristine WO3 showed nanorods with diameters of about 10–15 nm and length about 1.2 lm and Ti doped WO3 composed of numerous small nanocrystals. Introduction of Ti doping by chemical synthesis process suppressed the growth of one-dimensional nanorods along their axis direction and shows agglomeration of particulate like morphology and no elongated structures. Ti doping not only lowered the optimal operating temperature of WO3 nanostructures sensors from 250 to 200 C but also increased the maximum value of sensor response. Also the Ti-doped WO3 nanostructures exhibited rapid response characteristic to NO2 gas compared to pristine WO3.



TI DOPED WO_3 SENSOR

J Mater Sci: Mater Electron DOI 10.1007/s10854-016-5702-z

****RESEARCH WORK CARRIED OUT IN THE ACADEMIC YEAR 2017-18****

Ti doped WO_3 nanostructures based on glassy carbon electrodes for high-performance supercapacitors

The demand for high-performance energy storage devices such as supercapacitors and lithium-ion batteries has been increasing to meet the application requirements of renewable energy systems. Here, high energy and power density Ti doped WO_3 supercapacitor is assembled based on glassy carbon electrode positive electrode and tungsten trioxide (WO_3) nanorod bundles negative electrode. Well oriented monoclinic WO_3 nanoflakes arrays with average diameter of 150 ±50 nm and length of 2.0-3.0 µm has been successfully realized on glassy carbon electrolyte substrate via a simple hydrothermal method. The morphology, crystallinity, atomic composition and chemical state of WO_3 nanostrutcures are investigated by scanning electron microscopy (SEM), high resolution transmission electron microscopy (HRTEM), energy dispersive spectrometry (EDS), X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS). Moreover, the supercapacitive properties of pristine and 1 and 3 at % Ti doped WO_3 nanoflakes are also examined. The Ti doped WO_3 supercapacitor operates with a voltage of 0.8 V and achieved a high energy density of 5.60 Wh^{-1} kg at a power density of 150 W kg^{-1}. Furthermore, the device shows an excellent cycling performance with capacitance retention of 83% even after 1100^{th} cycles.

Revision of paper is submitted to Journal as

Journal of Solid State Electrochemistry

We work on Project THERMEN

Electricity generating device from waste heat of gas stoves and chul has using thermoelectric effect

Problem Statement

It is observed that most of the kitchens in India, be it rural or urban regions, uses gas/fuel/firewood stove as a primary equipment for cooking and heating. But the percentage of heat energy actually used for heating is very less, and a large part of it escapes into kitchen atmosphere, which is a big loss of energy. Also, many rural areas lack electricity supply, and experience large cut-offs. They have no source to charge their phones and devices and also experience problem at night time for lighting. stats: 1) About 40% of the total heat energy is wasted while combustion, i.e. for every 3 gas cylinders over 1 cylinder is wasted for nothing. 2) About 70% of the total population uses gas/firewood stoves and thus a large part of the energy is wasted.

Solution

We have found a technique to harness energy which is getting wasted in various heating processes. Our device “Therman”, can actually trap heat emitted while combustion and can produce some additional usable energy in the form of electricity.

‘Therman’ works on the principle of Thermoelectric effect or also called the seebeck effect.

This device can be installed on any standard available stoves and chulahas. Thus everyone can use it to produce their own electricity. Our device can prove to be very useful in the off-grid rural and remote areas, where electricity is limited or unavailable. ‘Therman’ uses thermoelectric modules (TEG) to absorb waste heat from the source, and converts it directly into electricity. This electricity is then stored and a regulated output is obtained for various uses like : 1. Charging mobiles and gadgets. 2. Lighting purposes. 3. Driving compatible kitchen chimneys. 4. Sound systems. 5. Camping and disaster situations.

PROJECT STUDENT: MR.AYUSH AGARWAL , FE MECH

We won the 2nd Silver Prizewith 2.5 lakh cash prize All Over India under KPIT SPARKLE 2018 project Compition with Special appreciation received from Pad. Dr Raghunath Mashelkar Scientist CSIR New Delhi and Pad Dr Radhakrishna EXChairman ISRO.

****FUTURE PLAN AND SCOPE OF RESEARCH AND INSTRUMENT**

FACILITY IN OUR LABORATORY FOR SYNTHESIS OF NANOMATERIALS*

Synthesis and Characterization of WO3/Graphene/polymer Nanocomposites by One-Step

In-Situ Hydrothermal Reaction

For the Applications:

- **Gas sensors**
- **Batteries**
- **Supercapacitors**
- **Hybrid devices**
- **Solar cells**
- **Smart farming**
- **Transport solutions**

****INSTRUMENT FACILITY IN OUR LAB****

1. HYDROTHERMAL TECHNIQUE FOR SYNTHESIS OF NANOMATERIALS
2. 4 PROBE TECHNIQUE RESISTIVITY MEASUREMENT
3. SCREEN PRINTING TECHNIQUE FOR THICK FILM PREPARTION

Dr. Vandana B Patil

Educational Qualification: MSc, BED PhD

Experience: 10 Yrs.

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Areas of Interest: Solid State Physics

Memberships: ISTE, IAAM, MAVIPA

Courses Handled: Engineering Physics

Interaction with Outside world:

1. DR VANDANA PATIL WORKING AS A MEMBER OF MAHARASHTRA VIDYAN PARISHAD
2. NCL, C-MET, SOLAPUR UNIVERSITY SOLAPUR

Awards/Accolades/Certifications/Achievements:

1. **State Level Avishkar Winner under Teacher Category in the year by SPPU 2015**
2. **Eklawaya Scholarship 2006-2007**
3. **Best Poster Presentation Award in the Year 2007in National Conference.**
4. **Third rank in Maharashtra Vidhyan Quiz 2016**
5. **Silver prize winner in KPIT SPARKLE 2018.**
6. **SELECTED IN FINAL ROUND IN KPIT BETTER WORLD CONTEXT**