CHAPTER 43

PHYSICS AND ASTROPHYSICS

Doctoral Theses

01. BHULI BAI

Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL) in Some Phosphate and Fluoride Materials for Their Applications in Radiation Dosimetry.

Supervisors: Prof. S.A. Hashmi and Prof. P.D. Sahare

Th 29197

Abstract

In the present study, phosphate (NaLi2PO4, Li3PO4 doped with rare earth and transition metals) and fluoride (K2LiAlF6:Eu) materials were synthesized for dosimetry of γ-ray, x-ray, and UV radiation by thermoluminescence and optically stimulated luminescence techniques. The formation of the materials confirmed by XRD technique. It was very interesting to observed phase change in K2LiAlF6 when annealed in reducing atmospheres.The morphological and compositional studies were done using XPS, SEM and EDS techniques. The materials were annealed in reducing and oxidizing atmospheres at various temperatures. ESR and PL studies were conducted for studying redox reactions due to annealing and its effect on TL/OSL characteristics. It was observed that at ~10 Gy, NaLi2PO4:Cu(II) is around 3.3, 3.0 and almost equally sensitive than TLD-900 phosphor on annealing in air, 10% H2 in Ar and CO/CO2 at 400, 400 and 800 °C, respectively. However, NaLi2PO4:Cu(I) becomes 1.8 times sensitive after annealing in CO/CO2 at 800 °C and NaLi2PO4: Sm/Tb is 1.28 times more sensitivity then TLD-900. K2LiAlF6: Eu annealed in CO/CO2 atmosphere, it is almost ~ 13.93, 22.0 and 1.4 times more intense then compared to the standard TLD-100, TLD-900 and TLD- 700H phosphors at 10Gy. Similarly, in H2/Ar atmosphere, it is almost ~ 24.0, 37.0 and 2.5 times more intense then compared to the TLD-100, TLD-900 and TLD-700H phosphors. It was 8.7, 6.6, 2.9 times more sensitive than STD. Al2O3:C OSLD phosphor, in CO/CO2, H2/Ar, Air atmospheres respectively. Phosphate and fluoride materials showed wide dose response, minimal fading and good reproducibility make good contender for dosimetric applications.TL results of Li3PO4: Dy shows that varying the irradiation temperature between 323 and 600 K had not much effect on the TL response. These properties suggest that the phosphor can be used in UV and X-ray dosimetry of ionizing radiation in a high-temperature environment.

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1. Introduction 2. Experimental Techniques 3. Thermoluminescence study of Cudoped $NaLi_2PO_4$ Phosphors 4. Thermoluminescence and Photoluminescence Characteristics of Tb^{3+}, Sm^{3+} Co-doped $NaLi_2PO_4$ Phosphors Synthesized by the Solid-State Diffusion Method 5. Study of Thermoluminescence (TL) and photoluminescence (PL) in new highly-efficient Eu-doped K_2LiAlF_6 Elpasolite phosphor 6. Optically Stimulated Luminescence Studies of K_2LiAlF_6: Eu OSLD

Phosphor 7. Study of High-Temperature Environmental Dosimetry for UV, X-Ray and γ-Ray Radiation Using Li_3PO_4: Dy^{3+} Thermoluminescent Phosphor 8. Summary and Future scope.

02. FALTA
Relativistic Atomic Structure Calculations and Photoionization of Ions in Plasma Environment.
Supervisor: Prof. Narendra Singh
Th 29198

Abstract

This thesis is composed of five chapters. In chapter 1, we have provided introductions relevant to need and significance of atomic data in several fields. We have discussed about the various theoretical methods, models and online atomic database. In Chapter 2, we examine the impact of a dense plasma environment on the transition properties and level structures of hydrogen-like carbon, nitrogen, and oxygen ions. The new data provided in this work are expected to be valuable for future investigations of plasma effects in astrophysical and fusion plasmas. In Chapter 3, we present detailed calculations of the energy levels and radiative data of the Fe III ion using the relativistic configuration interaction approach implemented in the Flexible Atomic Code (FAC). Ratios of emission-line intensity for optical transitions among the fine-structure levels of the $3d^6$ configuration are computed at a temperature of 10^4 K for a range of electron densities. Furthermore, we analyzed the influence of plasma screening on the excitation energies of Fe IV ion using FAC, which incorporates an analytical ion-sphere plasma screening potential. The effects of plasma environment on the photoionization cross-section of Fe III ion were investigated over an electron density range from $10^{19}\,cm^{-3}$ to $10^{21}\,cm^{-3}$. In the chapter 4, we presented relativistic calculations of total photoionization (PI) cross-sections for Cr VIII ion from the ground state $3s^23p^5(^2P^o_{3/2})$ and the first two excited states $3s^23p^5(^2P^o_{1/2})$ and $3s^13p^6(^2S\ e_{1/2})$, using the Breit-Pauli R-matrix method. We identified nd resonance series below the first ionization threshold in the photon energy range of 13.82 to 14.00 Rydbergs. Our results provide valuable insights for the modeling and diagnostics of astrophysical plasmas involving Cr VIII. In Chapter 5, we have discussed about the future research work in atomic structure calculations, including such as ionization, electron-impact excitation, and recombination.

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1. Introduction 2. Structural Properties of H-like Ions in Plasma Environment 3. Study of FE iii and FE IV Ions 4. Photoionization Cross-Section Calculations for Cr VIII Ions 5. Future Work.

03. PANT (Megha)
Electronic and Thermoelectric Properties of Calcium Manganese Oxide Ceramics.
Supervisor: Prof. Ajit Kumar Mahapatro
Th 29200

Abstract

The global energy consumption continues to grow in accommodating the surging demands for accomplishing energy requirements. The limited availability and the

detrimental effect to the environment during CO2 emissions as byproduct during combustion of fossil fuels, motivates in searching for an alternative energy source. Possible utilization of the waste heat lost to the environment in producing usable form of energy by various industrial processes could serve as a new greener energy source to fulfill the energy requirement. Thermoelectricity is a process for direct conversion of heat into electricity and vice-versa by the phenomena known as Seebeck and Peltier effects, respectively. This thesis focuses on the enhancement of thermoelectric generation by elevating the power factor and figure of merit with favourable Seebeck coefficient and electrical conductivity, and minimal thermal conductivity in oxide based thermoelectric materials, considering calcium manganese oxide (CaMnO3) as the active material prepared by following cost-effective techniques and is accomplished by synthesizing highly pure CaMnO3 powders following optimized recipe and their consolidation to perfectly dense pellets by hot-press technique. These synthesized powders and pellets have been extensively characterized for their inherent materials properties with advanced materials, electronic, and spectroscopic characterization techniques. Electronic conduction through CaMnO3 ceramics is pursued by measuring the temperature dependent current-voltage characteristics using liquid nitrogen cryostat. The charge transport mechanism prevalent in the CaMnO3 ceramics is understood with dielectric spectroscopy by analyzing the dielectric properties, impedance spectroscopy, and ac-conductivity. Ceramics of nanostructured CaMnO3 powder by ball-milling the pristine CaMnO3 powder boosts the thermoelectric properties compared to the ceramics of as-synthesized CaMnO3. The effect of doping Bi in pristine CaMnO3 at different concentrations (1-5% at.%) are explored for enhancement in the thermoelectric properties. The current demonstration of enhanced TE properties in the nanostructured and Bi-doped CaMnO3 ceramics could be extended for widespread utilization in thermoelectric generator.

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1. Introduction 2. Perfectly dense hot-pressed ceramics with powder processing of highly pure as-synthesized calcium manganese oxide 3. Electronic conduction in hot-pressed calcium manganese oxide ceramics 4. Giant dielectric constant in hot-pressed calcium manganese oxide ceramics 5. Effect of nanostructuring on the electronic and thermoelectric properties of calcium manganese oxide ceramics 6. Effect of bismuth doping on the electronic and thermoelectric properties of calcium manganese oxide ceramics 8. Conclusion and future scope. Appendixes. List of Publications, Conferences and awards.

04. POOJA DEVI

Study of Graphene-based Nanocomposites under the Influence of Magnetic Field for Supercapacitor Applications.

Supervisor: Dr. Debabrata Mishra

Th 29199

Abstract

The performance and development of energy storage systems, especially supercapacitors, can be significantly improved through the application of a magnetic field. This thesis presents a systematic study of different graphene-based composite nanostructures synthesized using a simple in-situ hydrothermal reduction method followed by post-calcination and studying their capacitive properties. Several methods including Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Analysis (EDAX), X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA), Fourier Transform Infrared Spectroscopy

(FT-IR), Brunauer–Emmett–Teller (BET) surface area analysis, X-ray Photoelectron Spectroscopy (XPS), and Raman Spectroscopy were employed to characterize the nanocomposites. The primary experimental investigation detailed in the thesis focuses on the synthesis of Co3V2O8/RGO composite nanostructure for the positive electrode and RGO for the negative electrode in an asymmetric supercapacitor. This asymmetric supercapacitor shows excellent dramatic increase ~170% (344 Cg-1) and ~67% (185 Cg-1) in the specific capacity have been recorded at a current density of 0.5 A/g and 1.0 A/g, respectively when asymmetric supercapacitor device is subjected to an external magnetic field of strength of 0.5 T. Following this work, other nanocomposites investigated in the thesis are Fe2VO4/RGO and CoFe2O4/RGO nanocomposites prepared using similar method. It has been observed that magnetic field enhances the capacitive behaviour, energy density and power density for both vanadium-based transition metal oxides and oxides without vanadium content, i.e., CoFe2O4/RGO. Another distinctive feature of the study is that the effect of magnetic field is more prominent in vanadium-based transition metal oxides than pure ferrimagnetic metal oxides. It has thus been concluded that the ferro/ferri magnetic component is not solely responsible for the enhancement of the capacitive behaviour, rather vanadium plays an important role in enhancing the capacitance under the influence of magnetic field.

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1. Introduction 2. Experimental and Theoretical Method 3. Efficient Energy Storage Performance of in situ grown $Co_3V_2O_8$-RGO Composite Nanostructure for High Performance Asymmetric $Co_3V_2O_8$-RGO//RGO Supercapacitors and Consequence of Magnetic Field Induced Enhanced Capacity 4. High-performance Fe_2VO_4-RGO//RGO based Supercapacitor Driven by Magnetic Field 5. Magnetic Field Induced Improved Performance of Asymmetric Supercapacitor Device based on RGO and $CoFe_2O_4$/RGO Nanocomposite 6. Conclusion. List of Publications and Conference Presentations.

05. PRATIBHA KUMARI

Magnesium Ion-Conducting Gel Polymer Electrolytes for Application in Magnesium-Ion and Magnesium-Sodium Dual-Ion Batteries.

Supervisor: Prof. S. A. Hashmi

Th 29201

Abstract

The present thesis work focuses on the preparation and characterization of quasi-solid-state magnesium-ion conducting GPEs based on solvate ionic-liquids (SILs), dinitrile (adiponitrile) and ionic liquids (ILs) for their application in magnesium-ion batteries. Chapter-1 comprises of an introduction about the electrochemical energy storage devices, specially focused on batteries. Finally, the scope of the present thesis is presented in this chapter. The preparation and characterization of GPEs have been presented in Chapter-2. The characterization of the diglyme-based GPE using different physical and electrochemical techniques are presented in Chapter-3. This SIL-GPE exhibits good electrochemical performance. Stable magnesium stripping/plating behaviour makes it a promising electrolyte for application in magnesium-ion batteries. Chapter-4 describes the preparation and characterization of GPE-films comprising MgTf2 dissolved in a mixture of ADN:EMITf immobilized in PVdF-HFP. The GPE exhibits good electrochemical properties. The comparative studies of the interfacial-stability and Mg-stripping/plating tests on the two symmetrical cells with Mg and Mg-MWCNTs nanocomposite electrodes show the

improved reversibility of the electrolyte film with Mg-MWCNTs powder as anode material, compared to pure Mg-powder. Studies on the physico-electrochemical characterization of Mg-ion conducting gel polymer electrolyte (GPE) based on a polymer blend of PVdF-HFP and PMMA, has been presented in Chapter-5. The compatibility of the GPE-film as separator/electrolyte has been confirmed by assembling Mg-battery with Mg-anode and MnO2-incorporated cathode. Chapter-6 presents the work on a dual-ion conducting hybrid gel polymer electrolyte (hGPE) comprising both Mg and Na-salts dissolved in diglyme, entrapped in host polymer matrix PVdF-HFP. Prospects of the optimized hGPE-film to employ in Mg-Na hybrid batteries have been demonstrated via different electrochemical measurements on the cell: Mg-MWCNT|hGPE|Na3V2(PO4)3(NVP)-MWCNT. The MNHB shows prominent charge–discharge cycling stability and good rate capability. The overall thesis works and the conclusions drawn have been summarized and the scope of the future plan has been presented in Chapter-7.

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1. Introduction 2. Experimental Techniques 3. A Flexible Gel Polymer Electrolyte based on Diglyme as Solvent for Magnesium-Ion Batteries 4. A Flexible Gel Polymer Electrolyte based on High Flash Point Solvent Adiponitrile for Magnesium-Ion Batteries 5. An Electrochemically Stable and Flexible Gel Polymer Electrolyte based on PVdF-HFP/PMMA Blend for Application in Magnesium-Ion Batteries 6. A Flexible Dual-Ion Gel Polymer Electrolyte for Mg-Na Hybrid Batteries 7. Summary and Conclusions.

06. ROHIT

Realization of Barium Strontium Titanate (BST) Thin Films and Composites for Microwave Resonator and EMI Shielding Applications.

Supervisor: Prof. Arijit Chowdhuri

Th 29202

Abstract

Over the last decade advances in radar, communication, satellite and defence technologies have generated demand for miniaturized, lightweight and energy-efficient electronic systems. These developments have enabled compact sensing platforms and high-speed wireless communication, however; they have created challenges related to electromagnetic interference (EMI). The rapid expansion of 5G, Wi-Fi, Internet of Things (IoT) and advanced defence electronics has significantly enhanced electromagnetic radiation density, contributing to electromagnetic pollution, reduced device reliability besides signal degradation. Hence this work explores two complementary strategies a) electrically tunable functional materials for coplanar waveguide (CPW) microwave resonators and b) absorption-dominated EMI shielding materials specifically for X-band frequencies (8.2 – 12.4 GHz). Perovskite oxides (ABO3), particularly Barium Strontium Titanate (Ba1-xSrxTiO3, BST), exhibit high dielectric tunability, composition-controlled ferroelectric/paraelectric properties, cost-effectiveness besides compatibility with thin-film fabrication. By tuning the Ba/Sr ratio, dielectric response can be optimized for frequency-selective applications. Two compositions, Ba0.5Sr0.5TiO3 and Ba0.8Sr0.2TiO3, are hence examined in the study for tunable microwave resonators and X-band EMI shielding, respectively. Comparative assessment of planar microwave transmission structures identifies coplanar waveguides as exhibiting simple geometry, reduced radiation loss and ease of DC bias integration. BST thin films are then characterized from kilohertz to terahertz frequencies while, Ba0.5Sr0.5TiO3 in noted to exhibit strong electric-field tunability (δf = 490 MHz for Ba0.5Sr0.5TiO3/SiO2/Si) with low dielectric loss,

whereas Ba0.8Sr0.2TiO3 exhibits higher losses and lower tunability, making it less effective for resonator applications. Consequently, Ba0.8Sr0.2TiO3 based composites are developed for X-band EMI shielding. Micro- and nanoscale BST particulates synthesized via solid-state and sol-gel routes are embedded in polymer matrices with carbon fillers such as multi-walled carbon nanotubes, carbon fibers and graphite. Finally, PANI/BST-np/MWCNT composite is noted to exhibit high shielding effectiveness [SE(T) = -80.29 dB] through combined dielectric & conductive losses, improved impedance matching besides multiple scattering.

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1. Introduction, Literature Survey and Thesis Objectives 2. Growth Techniques, Characterization Tools, Simulation Software and Optimization of $Ba_{0.5}Sr_{0.5}TiO_3$ and $Ba_{0.8}Sr_{0.2}TiO_3$ Thin Films 3. Electrical Properties of $Ba_{0.5}Sr_{0.5}TiO_3$ and $Ba_{0.8}Sr_{0.2}TiO_3$ thin film and fabrication of CPW resonator 4. CPW Tunable Microwave Resonator and its Theoretical Validation 5. Effect of particle size of $Ba_{0.8}Sr_{0.2}TiO_3$ in EMI Shielding properties 6. Advanced Hybrid EMI Shielding Composites using PANI-$Ba_{0.8}Sr_{0.2}TiO_3$ Nanoparticles and MWCNT 7. Summary, Conclusion and Future Scope of Work.

07. SHARMA (Babita)
Fabrication of Potassium Sodium Niobate (KNN) Thin Films and Flexible Composites for Energy Harvesting Applications.
Supervisor: Prof. Monika Tomar
Th 29204

Abstract

Ever burgeoning demand for environmentally sustainable and flexible electronic devices has accelerated the search for high performance lead-free ferroelectric materials. Conventional lead-based piezoelectric materials such as PZT, although widely used due to their superior electromechanical properties, pose serious environmental and health concerns due to toxicity of lead. In this context, Potassium Sodium Niobate ((KNN) has emerged as a promising lead-free alternative owing to its high Curie temperature, excellent ferroelectric, piezoelectric and pyroelectric properties. The present thesis focuses on the growth and characterization of highly crystalline KNN thin films deposited using Radio Frequency (RF) magnetron sputtering technique and integration of KNN powder as a functional filler in a Polyvinylidene Fluoride (PVDF) matrix for flexible electronic applications. Influence of deposition parameters such as working pressure and substrate temperature on structural, morphological, dielectric, ferroelectric, piezoelectric and pyroelectric properties of KNN thin films has been systematically investigated. The films deposited at 10 mTorr deposition pressure and 750 °C substrate temperature exhibited maximum piezoelectric and pyroelectric response with output power density of 15.65 mW/cm3 and 12 μW/cm2, respectively. Further, KNN-PVDF composites were developed with the variation of KNN concentration. Performance of PEH and PyEH was studied and 30 KNN-PVDF was found to be optimized composite with output power density of 39.81 mW/cm3 and 0.8 μW/cm2, respectively. Further, Nickel Ferrite (NFO) was incorporated into the KNN-PVDF composite system to simultaneously utilize its magnetostrictive properties along with piezoelectric properties of KNN-PVDF. It enabled dual energy harvesting and power density was observed to be 254.77 mW/cm3. Overall, this work advances the development of environmentally friendly, lead-free multifunctional materials and establishes KNN based thin films and composites as promising candidates for next-generation flexible electronics, piezoelectric, pyroelectric energy harvesters and smart sensing platforms.

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1. Introduction 2. Growth, characterization and optimization of KNN thin films using RF magnetron sputtering 3. Realization of pyroelectric and piezoelectric energy harvesters using KNN thin films 4. Growth, characterization and optimization of KNN-PVDF flexible composite sheets 5. KNN-PVDF Composite Sheets for Efficient Mechanical and Thermal Energy Conversion 6. Dual - Mode Energy Harvester based on NFO and KNN-PVDF Composites. Scope and Suggestions.

08. SHARMA (Lucky)
Mechanoluminescence Studies in Some Phosphor Materials for Their Application as Stress Sensors And UV-Dosimeters.
Supervisors: Prof. S. A. Hashmi and Prof. P. D. Sahare
Th 29367

Abstract

In the present study, more emphasis was given on the development of materials that exhibit luminescence on applying mechanical energy, which is called mechanoluminescence (ML). Eu-doped and Dy-codoped SrAl2O4 phosphor materials in microcrystalline form were prepared by a combustion method, and ZnS:Mn phosphor materials were synthesized using the solid-state reaction method. The formation of the materials in a single phase was confirmed by XRD analysis. The materials were crushed and sieved to get particles with different particle size ranges. They were further ball milled for 1-7 days to get particles in the nanosize ranges. The broadening of the XRD peaks of the phosphor material in nanocrystalline form was used to determine average particle sizes. The shapes and sizes of these particles could also be seen in FESEM images. It was very interesting to observe phase change and the complete loss of ML in SrAl2O4 on annealing above 800 oC. In all three cases (i.e., ML, TL, and OSL), the intensities are found to decrease with the particle size. The SrAl2O4 doped with Eu and codoped with Dy phosphor materials were used to study the dosimetry of UV radiation. The dose response of the phosphor material shows that the microcrystalline phosphors saturate early but the nanocrystalline materials though have little less sensitivity saturate at very high doses of the UV-radiation and could be used for estimation of such doses, where the microcrystalline phosphors fail. It was also very interesting to study the decrease in ML intensity in ZnS:Mn on annealing the material at different elevated temperatures due to phase transitions from ZnS to ZnO. The systematic study of particle size effect (over a wide range of particle sizes) on ML has great importance from a technological and application point of view for developing stress sensors and dosimetry of UV radiation.

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1. Introduction 2. Experimental Techniques 3. Effect of Particle Size and Annealing Atmospheres on Luminescence Properties of $SrAl_2O_4$:Eu Phosphors 4. Mechanoluminescence UV Dosimetry in $SrAl_2O_4$:Eu Phosphors: Effects of Particle Size, Phase change, and Annealing Atmospheres 5. Effect of Particle Size and Redox Reactions on the Mechanoluminescence (ML) and Thermoluminescence (TL) Properties of $SrAl_2O_4$:Eu,Dy 6. Mechanoluminescence and Photoluminescence in Mn Doped ZnS Phosphors: Effects of Particle Size and Annealing Atmospheres 7. Summary and Scope for Future Work. List of Publications and Conferences.

09. SINGH (Ishwar)
Three Flavor Neutrino Oscillations at the NOvA Experiment.
Supervisor: Prof. Brajesh C. Choudhary
Th 29205

Abstract

NOvA is a two-detector, long-baseline neutrino oscillation experiment located at Fermilab, Batavia, IL, USA. The NOvA experiment was designed primarily to constrain neutrino oscillation parameters by analyzing numu(numubar) disappearance and nue(nuebar) appearance data observed at the far detector. The Neutrinos at Main Injector (NuMI) beamline at Fermilab provides a high-purity beam of neutrinos and anti-neutrinos to the experiment. The NOvA experiment consists of two functionally identical, finely granulated liquid tracking calorimeters, both situated 14.6 mrad off-axis to the beam direction. The NOvA near detector, situated 100 meters underground and 1 kilometer from the beam source, detects the non-oscillated numu(numubar) and beam nue(nuebar) events. The far detector, located in Ash River, MN, USA, 810 kilometers from the beam source, records the oscillated numu(numubar) and the oscillated numu(numubar) and nue(nuebar) events. The NOvA experiment has been collecting data for the last 10 years, which is equivalent to neutrino-beam exposure of 26.60e20 protons-on-target (POT) and anti-neutrino beam exposure of 12.50e20 POT. The details of the most recent three-flavor neutrino oscillation analysis using 10 years of the NOvA experiment data will be discussed in this thesis. In addition, the impact of including high-energy nue(nuebar) events in the energy range 4 to 12 GeV on the experiment`s oscillation sensitivities is also presented in the thesis.

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1. Introduction 2. Phenomenology of Neutrino Oscillations 3. The NOvA Experiment 4. Simulation and Event Reconstruction 5. Three Flavor Oscillation Analysis Elements 6. Data Fits and Results 7. Improvement to Future Oscillation Analysis 8. Summary. Appendix A Charged Current Matter Potential. References.

10. SINGH (Jatinder Pal)
Realization of Sensors Based on MoO_3 Layers for Chemical Warfare Agent Simulant (DBS) and Bilirubin Detection.
Supervisor: Prof. Arijit Chowdhuri
Th 29206

Abstract

Mustard gas is a highly toxic chemical warfare agent (CWA) requiring rapid detection. Since handling of CWAs is dangerous & forbidden, hence simulants are used in sensor development. Dibutyl sulfide (DBS) is a well-established mustard gas simulant. Apart from skin and respiratory damage, mustard gas also disrupts liver function and hence monitoring bilirubin levels, a liver lth biomarker assumes importance. The current thesis develops MoO_3-based chemiresistive and QCM sensors for DBS detection and electrochemical sensor for bilirubin levels. RF-sputtered MoO_3 thin films were optimized, and their DBS sensing performance enhanced through UV illumination and metal cluster incorporation. 8 nm Cu cluster-incorporated MoO_3 thin film were noted to exhibit enhanced DBS (10 ppm) response of 84.28% at 80°C. Cu clusters-incorporated MoO_3 sensor was used to develop a portable DBS sensing module with internet of things (IoT) capability. For room temperature sensing of DBS at room temperature, MoO_3 based QCM sensor

was optimized to exhibit a sensitivity of 0.6 Hz/ppm. For the electrochemical bilirubin (BR) sensor, bilirubin oxidase (BOx) was first immobilized on the MoO_3 thin film. The fabricated bioelectrode showed a best sensitivity of 83.27 μA(mg/dL)-1 in the linear range of 0.05 mg/dL to 2.5 mg/dL of BR with a LOD (Limit of Detection) of 0.03 mg/dL besides good selectivity, repeatability and stability towards bilirubin. Finally, 2D layers of MoO_3 were fabricated and their DBS sensing performance evaluated. 2-Layer (2L), 5-Layer (5L) and 10-Layer (10L) 2D MoO_3 were successfully deposited using the RF sputtering technique. 5L MoO3 sensor exhibited exhibited an augmented DBS response of 124.56% at 90°C. All these results indicate the prototyping potential of 2D MoO_3 based sensors for sensitive detection of DBS.

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1. Introduction 2. Growth and characterization of MoO_3 thin films 3. Chemiresistive MoO3 thin film-based sensor for detection of DBS 4. MoO_3 thin film based QCM sensor for detection of DBS 5. Development of IoT enabled handheld prototype for DBS detection 6. Electrochemical based biosensor using MoO3 thin film matrix for the detection of bilirubin 7. 2D MoO_3 layer-based sensors for efficient detection of DBS. Scope and Suggestions.