كلية العلوم
Faculty of Science

مؤتمر الأبحاث الطلابية
كلية العلوم - جامعة سوهاج
بحث - ابتكار - تميز

جامعة سوهاج
Sohag University

المؤتمر الثاني للأبحاث الطلابية
كلية العلوم - جامعة سوهاج
٥ مايو ٢٠٢٦

2nd Conference for Student Research
Faculty of Science - Sohag University
May 05, 2026

Academic Year
2025/2026

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وكيل كلية العلوم لشئون التعليم والطلاب (مقرر المؤتمر)

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PREFACE

This abstract book comprises 81 research contributions (25 oral presentations and 56 posters), in addition to 36 scientific experiments prepared by undergraduate students of the Faculty of Science, Sohag University, during the academic year 2025/2026. These contributions were conducted under the supervision and guidance of the academic staff members of the Faculty of Science, Sohag University.

This book has been prepared on the occasion of the 2nd Conference for Student Research, held on May 5, 2026, at the Faculty of Science, Sohag University, under the patronage of **Prof. Dr. Hassan Al-Numani**, President of Sohag University, and **Prof. Dr. Hussein Taha Atta**, Vice President for Education and Student Affairs.

In addition to highlighting the scientific research activities of both students and staff members, this abstract book serves as a valuable reference for recent advances in research. Furthermore, the 2nd Conference provides an excellent opportunity for students and researchers from different departments—who may be working on similar research topics but rarely interact—to connect and exchange ideas.

This event also represents a valuable platform for sharing the significance and impact of our research with various sectors of the community. Thanks for Prof. Dr. Mahmoud Abdel-Aty (Mathematics department) for supporting the conference.

Dean of Faculty of Science

Prof. Dr. Hazem El-Meshnib

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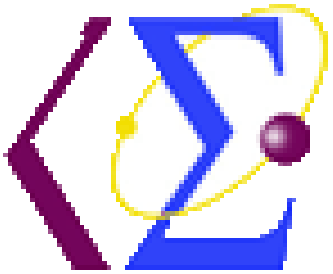

Mathematics

MO01

The Sinh Topp-Leone Inverse Rayleigh Distribution: Mathematical Properties and Applications in Biomedical Data

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ABSTRACT

This research introduces a new three-parameter lifetime model, named the Sinh Topp-Leone Inverse Rayleigh (ST-LIR) distribution. The proposed model is developed by compounding the Hyperbolic Sine-G family and the Topp-Leone generator with the Inverse Rayleigh distribution as a baseline. The mathematical properties of the new distribution, including the probability density function (PDF), cumulative distribution function (CDF), hazard rate function, and moments, are derived and discussed. The hazard rate function of the ST-LIR model exhibits various shapes, including increasing, decreasing, and unimodal, providing superior flexibility in modeling survival data. The parameters of the model are estimated using the Maximum Likelihood Estimation (MLE) method. A simulation study is conducted to evaluate the performance of the estimators. Finally, the practical importance of the proposed distribution is illustrated by applying it to real biomedical datasets. The results are expected to demonstrate that the ST-LIR model provides a better fit and more flexibility compared to the baseline Inverse Rayleigh and other well-known competitive models.

Keywords: Inverse Rayleigh distribution, Sinh-G, Topp-Leone, Hazard rate, Biomedical.

MO02

VulnHunter

A Python-based tool that automatically detecting web security vulnerabilities including SQL Injection, XSS, Port Exposure, and Directory Traversal.

Kirolous Talaat[1], Ali Rabie[1], Dr. Zeinab El-Zohary[2]

[1] Two Students from the Mathematical Department, Programming and Statistics Program, Faculty of Science, Sohag University.

[2] Professor at Faculty of Computer Science, Sohag University.

ABSTRACT

Web application security has become a critical concern in the modern digital era, as cyber-attacks targeting vulnerable websites continue to rise. This paper presents an automated web vulnerability scanner developed using Python, designed to detect common security vulnerabilities in web applications. The proposed system targets four of the most critical and widespread vulnerabilities identified by OWASP: SQL Injection, Cross-Site Scripting (XSS), Open Port Exposure, and Directory Traversal. The scanner was evaluated on two custom-built Flask web applications, one intentionally vulnerable and one securely developed, to demonstrate the system's ability to distinguish between vulnerable and secure targets. The tool features a graphical user interface (GUI) built with Tkinter, containing two tabs: a Scanner tab where users can input any target URL and select which vulnerabilities to test, and a Report tab that displays detailed results with color-coded severity indicators, vulnerability descriptions, and recommended fixes — all within the application itself without requiring a browser. Experimental results confirm that the scanner successfully detected all planted vulnerabilities in the vulnerable application while reporting no false positives on the secure application. The system provides an accessible and efficient solution for developers and security researchers to assess web application security during the development lifecycle.

Keywords: Web Security, Vulnerability Scanner, SQL Injection, XSS, Port Scanning, Directory Traversal, Python, Ethical Hacking.

MO03

Velox

An automated data analysis system with an interactive dashboard that turns raw data into insights for decision making.

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ABSTRACT

In the contemporary business landscape, Small and Medium Enterprises (SMEs) often struggle to extract useful insights from raw data due to limited analytical expertise. To solve this problem, this project introduces "Velox," an automated data analysis system designed to support decision-making and simplify business intelligence for SMEs. The system provides a web-based platform where users can upload their business data. The system then processes the data by removing duplicates, handling missing values, and detecting outliers using the Interquartile Range (IQR) method. After data preprocessing, the system performs exploratory data analysis to calculate key performance indicators (KPIs) such as total revenue, profit margins, and product performance, identifying both high and low-performing products. It also analyzes trends over time using time-series analysis. The processed data is displayed through an interactive React-based dashboard that visualizes metrics and trends in a clear and simple way. In addition, the system generates automatic insights and recommendations, such as cost reduction ideas and marketing suggestions, based on the analyzed data. Ultimately, Velox helps SMEs understand their data easily and make better decisions based on real information instead of assumptions.

Keywords: Automated Data Analysis, Data Cleaning, Business Intelligence, Key Performance Indicators (KPIs), Decision Support System, Small and Medium Enterprises (SMEs), Interactive Dashboard, Data Visualization.

MO04

Computational geometry algorithms using python.

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ABSTRACT

Computational geometry is a fundamental field in computer science that focuses on designing efficient algorithms to solve geometric problems. This research explores essential computational geometry concepts and implements key algorithms using Python. The study focuses on the Convex Hull problem and the Line Segment Intersection problem, analyzing their efficiency and practical applications. The results demonstrate the importance of selecting efficient algorithms to improve performance in geometric computations.

Keywords: Computational geometry, Geometric Algorithms, Convex Hull, Sweep Line Algorithm, Line Intersection.

MO05

On the Effect of Loss Function and Optimization Strategy in Physics-Informed Neural Networks for Nonlinear Differential Equations

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ABSTRACT

Physics-informed neural networks (PINNs) have recently emerged as a powerful tool for solving differential equations by incorporating physical laws directly into the loss function of neural networks. However, the performance of PINNs strongly depends on the optimization algorithm and the formulation of the loss function.

In this work, we investigate the impact of two optimization strategies, namely the BFGS and L-BFGS quasi-Newton methods, combined with two different loss formulations: the mean squared error (MSE) and the root mean squared error (RMSE). Four optimization configurations are therefore considered: BFGS-MSE, BFGS-RMSE, L-BFGS-MSE, and L-BFGS-RMSE.

To ensure a fair comparison between the two optimization strategies, the experiments were conducted using 5,000 iterations for BFGS and 25,000 iterations for L-BFGS, accounting for the faster per-iteration computational cost of L-BFGS, while acknowledging that BFGS is generally expected to achieve higher accuracy when the number of iterations is comparable.

The proposed approach is tested on several benchmark problems of the one-dimensional Burgers equation. The numerical experiments demonstrate that the choice of loss formulation significantly influences the convergence behavior of PINNs. In particular, the BFGS optimizer combined with the RMSE loss consistently provides the highest accuracy among the tested configurations.

The results indicate that an appropriate combination of optimizer and loss function can substantially improve the performance and stability of PINNs when solving nonlinear differential equations.

Keywords: Physics-informed neural networks, BFGS optimization, L-BFGS optimization, Burger's equation, Scientific machine learning.

MP01

Statistical Inference of Reliability Function from Arc-Tangent Exponential (ATE) Distribution

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ABSTRACT

This paper investigates the statistical properties and reliability characteristics of the Arc-Tangent Exponential (ATE) distribution. The primary objective is to analyze the behavior of the distribution through its fundamental reliability measures, specifically the Reliability (Survival) function, Hazard rate function, Mean Time to Failure (MTTF), and Mean Residual Life (MRL). These measures are essential for modeling lifetime data and understanding the failure mechanisms of various systems. The study further extends to the inferential side by estimating the reliability and hazard rate functions. Two prominent estimation methods are employed: the frequentist approach using Maximum Likelihood Estimation (MLE) and the Bayesian Estimation approach under both symmetric (SE) and asymmetric (LINEX) loss functions. A comparative study is conducted to evaluate the performance of these estimators, providing insights into their accuracy and applicability in practical reliability analysis.

Keywords: Arc-Tangent Exponential Distribution, Reliability Function, Hazard Function, Maximum Likelihood Estimation, Bayesian Estimation.

MP02

Integral curves and quasi- frame in Galilean space

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ABSTRACT

This paper is devoted to study integral curves associated with the quasi-frame (q-frame) in three-dimensional Galilean space G^3. Specially, we focus on the quasi-normal and quasi-binormal vectors. Moreover, we derive the Frenet frames for these integral curves based on the quasi-frame elements as well as their curvatures and torsions. In addition, some important geometric properties of both quasi-normal and quasi-binormal curves are discussed. Finally, some examples are given to illustrate the idea.

Keywords: Galilean space G^3, Quasi-frame, Frenet frame, Integral curves.

MP03

Fixed Point Theory and Its Applications

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ABSTRACT

Fixed Point Theory is one of the most important subjects in mathematics, especially within the field of functional analysis. It has a wide range of applications across many different disciplines. In this article, we will discuss some of the most significant theorems in this field, along with their most common practical applications.

Keywords: Fixed point, Functional analysis, Mathematics, Banach Fixed Point.

MP04

Statistical Inference for Lomax distribution

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ABSTRACT

The Lomax distribution, also known as the Pareto Type II distribution, is a continuous probability distribution widely used in modeling heavy-tailed data. It is particularly useful in fields such as economics, reliability engineering, and survival analysis.

This study introduces the Lomax distribution and discusses its key statistical properties, including the expected value، variance, and moment generating function. These properties provide insight into the behavior and spread of the distribution.

The paper also explores parameter estimation methods for the Lomax distribution, focusing on the Method of Moments and the Maximum Likelihood Estimation (MLE). These techniques are essential for fitting the distribution to real data and making statistical inferences.

Finally, several applications of the Lomax distribution are highlighted, demonstrating its effectiveness in modeling income distributions, failure times, and risk-related phenomena.

Keywords: Lomax Distribution Expected Value Variance Moment Generating Function Maximum Likelihood Estimation Distribution Properties Applications of Lomax Distribution.

MP05

Study of Heat and Mass Transfer in Hybrid Nanofluid Flow over a Stretching Surface with Thermal Radiation and Chemical Reaction Effects

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ABSTRACT

This study presents a comprehensive numerical analysis of heat and mass transfer in a steady two-dimensional flow of a hybrid nanofluid over a stretching surface. The hybrid nanofluid consists of a mixture of two types of nanoparticles, such as Copper (Cu) and Aluminum Oxide (Al_2O_3), suspended in a base fluid like water. The model incorporates the effects of thermal radiation and first-order chemical reaction, which significantly influence both heat and mass transfer processes.

The governing partial differential equations (PDEs) describing momentum, energy, and concentration are transformed into nonlinear ordinary differential equations (ODEs) using similarity transformations. These equations are solved numerically using the Runge–Kutta–Fehlberg method. The results show that increasing the nanoparticle volume fraction enhances thermal conductivity and heat transfer rate. Additionally, chemical reaction parameters reduce the concentration boundary layer thickness. The study confirms that hybrid nanofluids are more efficient than mono nanofluids in advanced cooling systems.

Keywords: Hybrid Nanofluid, Heat Transfer, Mass Transfer, Thermal Radiation, Chemical Reaction, Stretching Surface, Boundary Layer Flow, Thermal Conductivity

MP06

Chebyshev spectral method for solving second order ordinary differential equations with boundary conditions

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ABSTRACT

Spectral methods are of the most elegant numerical methods for solving ordinary and partial differential equations. These Methods offer several advantages over many other popular discretization methods in the literature and they have been extensively applied in many areas. The commonly used basis polynomials in spectral method are Chebyshev and Legendre polynomials for non-periodic Problems, and numerical differential formula based on their zeros or maxima points are used to discertize the differential operators. We introduce a Chebyshev spectral method for solving some ordinary differential equations with boundary conditions

Keywords: Spectral methods, Chebyshev polynomials, collocation methods, boundary value Problems.


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Physics

PO01

Effect of Cd Doping Concentration on the Structural and Optical Properties of SbO_2 Thin Films Prepared by Thermal Chemical Vapor Deposition

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ABSTRACT

Cd doped antimony oxide (SbO_2) thin films (Cd = 0, 0.5, 0.9 and 1.6 at. %) were systematically synthesized by thermal chemical vapor deposition technique (TCVD) to understand the influence of Cd incorporation on their structural and optical properties. XRD analysis revealed that undoped and low Cd-doped films exhibit a single-phase orthorhombic SbO_2 structure with good crystallinity. With increasing Cd concentration, noticeable peak shifts and broadening were observed, indicating lattice distortion and induced strain due to Cd substitution. At higher doping levels, the emergence of additional diffraction peaks corresponding to monoclinic SbO_2 confirmed phase segregation beyond the solubility limit, resulting in a mixed-phase system. All films exhibited high transparency in the visible region, while a red shift in the absorption edge was observed with increasing Cd concentration. The optical band gap showed a systematic decrease from 3.69 to 3.29 eV with increasing doping ratio from 0.5 to 1.6 at. %, indicating band gap narrowing attributed to defect states and disorder-induced band tailing. Furthermore, the refractive index increased significantly with Cd incorporation, suggesting enhanced optical density and polarizability, while the extinction coefficient indicated increased optical losses due to defect-related absorption. The films can be applied in optoelectronic applications.

Keywords: Cd doped SbO_2; Thin films; TCVD; Structural properties; Optical properties; Optoelectronic

PO02

Analysis of Occupational Radiation Exposure to 18F-FDG PET/CT Clinical Environment

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ABSTRACT

Positron emission tomography/computed tomography (PET/CT) is an imaging technique that uses18Fluorine-Fluorodeoxyglucose (18F-FDG) as a radioactive trace to positron emission. The detected images are used in the diagnosis of severe diseases. Working with 18F-FDG PET/CT exposes nuclear medical staff to high-energy radiation. Because of the 511 keV photons produced by the tracer, staff must carefully manage their time during dose preparation and patient administration to minimize their total radiation dose.

The aim of the study is determination the radiation exposure of staff working at the PET/CT facility. The radiation exposure data is extracted from 28 adult patients participants as well as 2 children to examine factors of age and weight. The exposure is evaluated by electronic personal dosimeter at the time of the injection directly, before CT imaging, and after a completion of CT scan. The radiation dose rates at 1 meter from patient are recorded 56.6 µSv/h following injection , 27.4 µSv/h before the positron emission tomography/computerized tomography imaging, and 20.4 µSv/h after the positron emission tomography/computerized tomography imaging.The higher weight of patients indicates higher exposure values. Radiation measurements taken at one meter confirmed that patients met regulatory safety standards for discharge after their PET/CT scan.

Keywords: 18F-FDG, PET/CT, radiotherapy, positron emission

PO03

Design of a vibrating reed magnetometer

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ABSTRACT

Due to the importance of magnetic materials which are used in a large variety of devices like passive circuit elements, sensors, read-write heads, information storage media, etc.

Our goal is desirable to build an apparatus (magnetometer) for measuring the magnetic properties of these magnetic materials.

The system is regarded as an alternating gradient force magnetometer (AGFM), also called vibrating reed magnetometer (VRM) because it measures the time varying force on the magnetized sample in a magnetic field. The system was designed exclusively for the recording of hysteresis loops of macroscopic ferromagnetic samples. The system sensitivity approaches that of the SQUID magnetometer, while preserving the easy, comparatively inexpensive and has versatile applicability of the VSM.

Keywords: magnetic materials, alternating gradient force magnetometer, vibrating reed magnetometer.

PO04

Fundamental Physics and Mathematical Frameworks for Solar Cell Device Simulation

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ABSTRACT

As the global community faces the urgent challenge of climate change, solar energy has emerged as a cornerstone of a sustainable future. It offers a clean, virtually inexhaustible power source that operates in harmony with natural systems rather than at their expense. By directly harnessing solar radiation, photovoltaic (PV) technology provides a transformative pathway to decouple human development from environmental degradation.

This work studies the fundamental physical principles and mathematical frameworks required for the advanced simulation and optimization of solar cell devices. It presents a comprehensive analysis of photovoltaic operation, focusing on three essential processes: photon absorption leading to the generation of electron–hole pairs, charge separation driven by internal electric fields, and charge collection at metal contacts.

The study further examines a range of solar cell architectures, comparing conventional monocrystalline and polycrystalline silicon technologies with emerging thin-film and multi-junction concentrator systems. Particular emphasis is placed on next-generation photovoltaics, especially perovskite solar cells (PSCs). These materials represent a significant breakthrough, with perovskite–silicon tandem configurations demonstrating the potential to exceed 43% efficiency through advanced layer engineering and interfacial optimization.

In addition, this research highlights the critical role of Modeling and Simulation (M&S) in accelerating photovoltaic innovation. Simulation tools enable accurate prediction of device behavior while reducing the cost and time associated with experimental fabrication. Key methodologies, including equivalent circuit modeling and numerical device simulation, are explored using industry-standard platforms such as Silvaco TCAD, MATLAB/Simulink, and SCAPS-1D, with a particular focus on thin-film and perovskite devices.

By solving the governing equations of semiconductor physics—namely Poisson's equation and the drift–diffusion equations—these tools provide

detailed insight into internal device behavior. This enables systematic optimization of key performance parameters, including open-circuit voltage (Voc), short-circuit current density (Jsc), and fill factor (FF), ultimately contributing to the development of high-efficiency solar technologies.

Keywords: Renewable Energy, Photovoltaics, Perovskite Solar Cells (PSCs), Device Simulation, SCAPS-1D, P-N Junction, Numerical Modeling.

PO05

Structural, electrical and magnetic properties of Cu-Mn-O Compound

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ABSTRACT

Copper-manganese spinel oxide ($CuMn_2O_4$) was synthesized by the conventional melt quenching technique followed by high-temperature heat treatment. X-ray diffraction confirmed the formation of a single-phase cubic spinel structure ($Fd\bar{3}m$), indicating successful phase formation. The d.c. electrical conductivity (ρ) measurements was carried out in the temperature range from 83 to 373 K. The magnetic susceptibility (χ) was measured at various temperatures ranging from ~100 to 400 K. The thermoelectric power were investigated to determine the compound's suitability as a thermoelectric element.

Keywords: Manganese Spinel Oxide, Electrical, Magnetic, Thermoelectric Power

PP01

Fusion energy is the energy of the universe

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ABSTRACT

Nuclear fusion will provide clean and limitless energy in the future. Fusion energy offers energy with no air pollution, no carbon dioxide, and no long-lived radioactive waste. Fusion is safe (impossibility of runaway accidents) and durable energy supply.

The most energy is released if the two isotopes of hydrogen (^{2}H & ^{3}H) fuse together in the reactions:

$$^2\mathrm{H} + {}^2\mathrm{H} \rightarrow n + {}^3\mathrm{He} \qquad Q = 3.3\ \mathrm{MeV}$$

$$^2\mathrm{H} + {}^2\mathrm{H} \rightarrow p + {}^3\mathrm{H} \qquad Q = 4.0\ \mathrm{MeV}$$

$$^2\mathrm{H} + {}^3\mathrm{H} \rightarrow n + {}^4\mathrm{He} \qquad Q = 17.6\ \mathrm{MeV}$$

The ignition temperature of the D-T reaction (≥ 55 million Kelvin) is much lower compared to that of the D-D reaction (≥ 100 million Kelvin). This means that D-T reaction requires less energy to achieve much higher reaction rate and energy than the D-D reaction. This is the crucial reason why D-T fusion is the focus of fusion energy research today. It's worth noting that each D-T reaction releases an energy of 17.6 MeV, which is much higher than the 3.27 MeV generated by the D-D reaction. This is necessary to maintain fusion plasma conditions.

The study pointed out that the reaction rate and the fusion power are maximized when the concentrations of deuterium and tritium are equal (50:50 mixture) in the future fusion reactors.

Keywords: Nuclear fusion, Inertial Confinement, Magnetic Confinement, D-D Fusion, D-D Fusion

PP02

Dosimetric Evaluation of Volumetric Modulated Arc Therapy (VMAT) versus 3D Conformal Radiotherapy in Complex Target Volumes

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ABSTRACT

This research introduces comparison study of the role of volumetric-modulated arc therapy (VMAT) and 3D-conformal radiation therapy technique for left-breast irradiation by comparing dosimetry parameters in the mode of free breathing (FB) and Deep Inspiration Breath-Hold (DIBH). Ten individuals presenting with node-positive left breast malignancy have been recruited for this dosimetric investigation. The study utilized five treatment configurations across both Deep Inspiration Breath-Hold (DIBH) and Free-Breathing (FB) datasets. These configurations comprised two 3D-CRT plans and three h-VMAT plans featuring varied dose-weighting ratios. To ensure objective evaluation, standardized planning constraints were applied across all models. Comparative analysis, based on dose-volume histogram (DVH) parameters for target volumes and organs-at-risk (OARs), demonstrated that the h-VMAT technique provided Planning Target Volume (PTV) coverage comparable to traditional 3D-CRT.

Keywords: VMAT,3D, Left breast, Radiotherapy.

PP03

Optical properties of GaZnO thin films prepared by DC magnetron sputtering at different power on Ga target

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ABSTRACT

Ga-doped ZnO (GZO) thin films made by direct current (dc) magnetron sputtering were examined for their optical characteristics. The GZO thin film was deposited on a glass substrate using DC power for ZnO 100 Watt, for Ga 100, 75, 50, 25, 0 Watt and Ar gas flow rate of 10 sccm. Films were maintained at a thickness of roughly 1013 nm. In the visible range (250–2500 nm), the films' average transmittance was roughly 80%. The optical band gap (Eg) was 3.35, 3.32, 3.31, 3.25, 3.22 eV respectively. According to the findings, transparent conducting oxide (TCO) can be used as an electrode in optoelectronic devices like solar cells, LEDs, and display technologies when GZO films are produced using DC magnetron sputtering.

Keywords: DC magnetron sputtering, GZO thin films, optical properties.

PP04

Enhanced Thermoelectric Performance of In-Doped Mg_3Sb_2 Synthesis, Characterization, and Electrical Properties

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ABSTRACT

Thermoelectric materials offer a clean solution for converting waste heat directly into electricity. Among them, Mg_3Sb_2 is a highly promising material, However, pure and intrinsic Mg_3Sb_2 manifests a poor thermoelectric performance because of its low electrical conductivity at room temperature. In this work, In was carried out to optimize the thermoelectric performance of Mg_3Sb_2 material. In this work, pure and In-doped Mg_3Sb_2 samples were successfully synthesized using a high-temperature vacuum melting method. The structural, morphological, and chemical properties were systematically investigated using XRD, TEM, and XPS.

The XRD results confirmed the high phase purity of the samples and showed a lattice contraction, proving the successful integration of the dopant into the host crystal. High-resolution TEM investigation confirmed the XRD results. Additionally, XPS analysis confirmed the specific chemical state of the Indium dopant inside the lattice.

Electrical measurements were performed using the four-probe method to investigate the electrical conductivity of the samples. The thermoelectric performance of In-doped $Mg_3Sb_2$is systematically investigated over a wide temperature range. The material demonstrates stable electrical conductivity and a moderate Seebeck coefficient, Thermoelectric measurements showed that these dopant-induced structural defects acted as strong scattering centers for phonons, which significantly reduced the lattice thermal conductivity. This study demonstrates that doping with Indium is a highly effective strategy to improve the thermoelectric performance of Mg_3Sb_2based materials.

Keywords: Thermoelectric materials; Zintl phase; Mg_3 Sb_2 ; Electrical transport; Seebeck coefficient; Figure of merit (ZT).

PP05

Design and Simulation of High-Efficiency Eco-Friendly CZTSe Thin-Film Solar Cells Using SCAPS-1D

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ABSTRACT

Photovoltaic (PV) technologies are essential for meeting the increasing global energy demand while reducing carbon emissions. Although thin-film solar cells based on CdTe and CIGS have achieved high efficiencies, their large-scale deployment is limited by high costs, toxicity concerns, and the scarcity of elements such as indium and gallium. Therefore, this study investigates sustainable quaternary compounds, particularly copper zinc tin selenide (CZTSe), as a promising alternative absorber material due to its non-toxic nature, earth-abundant constituents, and suitable direct band gap.

Numerical simulations were carried out using SCAPS-1D to evaluate device performance. A multilayer solar cell structure (SLG/Mo/Absorber/Buffer/i-ZnO/ZnO:Al) was designed and optimized. Key parameters, including absorber layer thickness and doping concentrations, were systematically varied to achieve maximum power conversion efficiency.

The simulation results show that the optimized CZTSe-based solar cell achieves a high efficiency of 14.64%. The optimal absorber thickness was found to be 2.0 μm, providing an effective balance between photon absorption and carrier recombination. Photovoltaic parameters such as open-circuit voltage (Voc), short-circuit current density (Jsc), fill factor (FF), and overall efficiency were analyzed under standard AM1.5G illumination conditions.

These findings confirm that CZTSe is a viable and eco-friendly alternative for next-generation thin-film photovoltaic applications, offering a pathway toward low-cost and sustainable solar energy technologies.

Keywords: Solar cell device, SCAPS-1D program, CZTSe absorber layer, Numerical modeling, Photovoltaic parameters

Physics Department Experiments

No.	Name of Experiment	Category	Students	Supervisor
PE01	Specific charge for electron	Solid-state	1- Eman Ali Nour El-Din	Fatima Shaaban Mohamed
PE02	Electron diffraction	Solid-state	1. Abdel Rahman Mohamed Hossam El-Din	Israa Osama Jalal
PE03	Eddy currents	Solid-state	1. Abdel Rahman Mohamed Hossam El-Din	Hasnaa Heem Hussein
PE04	Young's double slit	Optics	1. Shaimaa Salah Abdel Aal 2. Ahmed Walid Farouk	Donia Mohamed Farag
PE05	Full wave rectification Electronics	Electronics	1. Shaimaa Salah Abdel Aal 2. Ahmed Walid Farouk	Radwa Mahmoud Yassin
PE06	Light Sensor	Electronics	1. Mohamed Mahmoud Mohamed Abdel Rahman	Saleh Nidal Saleh
PE07	Encoder	Electronics	1. Mohamed Mahmoud Mohamed Abdel Rahman	Al-Mudathir Adel Ismail