KABARAK UNIVERSITY

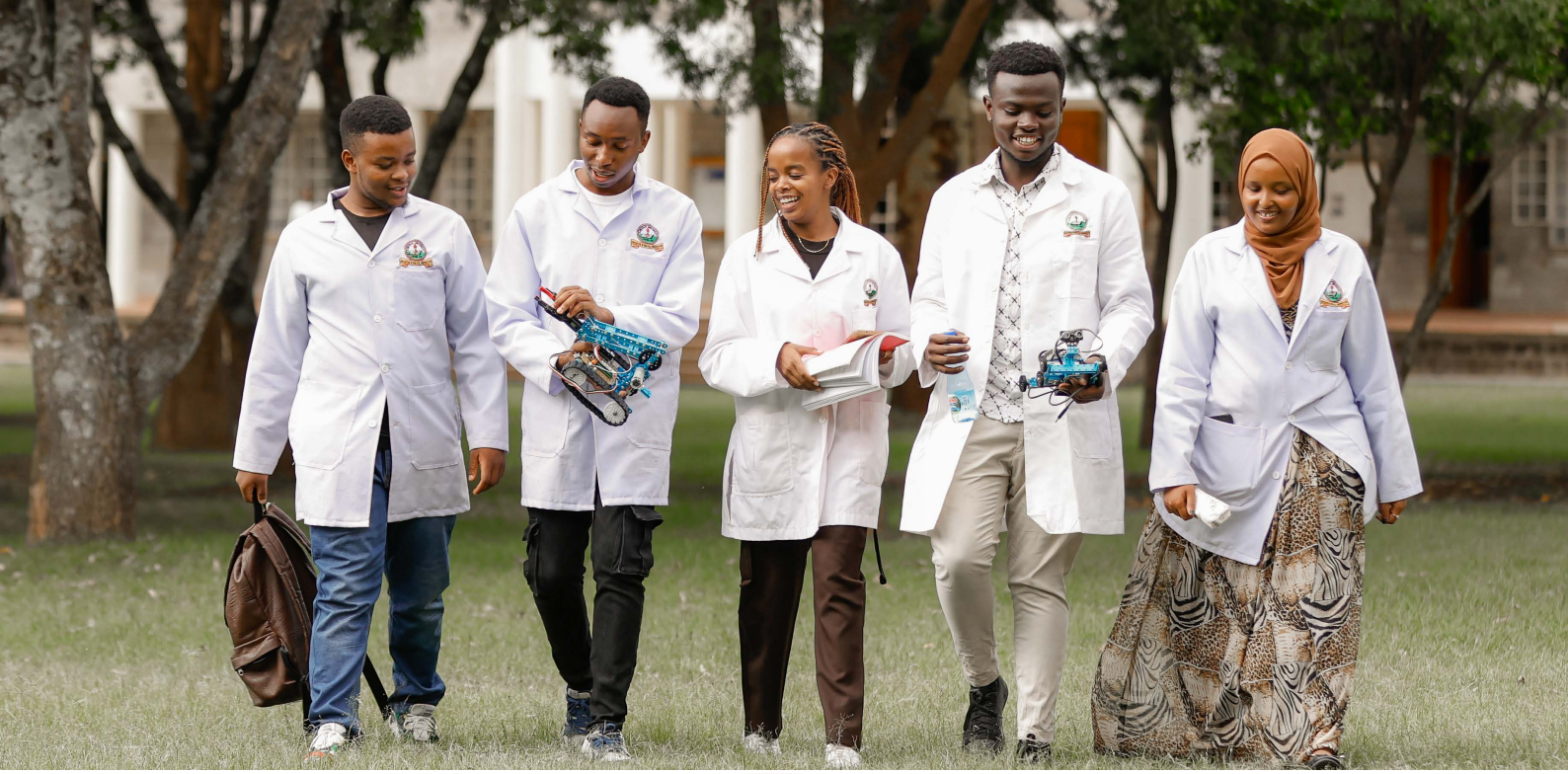
Education in Biblical Perspective

SCHOOL OF SCIENCE, ENGINEERING AND TECHNOLOGY

14TH INTERNATIONAL CONFERENCE ON RESEARCH TRENDS IN PHYSICS & CHEMISTRY OF MATERIALS - 2024

CONFERENCE PROCEEDINGS

Kabarak University is ISO 9001:2015 certified.



KABARAK UNIVERSITY | Education in Biblical Perspective

About Us

Kabarak University is a Chartered institution of higher learning that provides holistic Christian-based quality education, training, research and outreach activities for the service of God and humanity. The University was established in the year 2000 by the 2nd President of Kenya, H.E. the Late Hon. Daniel T. Arap Moi, who was also the founding Chancellor. This was as a result of his visionary idea of setting up a Christian University that would meet the demand for higher education in Kenya and offer quality education based on strong moral principles.

Location

Kabarak University Main Campus is located 20 kilometers north of Nakuru City, along the Nakuru-Eldama Ravine highway in a serene, spacious and beautiful environment that makes it ideal for learning. The University has state-of-the art facilities for teaching, learning, research, accommodation, catering, and sports. The facilities are purpose-built to enhance intellectual, physical, and spiritual growth. Nakuru City Campus is located one kilometer from Nakuru CBD, along Prison Road, off Nakuru-Kabarnet Road.

Vision

To become a centre of Academic Excellence founded on Biblical Christian values.

Mission

To provide holistic quality education, research and community outreach based on Biblical Christian values.

Philosophy

To provide quality education in Biblical perspective that transforms lives.

Core Values

- Integrity
- Professionalism
- Patriotism
- Innovativeness
- Being Mindful of Others

Kabarak University Moral Code

As members of Kabarak University family, we purpose at all times and in all places, to set apart in one's heart, Jesus Christ as Lord. (1 Peter 3:15)

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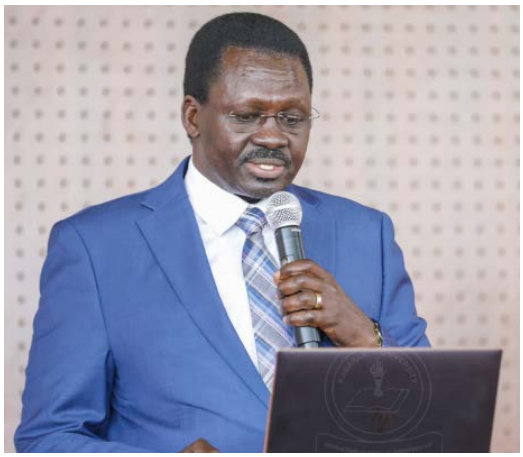


Prof. Henry Kiplangat,
Vice Chancellor
Kabarak University

VICE CHANCELLOR'S CONFERENCE SPEECH

On behalf of Kabarak University, I welcome you to this year's conferences on "Research Trends in Physics & Chemistry of Materials and Applications." This event, hosted by the School of Science, Engineering & Technology, is part of our ongoing series fostering research collaboration and knowledge exchange.

As we've seen with our Data Science, Media, Pharmacy, and Business conferences earlier this year, research is the engine of progress. Developed nations thrive on R&D (Research and Development), harnessing its power for economic growth. Conversely, developing nations with abundant natural resources often export them raw, only to repurchase them as finished products at a premium. This not only hinders local development but also fuels unemployment.

Therefore, I urge our researchers not just to innovate but also to bridge the "silo effect" by considering commercialization of their discoveries. Let's move beyond storing research on shelves – transform it into real-world solutions!

This conference brings together a diverse group of researchers from Kenya and beyond. We'll delve into exciting areas like solar energy applications, material characterization for solar cells, and photocatalysis. We also have presentations on computer simulations on characterization of materials from a number of participants. Energy solutions are key to our growth and development and in this conference we have quality papers from participants whose research looks into energy challenges and clean energy experimental approaches.

We have invited into this conference seasoned researchers with great experiences that will elicit discussions among participants. These speakers are international but also local. Local in the sense that they identify with our set up and challenges in regard to research. Prof. Patrick Ndungú from University of Pretoria being our Key note speaker will be addressing this gathering shortly. Also guest speakers Dr. Margaret Samiji of University of Dar-es-salam and Prof. Sabastian Waita will present in this conference.

A heartfelt thank you to all who made this conference possible, especially the Materials Science and Solar Energy Network for Eastern and Southern Africa (MSSEESA). Their sponsorship fosters collaboration through research fellowships and resource sharing. Notably, postgraduate students like Judith Chebogen and Victor Isahi (postgraduates of Kabarak University) benefitted tremendously from MSSEESA, conducting research in Zambia through co-supervision and equipment access. Judith is now pursuing her PhD research in South Africa, a testament to the power of these collaborations. In this conference, MSSESSA is a co-partner sponsoring a number of students' presentations just as they have done in the previous conferences.

Dr. Peter Rugiri, I encourage the School to continue nurturing these valuable partnerships while seeking new ones to enrich our science postgraduate programs further.

With that, I declare the 2024 International Conference on Research Trends in Physics & Chemistry of Materials officially open!

Thank you.

DEAN OF SCHOOL

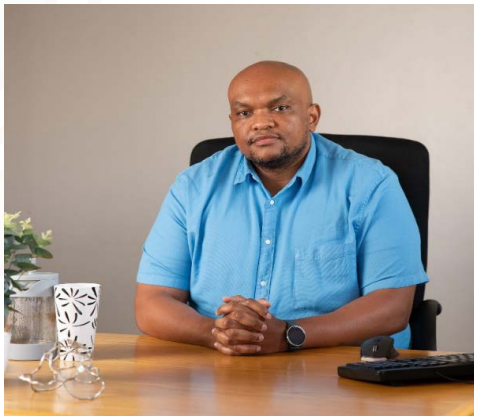
Dr. Peter Rugiri

It is with humility I welcome you all to our 14th Annual International Conference on Research Trends in Physics & Chemistry of Materials, 2024. The School of Science Engineering and Technology offers interdisciplinary undergraduate programs in Computer Science, Chemistry, Physics, Mathematics, Biology, and Technology related courses. We also have several postgraduate programs in Computer Science, IT, Environmental Science, Physics among others. In this school there are three conferences which are Data Science and Artificial Intelligence (DS&AI), Energy and Environment Conference and this current one. The first Conference on DS&AI took place in February, and the other two are currently joined together in this current conference.

As Dean of the School, I want to take this early opportunity to assure our participants that this conference is packed with articles that will elicit discussion worth its status. The conference has attracted quality speakers, quality presenters which is worthy of your time for the two days. We have papers from Physics, Chemistry, Biology and Environmental Science which have been well researched from our faculty and students. We also have participants from other universities within our borders and beyond. I take this opportunity to thank the university management for availing such a space for knowledge dissemination through such a gathering. I also thank speakers who have accepted to grace this occasion. I would also like to recognize Directorate of Research and Innovation under Dr. Moses Thiga for their effort to ensure that these conferences run every year.

KEY NOTE SPEAKER

Personal Details:



Title:	**Professor**
Surname:	**Ndungu**
First Name:	**Patrick**
Institution:	**University of Pretoria**
Country:	**South Africa**

Short Biography and Research Focus

Patrick Ndungu is a Professor (Physical and Materials Chemistry) and Head of the Department of Chemistry at the University of Pretoria. Born and raised in Kenya, Professor Ndungu completed his BSC degree at the University of Tennessee at Martin (USA), and then went on to work under the supervision of the late Professor Jean-Claude Bradley, at Drexel University (Philadelphia, USA), on his PhD studies. After completing his postdoctoral research fellowships at the University of the Western Cape, Professor Ndungu started his academic career as a lecturer at the University of Kwa-Zulu Natal, and after 5 years moved to the University of Johannesburg to continue as an Associate Professor and eventually promoted to Professor. To date, he has successfully supervised 15 doctoral candidates to completion, and 20 students at the master's level. He is a Scientific Editor (Nanotechnology) for The South African Journal of Chemistry, WaterSA Editorial Board member, and a C2-rated NRF Scientist.
His current research interests include environmental analytical chemistry, investigating the physical-chemical properties of nanocomposite materials, the development of novel and functional

nanosystems as integral components in low-cost water treatment technologies, and renewable energy devices, and novel aspects of nanoscience and nanotechnology in the context of providing inexpensive solutions for problems unique to the developing world.

GUEST SPEAKER

Dr. Margaret Samiji

Chief Coordinator of MSSEESSA

Dr. Margaret is Senior Lecturer in the Department of Physics. Currently she is the Departmental Examination Officer and Chief of MSSEESA Network, and Vice President of the East Africa Network for Women in Basic Sciences (EANWoBAS). She holds an MSc and a PhD in Physics, specializing on Materials for Solar Energy Applications. Her research interest involves thermochromic materials, solar selective coatings and PV and thermal systems. She is also involved in organizing science camps for A-level female science camps since 2016. She also received a number of awards including awards from Third World Academy of Science (TWAS) and Tanzania Commission for Science and Technology (COSTECH)

GUEST SPEAKER

Prof. Sabastian Waita

University of Nairobi

Prof Waita holds a PhD in Physics (Solar Energy) from the University of Nairobi, in a sandwich programme with Uppsala University where he carried out all his research work. He holds a Master's of Science in Physics with a bias in Solar Energy from the University of Nairobi. He got a First Class Honors degree in Physics from the University of Nairobi, which enabled him to benefit from DAAD scholarship both at Masters and PhD level. Currently, Prof Waita is Associate Professor in the Department of Physics, University of Nairobi. Prof. Waita holds a T3 solar PV technician License from Energy and petroleum Regulatory Authority (EPRA). He runs the Solar Academy in the Department of Physics as the Training Coordinator and Chief Trainer and has trained on solar systems design, sizing, installation and maintenance since 2012 with over 700 technicians trained.

Prof. Waita has undertaken several specialized courses and attended training workshops in Solar PV both at T2 and T3 levels in Strathmore and other places including a trainers' training. Prof Waita is actively involved in field installations of solar PV systems at the community level. He has installed solar PV systems in a number of institutions as well as private homes. In 2019, he was involved in the installation of a 3Kw Grid tie solar PV system in the Department of Physics, mainly for training and research. He has consulted for Makueni County, as the solar Expert (April 2015 - June 2015). He has been involved in workshops to develop draft solar PV regulations for solar PV installers, Vendors as well as contractors under the invitation of EPRA. Prof. Waita has served as a member of a government advisory committee on how to enhance solar PV uptake for homes and Businesses.

CONFERENCE PROGRAMME

Venue: Kabarak University

KATIBA AUDITORIUM

July 10th -11th 2024

Day One: 10th July 2024

REGISTRATION

Session Chair: Professor C.M. Maghanga

Theme: Recent Advances on Research Trends in Physics & Chemistry of Materials and Applications

Zoom Link: https://kabarak-ac-ke.zoom.us/meeting/register/tZcrduutpzgiH9CYB2Y0rMyo66NO6XK9789j

TIME	ACTIVITY	FACILITATOR
8.00– 8.30 AM	Registration	Ms.Sharon Cherotich
8.30– 8.40 AM	Meditation	University Provost
8.40– 8.50 AM	Welcoming Remarks	Head of Department, Biological & Physical Sciences, Dr. Philip Nyawere
8.50–9.00AM	Opening Remarks	Dr.Peter Rugiri, Dean School of Science, Engineering & Technology
9.00– 9.05 AM	DVC(A&R)	Prof. John Ochola
9.05 – 9-20 AM (FLEXIBLE)	Welcome remarks by the Vice Chancellor	Prof. Henry K. Kiplangat
9.20– 10.00 AM	Keynote Address	Prof. Patrick Ndungú (University of Pretoria)
10.00 – 10.30 AM	TEA BREAK	TEA BREAK
10.30– 11.00 AM	Guest Speaker	Prof. Sebastian Waita (Nairobi University)
11.00– 11.05 AM	Vote of thanks	Dr. Moses Thiga (Director RIO)
CHAPEL	CHAPEL	11.00 – 2.00 PM

Chair: Dr. Maxwell Mageto

Rapporteur:Ms.Abigael Nyandika

TIME	ACTIVITY	FACILITATOR
1.40– 2.10 PM	Guest Speaker	Dr. Margaret Simiji (Dar-es-salam University)
TIME	**PAPER**	**PRESENTER**
2.10-2.30	*ab* Initio Investigation of Electronic and Optical Properties in Sb/Bi codoped Methylammonium Lead Bromide	David Machiri, Victor Odari, Maxwell Mageto *Masinde Muliro University of Science and Technology, Kenya*
2.30 – 2.50 PM	PE242 Optical Properties of Cu Doped TiO_2 Nanoparticles for Photocatalytic Applications	Keya, Diana[1]; Simiyu, Justus[1]; Neil Goosen[2] and Motochi Isaac[1] *Masaai Mara University*

Chair: Dr. Caroline Chepkirui and Dr. Peter Tanui

REPORTEUR: Ms. Sharon Chemutai

TIME	PAPER	PRESENTER
2.50 – 3.10 PM	Computation of Electronic structure, Dynamical and Superconducting properties of Perovskite $LaBa_2Cu_3O_7$; First Principles Approach.	C. Seville, P. Tanui and P.W.O. Nyawere *Kabarak University, Kenya*
. 3.10– 3.20 PM	*Ab initio* computational study of electronic structure and effect of applied pressure on superconducting properties of Nb_3Sn and Ti;Nb_3Sn	A.N. Nyandika, P.W.O. Nyawere, S.Kebenei *Kabarak University*
3.20 – 3.40 PM	A comparative study of the properties of sol-gel synthesized ZnO/GO and ZnO/g-C_3N_4 nanocomposites for photocatalytic degradation of environmental contaminants	Judith Chebwogen Koskey *University of Nairobi*
3.40– 4.00 PM	Synergistic Effect Of Photocatalysis And Photo-Fenton For Cobalt Pigmented Anodized Tin Nanoparticulate Thin Films For Water Treatment	Sharon Chemutai, S. Kebenei, C. Maghanga *Dept. of Physical & Biological Sciences, Kabarak University*
TEA BREAK		4.00 – 4.15 PM

TIME	PAPER	PRESENTER
4.15– 4.35 PM	Assessment of the amount of energy produced by selectedbrandsofcellsinSigalagala National Polytechnic Laboratory	Eric Idamboh *The Sigalagala National Polytechnic, Kenya*
4.35– 4.55 PM	The Advancements and Applications of Solar Thermal Energy	Moses Rutinu, Francis Gaitho, Victor Odari *Masinde Muliro University of Science and Technology,Kenya*
4.55 – 5.15 PM	A Baseline Assessment of Pollinator Communities in Peri-Urban Environments of Nakuru City for Sustainable Urban Agriculture.	Wafula Elly Musungu, Bill Kiprono Gideon, Rioba James Nyamache, Rose Nyakemiso Sagwe *Kabarak University*
5.15 – 5.35 PM	Fabrication and Characterization of 2D/3D perovskite films for solar cell applications	Amos Milimo, Maxwell Mageto *Masinde Muliro University of Science and Technology, Kenya*
5.20 PM	PRAYER TO CLOSE DAY 1	Ms. Seville Cherotich

DAY TWO: 11th July 2024

Chair: Mr. Robert Rotich

Rapporteur: Mr. Chepkok

PAPER	PRESENTER	TIME
8.10 –8.20 AM	DEVOTION	DR NYAWERE
8.20 –8.40 AM	Piezo - Photocatalytic Performance of Fe- Doped $BaTiO_3$ Compounds	Wycliffe M. Isoe*, Bernard Omogo[1], Onesmus M. Munyati[2], Christopher M. Maghanga[4], Sylvester Hatwaambo[2], Maurice M. Mwamburi[3], Nicholas O. Ongwen[1], David Machiri[1], Benjamin V. Odari[1], Maxwell J. Mageto[1] *[1]Masinde Muliro University of Science and Technology, Kenya* *[2]University of Zambia, Zambia* *[3]University of Eldoret, Kenya.* *[4]Kabarak University,Kenya*

PAPER	PRESENTER	TIME
8.40– 9.00 PM	The Advancements and Applications of Solar Thermal Energy	Moses Rutinu, Francis Gaitho, Victor Odari *Masinde Muliro University of Science and Technology, Kenya*
9.00– 9.20 PM	Nanophotonic: Synthesis and Characterization of Plasmonic Nanomaterials.	Charleen Andalo *The Sigalagala National Polytechnic, Kenya*
9.20 – 9.40 PM	Effectiveness of mini-grids powered by solar in enhancing economic and community livelihood in Turkana central.	Sellah J. Kebenei (*Kabarak University*) & Odhiambo Caroline (*Moi University)*
9.40– 10.00 AM	PE Energy Conversion Efficiency I na Photovoltaic System with Lithium-Iron-Phosphate Storage Based on the Western Kenya Climate	Cornelius Masheti Lideli*, Francis Gaitho, Patrick Tonui, and James Owuor Masinde Muliro University of Science and Technology, Kenya
10.00– 10.30 AM		TEABREAK
CHAIR	DR. CAROLINE CHEPKIRUI	
10.30– 10.50 AM	PE Investigation of the Influence of S/Se ratio and Post-Selenization temperature on the Structural and Optical Properties of Sputtered $(Cu, Ag)_2ZnSn(S, Se)_4$ Absorber Layer	Anasia Maro, Lwitiko Mwakyusa and Margaret Samiji *University of Dar-es-Salaam, Tanzania*
10.50– 11.10AM	PC Experimental Study and Optimization Analysis of Mapi-Based Perovskites For Solar Cell Absorber Applications	Silas Abok, Celline Omondi, Francis M. Gaitho[1] and Maxwell J. Mageto *Masinde Muliro University of Science and Technology, Kenya*
11.10– 11.30AM	Development Of A Highly Efficient And Stable $Ch_3nh_3pbi_3$ Perovskite Solar Cells Induced Dy Solvent Engineering Methods	Wanyonyi M Stellah, Celline A. Omondi, Benard O. Omogo *Masinde Muliro University of Science and Technology, Kenya*
11.30 – 11.50 PM	Water Quality Parameters From The Five Boreholes At Kampi Ya Moto And Rafiki In Rongai Constituency, Nakuru County.	Kimeu A. Munyiva, Sellah Kebei, Caroline Chepkirui *Kabarak University, Kenya*

PAPER	PRESENTER	TIME
11.50 – 12.10 PM	Phytochemical Analysis and antimicrobial activity of the stem bark of *indigofera arnecta*	Thadius Bosire, Sellah Kebenei, Caroline Chepkirui *Kabarak University, Kenya*
12.10 – 12.30 PM	Comparative Study of Crystallization Kinetics and Phase Segregation of Triple Cation and Methylammonium Lead Iodide Perovskites on Moisture Probing using Synchrotron X-ray Based Radiations	Miller Shatsala[1], Stella Wanyonyi[2], Celine Awino[1], Maxwell Mageto[1],Hussein Golicha[1], *Masinde Muliro University ofa Science and Technology, Kenya*
12.30 – 12.50 PM	Determining the impacts of stone quarry works on riparian vegetation of river Molo in Rongai sub-county, Nakuru County, Kenya	Kipyator K. Dennis, E. Michura, *Kabarak University, Kenya*
12.50 – 1.50 PM		LUNCH
CHAIR	DR. SELLAH KEBENEI& MR. AWINDA DANICE	
2.00 – 2.20 PM	Light Trapping Properties of Textured Surfaces of Perovskite-Silicon Tandem Solar Cell Using OPAL 2 and Wafer Tracer Techniques	Miller Shatsala, Celline Awino, Maxwell Mageto,Hussein Golicha[1], Stella Wanyonyi, *Masinde Muliro University of Science and Technology, Kenya*
2.20 – 2.40 PM	Investigation of the Influence of Graphene on the Properties and Performance of Binary Mixture of Pentaerythritol and Tris(hydroxymethyl) aminomethane Phase Change Materials for Use in Solar Cookers	Sabuni M. Rutobora, Nuru Mlyuka and Margaret Samiji *University of Dar es Salaam, Tanzania*
2.40 – 3.00 PM	Investigation on the Influence of Deposition Temperature and Layer Thickness on Thermochromic Properties of Low Emissivity-based ITO/VO_2/MgO Multilayer Structure for Smart Window Application.	Mmary N. E, Mlyuka N.R and Samiji, M.E *University of Dar es Salaam, Tanzania*
3.00 – 3.20 PM	Investigation on the effects of O_2/ Ar flow ratio and copper oxide layer thickness on structural, optical, and photocatalytic properties of CuO/TiO_x heterostructure for water purification.	Peter Simwinga, Lwitiko P Mwakyusa and Nuru R Mlyuka *University of Dar es Salaam, Tanzania*

PAPER	PRESENTER	TIME
3.20 – 3.40 PM	Investigation of the physio-chemical parameters of watermelon seed oil around Rafiki, Rongai Sub-County	Mwanza Vuthi, Sellah Kebenei, Caroline Chepkirui *Kabarak University, Kenya*
3.40 – 4.00 PM	investigation of analgesic effects of mugwort (*Artemisia vulgaris*) using a rat model	Gladwell Chepkorir, Sellah Kebenei, Caroline Chepkirui *Kabarak University, Kenya*
4.00 – 4.20 PM	Assessment of the socio-economic factors influencing uptake of biogas technology among rural households in Kuresoi south sub-county, Nakuru county	Gypson Kurere, E. Michura, Sellah Kebenei *Kabarak University, Kenya*
4.20 – 4.40 PM	Evaluating the effectiveness of ecosystem-based adaptation strategy in mitigating climate change risks among smallholder farmers in Uasin Gishu county	Abigael Kibet, Kitetu J, Awinda D *Kabarak University, Kenya*
4.40 – 5.00 PM	Bulk Properties of Al–Mg–Si Alloys (6xxx Series)	Kipkorir Kirui Pius, Maxwell Mageto *Masinde Muliro University of Science & Technology Kenya.*
5.00 – 5.20 PM	CLOSING PRAYERS & TEA	DR. PHILIP NYAWERE

Investigation of Analgesic Effects of Mugwort (Artemisia Vulgaris) Using A Rat Model

Gladwell Chepkorir
Department of Biological & Physical Sciences, Kabarak University

ABSTRACT

Artemisia vulgaris (common mugwort) is a species with great importance in the history of tradition medicine and was called the "mother of herbs" in the middle Ages. It has been used ethnomedically for various purposes, including analgesic, anti-inflammatory, antibacterial and antihistamine properties. This study aims to access for the analgesic properties of A. vulgaris which is motivated with the fact that the available convectional medicines have a myriad of side effects hence the need for research for alternatives. The rat model method was used whereby the plant methanolic extract in different concentrations was orally given to albino rats and ibuprofen as a positive control. The two phases of nociceptive activity was observed and recorded within the first few minutes and thirty minutes later after formalin injection. The determination of the mean and standard deviation was acquired through the use of Microsoft excel. To determine whether the plant extract had analgesic properties the P- value was analyzed using the one way ANOVA .The results obtained showed that In the early phase, the percentage paw licking inhibition of the 150mg/kg extract was 67%, which was slightly higher than the percentage inhibition of the positive control, diclofenac, which was at 60%. The other concentrations showed lower percentage inhibition than the positive control. This could be due to an error encountered in the lab, eg. in terms of proper concentration of the extract. This is also true for the late phase. Moreover, the extracts showed inhibition of paw licking activity in a dose dependent manner, such that, a higher dose indicated better analgesic activity as compared to a lower dose. We can therefore say that a higher dose led to a higher concentration of the active ingredient at the analgesic receptors, which led to a higher pharmacological action as compared to a lower dose.

In conclusion, *Artemisia vulgaris* contains analgesic properties. Both methanol and n-hexane extracts of *Artemisia vulgaris* possessanalgesic activities in vivo. However, the activity of methanol extract was significantly greater than that of the n-hexane extract, which may be as a result of higher flavonoids concentration in methanol extract. The analgesic effects are dose dependent such that 50mg/kg was less effective than 100mg/kg of the extract, whereas the 150mg/kg was more effective than 100mg/kg.

Keywords: *Artemisia vulgaris*, pain, phytochemical characteristics, medical history.

Optical Properties of Cu Doped TiO2 Nanoparticles for Photocatalytic Applications

Keya, Diana[1]; Simiyu, Justus[1]; Neil Goosen[2] and Motochi Isaac

[1]Mathematics and Physical Sciences Department, Maasai Mara University, P.O. Box 861-20500, Narok, Kenya

[2]Department of Chemical Engineering, Stellenbosch University, South Africa

Corresponding author: dianachep2444@gmail.com, cherop20238@student.mmarau.ac.ke

ABSTRACT

Photocatalysis, a green and sustainable technology, has gained significant attention in recent years due to its potential for addressing pressing environmental and energy challenges. Sol-gel method has been employed to synthesize TiO_2 nanoparticles with transition metal Copper (Cu) incorporated into the TiO_2 matrix at 2, 4 6, and 8 wt.% weight percentages to investigate its influence on the photocatalytic performance. Diffuse Reflectance Spectroscopy (DRS) analysis revealed that the Cu-TiO_2 nanoparticles exhibited a significant ability to absorb visible light compared to undoped TiO_2. This observation suggests the successful incorporation of Cu, as pure TiO_2 primarily absorbs in the ultraviolet (UV) region. Furthermore, DRS analysis indicated a reduction in the band gap energy of the nannoparticles with increasing Cu doping densities. This decrease in band gap energy is a desirable outcome for photocatalysis, as it allows for activation by a wider range of light wavelengths, potentially leading to enhanced photocatalytic activity. Photoluminescence (PL) spectroscopy revealed the recombination rates of photogenerated electron-hole pairs. Lower florescence intensity signifies reduced recombination, which is beneficial for improved photocatalytic performance.

Keywords: Photocatalysis, Nanoparticles, doping densities

Computation of Electronic structure, Dynamical and Superconducting properties of Perovskite $LaBa_2Cu_3O_7$; First Principles Approach

C. Seville, P. Tanui and P.W.O. Nyawere

Department of Physical & Biological Sciences
Kabarak University, P.O. Box, Private Bag – 20157 Kabarak
Nakuru, Kenya

ABSTRACT

Perovskite materials have attracted research because of their ability to transition from normal metals to superconductors. They are attractive for a wide range of applications due to their unique characteristics and properties such as light-emitting diodes, power transition cables, photovoltaic'sand pressure induced emission. Electronic structure and mechanical properties are key in understanding behaviour of materials in relation to mechanical stability for superconductivity. My investigation explores the electronic structure in depth, uncovering essential aspects like bandgaps, Fermi surfaces, and density of

states, offering valuable insights into the material's behaviour. Furthermore, the dynamical properties, investigating phonon spectra and lattice dynamics to analyze vibrational modes and their impacts on material stability and functionality.Additionally, my investigation extends to the superconducting properties of $LaBa_2Cu_3O_7$, where i have analyzed the critical temperature and superconducting gap through first principles computation. The main objective of this research is to study externally applied pressure doping, phase transition behaviour and superconducting properties of $LaBa_2Cu_3O_7$ using *ab initio* approach. This material may appear to have the cubiccrystal form but it is often pseudo cubic and actually crystallize in the orthorhombic system. I have conducted calculations for the ground state energy in the framework of density functional theory (DFT) based on plane wave self-consistent field (PWscf) and ultrasoft pseudo potential (USPP) method as treated in the Perdew-Burke Ernzerhof (PBE) generalized gradient approximation and local density approximations as implemented in Quantum Espresso Code The results show that $LaBa_2Cu_3O_7$ is orthorhombic structure with lattice parameter calculated to be 3.925 Å and a band gap of 2.043eV which is in good agreement with other studies.. These results will guide in the pressure induced phase transition study.

Key words: perovskite, phase transition and orthorhombic.

Ab initio computational study of electronic structure and effect of applied pressure on superconducting properties of Nb_3Sn and $Ti;Nb_3Sn$.

A.N. Nyandika[1] , P.W.O. Nyawere[2] ,S.Kebenei

[1,2] Department of Physical and Biological Sciences
School of Science, Engineering and Technology,
Kabarak University – Private Bag - 20157

ABSTRACT

Superconducting magnets have been on demand due to their high magnetic fields and currents. In high field magnets, especially in Magnetic Resonance Imaging and International Thermonuclear Experimental Reactor and transmission cables, mechanical loading during cooldown due to thermal contractions of the material is very large. This can lead to poor performance of Niobium Tin since it is a major component of the magnetic coils whose superconducting performance is affected by pressure. Similarly, Niobium Tin made by the internal tin process during fabrication still lacks some significant potential in performance. To achieve this potential, the concept must be re-examined and optimized for future needs. The idea in this proposal originates from re-examining the concept of internal tin, recognizing what has been learned on its strengths and weaknesses and using that knowledge to propose a high performance conductor suitable for various strains and conditions and still maintaining its high current density. Niobium Tin will be doped with Titanium and the end product be subjected to pressure to study the much strain it can withstand. To introduce the concept, it requires an understanding of some of the fundamental aspects necessary to meet the goals of high performance. The study will report the electronic structure, elastic properties which give information on the material's stability, dynamic properties and pressure induced superconducting properties of Niobium Tin and Titanium doped Niobium Tin ($Ti;Nb_3Sn$). The study was done using computation method, using the Density Functional Theory Method, and applying the open source software

Quantum ESPRESSO. This report contains preliminary calculations regarding the electronic structure of the undoped Niobium Tin. The density of states was studied which showed the number of states at a particular energy level , the lattice parameter here was also calculated to be (alat) 9.9917 which compares closely with other studies. In addition to this, the band gap is also computed by plotting the electronic band structure showing that this material is metallic in nature. These results are in good agreement with other studies reported for this material.

Key words: Density of States, Band Structure

Synergistic Effect of Photocatalysis and Photo-Fenton for Cobalt Pigmented Anodized Tin Nanoparticulate Thin Films for Water Treatment

Sharon Chemutai, Sellah J. Kebenei & Christopher Maghanga

Kabarak University Physical & Biological sciences, Kabarak University

The global demand for effective water treatment technologies has prompted an exploration into innovative materials and processes. This research will investigate the synergistic effect of photocatalysis and the Photo-Fenton process for water treatment, utilizing cobalt pigmented anodized tin (IV) oxide Nano particulate thin films. The thin films will be synthesized through electrochemical anodization, serving as multifunctional platforms for water remediation applications. The study will begin by fabricating cobalt-doped SnO_2 Nano particulate thin films, employing an electrochemical anodization method. The films will then be subjected to individual and combined processes of photocatalysis and Photo-Fenton. The photocatalytic activity will be harnessed through the inherent properties of the anodized tin oxide matrix, while the introduction of cobalt pigmentation will enhance catalytic efficiency. Optical characterization will reveal the impact of cobalt concentrations on the thin films' optical properties, ensuring the films' suitability for light-driven processes. The synergistic effects of photocatalysis and Photo-Fenton processes will be evaluated for their efficacy in degrading contaminants, particularly focusing on the degradation of methylene blue as a model pollutant. The degradation rate and percentage of methyl blue will indicate that the combined processes exhibit enhanced catalytic activity compared to individual treatments. The thin films will demonstrate improved degradation efficiency for methylene blue under visible light, showcasing their potential as sustainable and efficient water treatment materials. The synergistic effects will further be analyzed through X-ray diffraction, UV-Visible spectroscopy, and catalytic activity measurements to provide comprehensive insights into the structural and optical changes induced by the processes.

Keywords: Pigmentation, Anodization, Photocatalysis, Tin (IV) Oxide, Photo-Fenton, Synergistic effect.

The Advancements and Applications of Solar Thermal Energy

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ABSTRACT

This paper delves into the comprehensive landscape of solar thermal energy technologies, examining their foundational principles, recent advancements, diverse applications, and future prospects. Solar thermal energy, distinct from photovoltaic systems, harnesses the sun's heat for various purposes ranging from residential water heating to large-scale power generation. The growing imperative to mitigate climate change and reduce dependence on fossil fuels underscores the critical role of solar thermal technologies in the global energy transition. The primary types of solar thermal systems—low-temperature, medium-temperature, and high-temperature—cater to different applications based on their operating temperatures. Technological advancements have significantly enhanced the efficiency and applicability of solar thermal systems. Innovations such as selective coatings have improved the efficiency of solar collectors by minimizing heat loss. Solar thermal energy offers a wide range of applications, providing significant economic and environmental benefits. In residential and commercial settings, solar water heaters reduce energy bills and carbon footprints by providing hot water and space heating. Industrial applications leverage solar thermal systems for process heat, offering a sustainable alternative to conventional heating methods in sectors such as food processing, textile manufacturing, and chemical production. On a utility scale, CSP plants generate large amounts of electricity and can be integrated into the power grid, providing base-load power and complementing other renewable energy sources like wind and photovoltaics. The economic benefits of solar thermal energy include cost savings from reduced reliance on fossil fuels and lower operational costs for heating and power generation. Environmentally, solar thermal systems produce no direct emissions, significantly reducing greenhouse gas emissions and air pollution. Additionally, utilizing locally available solar resources enhances energy security by decreasing dependence on imported fuels. Solar thermal energy is a versatile and sustainable technology poised to play a crucial role in the global transition towards sustainable energy. Its wide range of applications, coupled with technological advancements and increasing environmental awareness, drive its adoption across various sectors. By addressing the challenges and capitalizing on opportunities through policy support and innovation, solar thermal energy can significantly contribute to achieving global climate and energy goals. As the world progresses towards a more sustainable future, solar thermal energy will be an indispensable component in the global energy landscape.

Key words: solar thermal, fossil fuel, water heaters, solar collectors

Assessment of the amount of energy produced by selected brands of cells in Sigalagala National Polytechnic Laboratory

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ABSTRACT

Lithium-ion batteries (LIBs) have been proven as an enabling technology for consumerelectronics, electro mobility, and stationary storage systems, and the steadily increasing demand for LIBs raises new challenges regarding their sustainability. The rising demand forcomprehensive assessments of this technology's environmental impacts requires theidentificationofenergyandmaterialsconsumedforitsproduction,onlaboratorytoindustrialscale. There are no studies available that provide a detailed picture of laboratory scale cell production, andonly a few studies provide detailed analysis of the actual consumption, with large deviations. The research used data from primary and secondary sources. Thus, the amount energy produced was determined using three types of cells; Itel Li- ion, Infinix Li-ion and Tecno Li- ion cells. The analyzed energy requirements of individual production steps were determined bymeasurements conducted on a laboratory scale lithium-ion cell production and displayed in atransparentandtraceablemanner. Forthecomparisonwithliteraturevaluesadistinctionismade between thedifferent production scales. The people who are going to benefit from this paper was be Cell manufacturing companies, Mobile Phone Production companies and large institution that manufacture battery cell for use. The study establishes the cells that produced higher amount of energy ant the cells that are recommended to be used.

Key Words: Lithium-ion batteries, Industrialscale, Production, Phone Production, environmental impacts

Nanophotonic: Synthesis and Characterization of Plasmonic Nanomaterials

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ABSTRACT

Nanophotonics, an emerging domain that merges nanotechnology with photonics, holds significant promise for advancing light manipulation at the nanoscale. This research focuses on the synthesis and characterization of plasmonic nanomaterials, crucial for applications in sensing, imaging, and information processing. Plasmonic nanomaterials, particularly gold and silver nanoparticles, are notable for their localized surface plasmon resonances (LSPR), which impart unique optical properties. Various synthesis techniques, including chemical reduction, seed-mediated growth, and laser ablation,

are employed to produce nanoparticles with controlled size, shape, and composition. Advanced characterization methods such as transmission electron microscopy (TEM), scanning electron microscopy (SEM), and X-ray diffraction (XRD) are utilized to elucidate structural properties. Optical properties are examined through UV-Vis spectroscopy and surface-enhanced Raman scattering (SERS). The study reveals that synthesis parameters significantly influence LSPR characteristics, allowing for tunable optical responses. For instance, modifying the concentration of reducing agents during chemical reduction impacts nanoparticle size, while seed-mediated growth enables precise shape control. Laser ablation provides a method for synthesizing nanoparticles without chemical contaminants, crucial for certain applications. Our findings highlight the potential of plasmonic nanomaterials to enhance the sensitivity and specificity of photonic devices. This research contributes to a deeper understanding of the interplay between nanostructure design and optical functionality, driving innovations in nanophotonic applications. Future work will explore the integration of these materials into complex photonic systems, aiming to exploit their full potential in practical applications.

Keywords: nanophotonic, plasmonic nanomaterials, localized surface plasmon resonance, synthesis techniques, optical characterization.

A comparative study of the properties of sol-gel synthesized ZnO/GO and ZnO/g-C_3N_4 nanocomposites for photocatalytic degradation of environmental contaminants

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ABSTRACT

Photocorrosion, charge recombination, a wide band gap and particle aggregation limit ZnO applicability in photocatalysis. Carbon-based materials have proved effective in remarkably inhibiting ZnO drawbacks. This study evaluated the structural, optical, morphological and surface area properties of sol-gel synthesized ZnO/GO and ZnO/g-C_3N_4 nanocomposites. An improvement in the surface area, reduced agglomeration and recombination was observed in both nanocomposites. A reduction in band gap from 3.28 eV to 2.75 eV was observed in ZnO/g-C_3N_4 but an increase to 3.39 eV was noted in ZnO/GO. Although both nanocomposites exhibited good photocatalytic properties, ZnO/g-C_3N_4 possessed a greater potential for environmental remediation.

Emerging Trends and Innovations in Experimental Chemistry and Computational Modeling

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ABSTRACT

Recent advancements in experimental chemistry and computational modeling have ushered in a new era of innovation and efficiency in scientific research and education. The integration of sophisticated computational tools and simulation software facilitates the precise modeling of molecular structures and chemical reactions, enhancing our understanding and capabilities in material science. These trends not only advance our fundamental understanding of chemistry but also drive practical applications in areas like energy conversion, where they contribute to the development of more efficient and sustainable technologies. Despite the substantial progress, several challenges and gaps persist that hinder the full potential of these trends in both research and educational contexts. The study aims to systematically identify and categorize the current trends in experimental chemistry and modeling. In addition, the role of emerging technologies, like machine learning, artificial intelligence and virtual laboratories in transforming experimental chemistry and modeling will be assessed as well as investigating how advancements in modeling and experimental techniques are being incorporated into chemistry education and how they affect learning outcomes. Qualitative data will be collected from experts in the field through surveys and interviews. Specific case studies will be used to analyze successful integration of experimental chemistry and modeling techniques in research and education. Statistical tools will be used to analyze quantitative data from surveys as well as applying correlation and regression analysis to determine relationships between different variables. The results obtained from this study will help to establish the effectiveness of these trends in experimental chemistry and modeling in education and scientific research.

Energy Conversion Efficiency in photovoltaic System with Lithium-Iron-Phosphate Storage Based on the Western Kenya Climate

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ABSTRACT

The renewable energy sector has received significant attention because of the current climate change campaign that seeks to phase down fossil fuel use. Solar energy is among the most widely researched because of its vast availability in many regions across the globe. As one of the most abundant renewable sources, it has attracted much research to maximize the efficiency from design to use.Once a Photovoltaic

(PV) module exits the manufacturing line, its parameters, such as size and material composition, remain unchanged during its lifetime, leaving environmental, installation operation, and maintenance factors variable. After installation, only environmental factors, mainly irradiance, temperature, humidity, and wind speed, remain variable. They are also region-dependent. The intermittent nature of solar energy necessitates installing a storage device like a Lithium-ion battery to supply energy when the irradiance drops significantly. This fact also requires a mechanism that can tune the PV system to deliver the maximum power to the load at all times. This research examines the effect environmental factors, particularly irradiance, humidity, wind speed, and ambient temperature, have on the efficiency of a PV system with Lithium- Iron Phosphate storage using data of the four factors from Kisumu and Kakamega, representing the western Kenya climatic conditions modeled in Matrix Laboratory (MATLAB) and Simulink. Their measures from the field will help model irradiance and cell temperature data for determining the PV system's efficiency in MATLAB's Simulink.

Keywords: Irradiance, Cell temperature, Humidity, Wind speed, MATLAB, PV system, Efficiency

Investigation of the Influence of S/Se ratio and Post-Selenization temperature on the Structural and Optical Properties of Sputtered $(Cu, Ag)_2ZnSn(S, Se)_4$ Absorber Layer

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ABSTRACT

Kesterite based solar cells such as $Cu_2ZnSn(S,Se)_4$ have proven potential of being an alternative to the CIGS and CdTe based solar cells not only for use of earthly abundant and non-toxic materials but also due to their promising properties that are needed for the commercial solar cells efficiency. These properties include a tunable direct bandgap between 1 eV to 1.5 eV and a high absorption coefficient above 10^4 cm^{-1}. Despite its promises, the highest power conversion efficiency attained by kesterite-based solar cells up to date is 12.6 0.5% ($Cu_2ZnSn(S,Se)_4$), which is still far from a commercialization viable level. One of the factors that hinders the efficiencies of kesterite-based solar cells is the high open-circuit voltage (V_{oc}) deficit. The high V_{oc} deficit is attributed by a charge carrier recombination in the absorber due to the formation of a large number of Cu_{zn} antisite defects and detrimental secondary phases. These Cu_{zn} antisite defects are caused by the similarity in ionic size of Cu and Zn atoms (Cu, Zn ≈ 1.35Å). It is often hypothesized that the occurrence of these Cu_{zn}antisite defects reduces the V_{oc} of $Cu_2ZnSn(S,Se)_4$ devices. Moreover, it has been postulated that Cu_{zn}antisite defects contribute to the band tailing effect which produces bandgap fluctuations. These fluctuations produce not only electrostatic potential variation, but also local changes in the carrier density and effective bandgap. The replacement of cation with a much bigger size than Cu or Zn is expected to reduce the formation of Cu_{zn}antisite defect. Therefore, choosing an element to replace Cu or Zn inorder to decrease the band tailing in kesterite based solar cells is of great significance, these elements includes cadmium (Cd), silver (Ag) and barium (Ba). Since these elements have large radius than Cu and Zn its incorporation into a kesterite lattice is expected to reduce the formation of Cu_{zn}antisite defects which in turn could enhance open-circuit voltage. $Cu_2ZnSn(S,Se)_4$ and $(Cu,Ag)_2ZnSn(S,Se)_4$have been prepared and were

successfully synthesized by using Balzer BAE 250 coating system. Whereby the sputtering system was evacuated to a base pressure of 10^{-6} mbar, working pressure was 5.8mbar, deposition time 5 minutes and sputtering power 100 W additionally, after deposition of ZnO-Sn-Cu precursor were annealed using RTP Furnace whereby amount of sulfur was fixed at 250 mg while selenium amount were varied from 250 mg to 62.5 mg, these evaporates were mixed at once while annealing temperature was 540 . For the case of the influence of post-selenization temperature ZnO-Sn- Cu-Ag precursor was deposited on an ITO glass, whereby the system was evacuated to a base pressure 10^{-6} mbar, working pressure was 5.8mbar, deposition time 5 minutes and sputtering power 110 W while during annealing amount of sulfur and selenium was fixed 250 mg and 50 mg respectively, sulfurization temperature was 540^0C and selenization temperature were varied from 350^0C to 550^0C. The synthesized thin film will be characterized by means of atomic force microscope (AFM) and Scanning Electron Microscope for morphology, size of grains. UV –Visible spectrophotometer for optical properties, IQ tanker surface profiler for film thickness.

Key words: Selenization, absorber layer, post annealing

Experimental Study and Optimization Analysis of MAPI-Based Perovskites for Solar Cell Absorber Applications

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ABSTRACT

This research work aims to conduct an in-depth experimental study on the synthesis, characterization and optimization of MAPI (Methyl Ammonium Lead Iodide) -based perovskites for solar cell absorber applications. Obtained data will be mapped onto Python programming tool for visualization and analysis. The research focuses on enhancing power conversion efficiency and stability through innovative processing techniques. The study includes the synthesis of MAPI-based perovskites using various methods and detailed characterization utilizing advanced analytical tools, leveraging various Python modules for analysis. The key properties of MAPI perovskite materials, specifically their optical, electrical and structural characteristics will be investigated and the results expected to reveal significant improvements in solar cell efficiency with the optimized perovskite materials. Additionally, characterization techniques such as JV scanning will be employed using the Keithley Instruments (Model 2400) to further evaluate the photovoltaic performance of the resulting fabricated organic/inorganic halide perovskite-based solar cells. This research showcases the potential of Python-based data analysis in advancing perovskite materials for solar cell applications, contributing to the development of renewable energy technologies.

Key Words: MAPI-based Perovskites, Solar Cell Absorber, Optimization Analysis, Python Programming, Characterization Techniques, IV Scanning, Renewable Energy.

PC Computation of Electronic structure, Dynamical and Superconducting properties of Perovskite $LaBa_2Cu_3O_7$; First Principles Approach

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ABSTRACT

Perovskite materials have attracted research because of their ability to transition from normal metals to superconductors. They are attractive for a wide range of applications due to their unique characteristics and properties such as light-emitting diodes, power transition cables, photovoltaic'sand pressure induced emission. Electronic structure and mechanical properties are key in understanding behaviour of materials in relation to mechanical stability for superconductivity. My investigation explores the electronic structure in depth, uncovering essential aspects like bandgaps, Fermi surfaces, and density of states, offering valuable insights into the material's behaviour. Furthermore, the dynamical properties, investigating phonon spectra and lattice dynamics to analyze vibrational modes and their impacts on material stability and functionality.Additionally, my investigation extends to the superconducting properties of $LaBa_2Cu_3O_7$, where i have analyzed the critical temperature and superconducting gap through first principles computation. The main objective of this research is to study externally applied pressure doping, phase transition behaviour and superconducting properties of $LaBa_2Cu_3O_7$ using *ab initio* approach. This material may appear to have the cubiccrystal form but it is often pseudo cubic and actually crystallize in the orthorhombic system. I have conducted calculations for the ground state energy in the framework of density functional theory (DFT) based on plane wave self-consistent field (PWscf) and ultrasoft pseudo potential (USPP) method as treated in the Perdew-Burke Ernzerhof (PBE) generalized gradient approximation and local density approximations as implemented in Quantum Espresso Code The results show that $LaBa_2Cu_3O_7$ is orthorhombic structure with lattice parameter calculated to be 3.925 Å and a band gap of 2.043eV which is in good agreement with other studies.. These results will guide in the pressure induced phase transition study.

Key words: perovskite, phase transition and orthorhombic

Development of A Highly Efficient And Stable $CH_3NH_3PbI_3$ Perovskite Solar Cells Induced Dye Solvent Engineering Methods

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ABSTRACT

Hybrid organic-inorganic perovskite solar cells have emerged as a prospective class of semi-conductors that have attracted substantial interest due to their high efficiency, low fabrication cost and feasibility. Their power conversion efficiency has exceeded 25% in the year 2020 and now approaching their silicon based counterparts. However, the intrinsic stability of the lead halide perovskites under ambient environment hinders their practical implementation and commercialization. High quality crystalline thin films determine the stability and electronic properties of the cell. For instance, most perovskites are affected by moisture due to their hydrophilic nature. Moisture degrades their structures into their constituent compounds leading to trap states. Here we device a suitable approach for development of a highly crystalline and stable $CH_3NH_3PbI_3$ perovskite by solvent engineering and use of suitable hole selective conducts (HTM). A mixture of dimethylformamide (DMF) and Dimethylsulfoxide (DMSO) were used in a volume ratio of 7:3. To improve the cells PCE, various anti-solvents were used. The band gap (E_g), exponential tail (E_t) and density of states (DOS) determines the efficiency of the cell since they give information on photo-generation and Fermi-level splitting in semiconductors. The band gap (E_g) exponential tail (E_t) and density of states of $CH_3NH_3PbI_3$depends on the preparation conditions and degradation process of the films. Therefore, we studied the (E_g), (E_t) and (DOS) of $CH_3NH_3PbI_3$ perovskite both experimentally band computationally. Experimentally was done with respect to hole selective conducts, annealing time and degradation of the perovskites in ambient air. Several characterization techniques were employed to determine the suitable film composition. It was found out that (E_g), (E_t) and (DOS) were influenced by the substrate and degredation in air. Computational methods were done based on density functional theory (DFT) and a band gap of 1.57 Ev was obtained with E_t of 26 meV. Highly crystalline films with improved morphological qualities were witnessed in films obtained by using mixed solvents of DMF and DMSO in a volume ratio of 7:3, with chlorobenzene as anti solvent and 60 minutes annealing time with $CH_3NH_3PbI_3$ film deposited on PEDOTs:PSS hole selective conduct.

Key words: Perovskite, band gap, solvent engineering, crystalinity, film

Water Quality Parameters from the Five Boreholes at Kampi Ya Moto and Rafiki in Rongai Constituency, Nakuru County

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ABSTRACT

Water occupies 70% of the earth's crust and is used daily to run human activities, therefore it has to be clean and safe. Water that is not fit for use is termed as polluted water and some causes of pollution include manmade activities and natural causes. For good health, people are recommended to take quality water that has been tested for its quality by specific health organizations. This study targeted Kampiya Moto and Rafiki locations which are tree kilometers apart and near Kabarak University within east of Rongai constituency, Nakuru County. There are two boreholes in Rafiki(B004 and B005) and three in Kampiya Moto(B001,B002 AND BOO3) and the aim was to test for their quality. Water samples were collected from the specific boreholes using 0.5L storing bottles that were filled with water samples from each borehole. The parameters that were analyzed include acidity and alkalinity (PH), total dissolved solids, electrical conductivity, dissolved oxygen, hardness, temperature, nitrates and phosphates. The instruments used include thermometer for measuring temperature, JENWAY 370 PH meter for PH, P.R.O.C S/N 10343197 conductivity meter for electrical conductivity, JENWAY 9500 dissolved oxygen meter for dissolved oxygen, UV-VIS Make-Lasany, Model: Li-2904,190-1100nm spectrophotometer for analysis of nitrates and phosphates and finally titration method to determine concentration of calcium carbonates as hardness of water. The data obtained were tabulated and compared to WHO standards for water quality as shown below.

PARAMETER	B001	BOO2	BOO3	BOO4	BOO5	WHO
PH	7.78	7.74	7.79	8.33	8.33	6.5-8.5
DO(mg/L)	5.88	5.52	5.57	6.59	6.61	4.0-6.0
TDS(ppm)	126	146	155	490	456	500
Conductivity(µs)	174.6	260	294	947	900	2500
Hardness(mg/L)	56	56	56	52	60	10-500
Temperature(°c)	22.3	24.3	23.2	23.3	22.7	25
Phosphates(mg/L	0.333	0.319	0.343	0.3178	0.328	0.05
Nitrates(mg/L)	-0.34	-0.45	-0.469	-0.52	-0.52	10

This study showed that Rafiki boreholes were polluted since dissolved oxygen levels exceeded by 0.5 while Kampiya Moto boreholes had quality water for consumption.

Emerging Trends and Innovations in Experimental Chemistry and Computational Modeling

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ABSTRACT

Recent advancements in experimental chemistry and computational modeling have ushered in a new era of innovation and efficiency in scientific research and education. The integration of sophisticated computational tools and simulation software facilitates the precise modeling of molecular structures and chemical reactions, enhancing our understanding and capabilities in material science. These trends not only advance our fundamental understanding of chemistry but also drive practical applications in areas like energy conversion, where they contribute to the development of more efficient and sustainable technologies. Despite the substantial progress, several challenges and gaps persist that hinder the full potential of these trends in both research and educational contexts. The study aims to systematically identify and categorize the current trends in experimental chemistry and modeling. In addition, the role of emerging technologies, like machine learning, artificial intelligence and virtual laboratories in transforming experimental chemistry and modeling will be assessed as well as investigating how advancements in modeling and experimental techniques are being incorporated into chemistry education and how they affect learning outcomes. Qualitative data will be collected from experts in the field through surveys and interviews. Specific case studies will be used to analyze successful integration of experimental chemistry and modeling techniques in research and education. Statistical tools will be used to analyze quantitative data from surveys as well as applying correlation and regression analysis to determine relationships between different variables. The results obtained from this study will help to establish the effectiveness of these trends in experimental chemistry and modeling in education and scientific research.

Piezo - Photocatalytic Performance of Fe- Doped $BaTiO_3$ Compounds

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ABSTRACT

Barium titanate ($BaTiO_3$) is a feasible photocatalytic semiconductor. This has been demonstrated in both experimental and computational studies on the material. To enhance its photocatalytic performance under visible light, this study investigated the effect of introducing iron (Fe) dopant into its structure. The undoped and Fe-doped $BaTiO_3$ films were synthesized and deposited on glass substrate using the spin coating technique and its photocatalytic activity was evaluated through photodegradation of methyl blue aqueous solution. The bandgap of the synthesized $BaTiO_3$ reduced from 3.26 eV to 1.59 eV for the undoped and the 0.5%wt Fe doped samples, respectively. Further analysis revealed that 0.5%wt Fe had the best photocatalytic performance with a photo-degradation constant of . The effect of Fe doping on the structural and electronic properties of $BaTiO_3$ was further investigated by employing the Density Functional Theory. The electronic structures showed that Fe creates some defect states in the energy band, which forms weak coordinate covalent bond that greatly reduces the bandgaps of the doped materials. These results demonstrate the potential of employing Fe-doped $BaTiO_3$ as a visible light photocatalytic material.

Bulk Properties of Al–Mg–Si Alloys (6xxx Series)

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ABSTRACT

Aluminum and its alloys have a wide range of applications such as in plane skin, cooking wares, cladding in buildings, train coaches, and electric cables. This is due to the advantages that they have, which include low density (physical density of 2.7g/cm^3, which is approximately a third that of steel), non-corrosivity, formability, good thermal and electrical conductivity, and availability. Moreover, its

non-corrosivity diminishes with alloying. Several studies, mostly experimental, have been done on aluminum-magnesium-silicon (Al-Mg-Si) alloys (6xxx series). Mechanical properties, especially strength and ductility, have been explored in those studies. However, other mechanical properties such as bulk modulus, shear modulus, Young's modulus, Poisson's ratio, Pugh's ratio, creep, and resilience have not been explored extensively. While this study touched on ductility and hardness, it also explored the bulk modulus, shear modulus, Young's modulus, Poisson's ratio, Pugh's ratio, and yield strength of Al-Mg-Si alloys. The main objective of this study was to determine the alloy composition that could yield stronger, harder and more ductile materials that are appropriate for both aerospace and automotive industries by making use of density functional theory (DFT) calculations. The specific objectives of the study were: (i) to model, using Burai software, the structures of aluminium-magnesium-silicon alloys at different concentrations of aluminium, magnesium and silicon, (ii) to determine the mechanical properties of the modelled aluminium-magnesium-silicon alloys using DFT, and (iii) to investigate the effect of silicon/ magnesium ratio on the mechanical properties of aluminium-magnesium-silicon alloys. The modelling of the structures was done using Al cell as the starting structure, whose crystallographic information file was downloaded from Materials Project website. It was then transferred to Burai software, where the unit cell was visualized and then transformed into $3 \times 3 \times 3$ supercells containing 108 atoms, after which the supercells were alloyed with the appropriate number of Mg and Si atoms. Nine structures of Al-Mg-Si alloys with different percentages of Al, Mg and Si were investigated. Structural optimization of the alloyed supercells was done as a preliminary to the study. The variable-cell relaxation was done using the Brodyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm. The stress-strain method was employed in the calculation of elastic stiffness constants, from which mechanical properties were obtained. Calculation of the elastic constants was done within DFT with *Perdew-Burke-Ernzernhof functional for SOLids*(PBESOL)functionalsas implemented in the *Quantum Espresso* code. This study has successfully established that Si/Mg ratio is a critical factor when dealing with the mechanical properties of Al-Mg-Si alloys. The optimum properties obtained in this study were: density of 2762 kg/m^3, bulk modulus of 83.3 GPa, Shear modulus of 34.4 GPa, Vickers hardness of 2.79 GPa, Poisson's ratio of 0.413, Pugh's ratio of 5.42, and yield strength of 8.38 GPa. The alloys at these optimum properties can be used for industrial applications where the properties are required such as in plane skins and mining equipment for the alloys with optimum hardness and yield strength. Their high ductility allows them to be used in making motor vehicle parts as well as train coaches. The low density of the alloys makes them suitable for use in making aircraft parts as they increase the load carried by reducing the weight of its parts.

ab Initio Investigation of Electronic And Optical Properties In Sb/Bi codoped Methylammonium Lead Bromide

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ABSTRACT

Three-dimensional (3D) perovskite materials have demonstrated incredible performance in the photovoltaic applications with device power conversion efficiencies rapidly progressing from 3% to 25.5% in recent years. Despite their outstanding photoelectric performance, the inherent instability toward external stresses such as humidity, heat, and light remain a major hurdle for their

longevity and hence commercialization. My research aimed to fabricate a two-dimensional (2D) perovskite layer (Dion Jacobson (DJ) type) with ethylenediammoniumdiiodide ($C_2H_8N_2$*2HI, $EDAI_2$) mixed in with *n*-butylammonium iodide ($C_{16}H_{36}IN$, BA) cation spacers (ligands) in varied rations {(1.5mg $EDAI_2$+0.5mgBA), (1mg$EDAI_2$+1mgBA) and (0.5$EDAI_2$+1.5mgBA) in 1mL Isopropanol (IPA)} to functionalize the 2D perovskite layer deposited on top of the 3D perovskite layer. The 3D perovskite materials were fabricated in two approaches, solution processing (Spin coating) and Thermal Vacuum Vapor deposition at the National Thin Film Cluster Facilities. BA helps in the formation of the 2D structure while EDAI2 retards perovskite growth leading to preferential growth orientation for enhanced charge transport coupled with postulated high dipole moment.

Fabrication and Characterization of 2D/3D perovskite films for solar cell applications

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ABSTRACT

The 2D/3D perovskite films were characterized with promising results by Photoluminescence PL, Transient photoluminescence TRPL, Ultraviolet-Visible absorption spectroscopy and X-Ray diffraction XRD. The 2D on solution processed 3D exhibit higher intensities in PL and TRPL. '0.5$EDAI_2$+1.5mgBA' ratio variant shows enhanced performance in Photoluminescence spectra. Blue shifted PL spectra evidencing influence of the binary organic cation spacers on electronic structure of the 2D-3D perovskite. There is enhanced charger carrier lifetime in '1.5mg $EDAI_2$+0.5mgBA' 2D cation ratio on solution processed 3D perovskite, but low on vapor deposited 3D perovskite. 0.5$EDAI_2$+1.5mgBA 'binary ratio samples showed consistent high TRPL on both solution and vapour deposited 3D perovskite films. '1mg$EDAI_2$+1mgBA' ratio variant shows strong optical activity with via UV-Vis spectra, evidencing the influence of the long chain organic cations. Reduced surface energies and improved crystallinity is evidenced by enhanced peak intensities of the XRD spectra with addition of the 2D spacer cations.

To increase perovskite solar cell performance with enhanced stability, we must suppress surface and bulk defects. Well optimized binary cation spacers offer a viable alternative.

Effectiveness of Mini-Grids Powered by Solar In Enhancing Economic and Community Livelihood in Turkana Central

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ABSTRACT

The effectiveness of mini-grids in Turkana Central is a critical issue that needs to be addressed. Turkana Central is a remote and underdeveloped area in Kenya, where the majority of the population lives in poverty and lacks access to basic amenities such as electricity. The government and other stakeholders have initiated mini-grid projects in Turkana Central to provide clean and reliable electricity to the residents. Furthermore, there is a need to determine the barriers that hinder the successful implementation of mini-grid projects in Turkana Central. These barriers could include the lack of funding, inadequate infrastructure, and inadequate technical expertise. The purpose of this study was be to establish the effectiveness of mini-grids powered by solar in enhancing economic and community livelihood in Turkana Central. Study objectives were to: evaluate community livelihood improvement as a result of establishment of mini-grid system powered by solar in Turkana Central; assess the contributions of mini-grids in economic development in Turkana Central; and identify the gaps in utilization of the mini-grids powered by solar energy by the communities in Turkana Central. The study was anchored on dependency theory. Descriptive research design was applied. The sample size was derived using Morgan and Kregcie table. With a target population of 245, the sample size realized was 150. Both purposive and simple random sampling was used. Data was collected using questionnaires and interview guide. The findings showed that mini-grids systems powered by the solar have improved lighting in the area as shown in table 4.2 with a mean of 4.8588. In addition, the findings revealed that solar powered mini-grids had improved the means of communication of the villagers as evidenced by a mean of 4.2763 and at the same time it has aided fishing production in the area as supported by the mean of 3.9940.Results showed that solar powered mini-grids have contributed towards SME business expansion as supported in table 4.3 by a mean of 4.4403. With a mean of 4.6763, the research findings indicated that solar powered mini-grids have improved access to health services in the area while a few respondents moderately agreed as supported by a mean of 3.0456 that mini-grid solar powered systems have led to the creation of jobs for the youth and women. Majority of the respondents were of the view that there are rampant illegal connection as evidenced by a mean of 2.9900. Majority of the respondents further agreed to a greater extent that there is variance in pricing of the solar energy cost as supported by a mean of 4.8420 while on the contrary, most of the respondents were of the view that there isn't prudent repair of the mini-grid as supported by a mean of 2.1042.Conclusion has been made on community livelihood improvements as a result of establishment of mini-grids systems powered by solar. The study concluded that community livelihood have improved as a result of establishment of mini-grid system powered by solar. The research also concluded that mini-grids system powered by solar have contributed to economic development of the area. Finally, the study concluded that there are several gaps that accrue in the utilization of the mini-grids powered by solar energy on the communities in Turkana Central.

Key words: low income areas, solar power, Education sector, community utilization

A Baseline Assessment of Pollinator Communities in Peri-Urban Environments of Nakuru City for Sustainable Urban Agriculture

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ABSTRACT

Maintaining food security for a growing global population, particularly in urbanizing areas, presents a substantial challenge. Urban agriculture offers a potential solution, but the ecological role of pollinators within these environments remains poorly understood. This study investigated pollinator communities in the peri-urban zone surrounding Nakuru City, Kenya. Insect pollinators were surveyed using sweep nets to collect flower-visiting insects from August to September 2023. The collected insects were subsequently identified and analyzed for diversity. A total of 403 insect pollinators were collected, representing four insect orders: Hymenoptera (71%), Lepidoptera (15%), Diptera (13%), and Coleoptera (1%). Thirteen distinct insect taxa were identified, with the honeybee (*Apismellifera*) composing the majority (60.3% of all insects). The Shannon diversity index (H') indicated moderate diversity (1.5), while the Simpson's Evenness Index (E) revealed a relatively balanced distribution of species (10.8). Common tree species frequently visited by pollinators included *Coleus amboinicus, Vernoniaesculenta, Malentherascandens, and Vernonialasiopus*. These findings highlight the diversity and abundance of pollinators in peri-urban areas of Nakuru city and underscore the potential for urban areas to support productive agriculture through effective pollination services. Further research is needed to better understand urban pollinator dynamics and develop strategies to support pollinator health in urban agricultural systems.

Keywords: Biodiversity conservation, Nakuru County, Peri-Urban agriculture, Pollinator communities.

Determining the Impacts of Stone Quarry Works on Riparian Vegetation Of River Molo in Rongai Sub-County, Nakuru County, Kenya

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ABSTRACT

The contribution made by stone quarrying to the Gross Domestic Product (GDP) in many countries globally is enormous. Whether small or large-scale, stone quarrying is inherently disruptive and can cause detrimental effects on riparian vegetation which is considered the most vulnerable and fragile ecosystem. This research aimed to determine the impacts of stone quarry works on the riparian vegetation of river Molo in Rongai Sub-County, Nakuru County. The specific objectives were to assessing the status of riparian vegetation between 2000- 2023 along river Molo and determine

the effects of stone quarry works on riparian vegetation of R. Molo. A descriptive survey design was adopted to assess the impacts of stone quarry works on riparian vegetation. A total of 35,545 households in Visoi, Soin and Mosop ward were targeted where 404 household heads were randomly sampled. Additionally, 15 key informants were purposively selected for interviews including, chiefs, NEMA official, Rongai sub-county public health officer and environment officer. Both random sampling and purposive sampling were used in administering questionnaires, key informant interviews and selection of 5 quarry sites. Desk reviews, field observations, oblique photography, questionnaire survey, interviews, GIS and remote sensing were employed to obtain adequate data for analysis. GIS and remote sensing were utilized to acquire and analyze spatial data by incorporating time series analysis of the Normalized Difference Vegetation Index (NDVI). Additionally, Ms. Excel and Statistical Package for the Social Sciences (SPPS -version 25) was employed to analyze descriptive data using cross-tabulation, chi-square and descriptive statistics. ArcMap GIS software and satellite imagery analysis using google earth pro was used to identify specific location of the five sampled quarries. The NDVI analysis indicated a decline in vegetation index along riparian areas of river Molo which can be largely attributed to land use changes particularly agriculture and quarrying activities in the area. It was also revealed that all five sampled quarries were very close to the riparian areas of river Molo, with nearest being 49.48m away. This proximity directly contributed to trees being felled down, reduced natural regeneration, altered photosynthesis due to dust emissions, soil erosion and heaping of quarry overburden on already existing trees leading to reduced vegetation richness and abundance. By and large, this research suggests rehabilitation and reclamation of quarry site after extraction, public education and sensitization, proper disposal of quarry overburden, planting of trees and grasses and enactment of quarrying laws and policies at the county level to curb the decreased vegetation index along riparian areas of river Molo as a result of quarrying operations.

Assessment of The Socio-Economic Factors Influencing Uptake of Biogas Technology Among Rural Households in Kuresoi South Sub-County, Nakuru County

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ABSTRACT

Biogas technology is considered as a sustainable and renewable energy source that can reduce greenhouse gas emissions and improve energy security, create jobs in rural areas and improve environmental sanitation. The purpose of this study was to assess the socio-economic factors affecting uptake of biogas technology among rural households in Kuresoi South Sub-county. This research used a descriptive study design and systematic sampling design. The study also employed primary and secondary data where primary data was collected using a questionnaire survey, focus group discussions, key informant interviews and observations. The sample size was made up of 155 respondents. Two Key informants were selected using purposive sampling. The data collected was analyzed using descriptive statistics, cross-tabulation and linear multiple regression presented using frequency tables and detail analysis was done using statistical package for social science (SPSS version

26).100% response was rate was realized with demographic analysis revealing a predominantly older population with substantial agricultural engagement. The research identified fixed dome and tubular bio digesters as the primary types adopted, observing their respective benefits in resilience, affordability and environmental sustainability. Findings highlight significant reliance on firewood despite high awareness of biogas technology. Economic challenges mostly income levels had a significance (p-value) of 0.048 indicating a statistically significant association at the 5% significance level impeding widespread adoption despite favorable perceptions of long-term benefits. Gender analysis indicated minimal influence on energy choices underscoring broader socio-economic determinants. Effective dissemination through radio highlights its vital role in rural outreach, necessitating enhanced educational efforts to bridge knowledge gaps and promote sustainable energy transitions.

Key words: Biogas Technology, greenhouse gas, Energy Security, Adoption, Socio-economic factors

Assessing Climate Change Risks in Uasin Gishu County, Kenya

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ABSTRACT

The impacts of climate change have been and continue to be experienced in Kenya. The country has been ravaged by extreme climatic events such as droughts, extreme temperatures and floods that have damaged both property and livelihoods. Thus, climate change presents a threat to the achievement of Kenya's national goals, aspirations, and development priorities. In respect to climate change, this study will focus to identify the climate change risks, hazards and vulnerabilities, establish the probability and impact of climatic hazards currently and the future in the County, identify the vulnerable sectors to climate change in the County and identify their respective adaptive capacities, develop a climate change vulnerability and risk map of the County and develop a list of indicators for the vulnerability to climate change in the County. This is in line with international and national policies on climate change action that recognizes the role of climate change risk and vulnerability assessments in enhancing a targeted approach to tackling climate change. The study will adopt a mixed-methods approach, combining both qualitative and quantitative data collection and analysis techniques. This will ensure a comprehensive understanding of the climate change risks, hazards, and vulnerabilities in the county. The target population for the study will include the county's residents, local government officials, community leaders, and representatives from key economic sectors, such as agriculture, livestock, water, and environment. A stratified random sampling technique will be used to ensure a representative sample of the target population. The county will be divided into different strata based on geographical and socio-economic factors, and a random sample of participants will be selected from each stratum. The study will use questionnaires, interviews, focus group discussions, and document reviews to collect data. Quantitative data obtained from the respondents will be cleaned, coded, and analyzed using SPSS and Microsoft Excel. This will enable the researcher to make meaningful interpretation. The study will be analyzed using descriptive statistics such as frequencies, percentages, mean and standard deviation. The analyzed data will be presented in forms frequency tables, charts and graphs. The qualitative data collected through the interviews, focus group discussions, and document reviews will be analyzed thematically, using coding and categorization techniques.This will assist to ensure integration of climate change risk and vulnerability assessment in environmental impact assessments and strategic environmental assessments to enhance climate resilience and adaptive capacity.

Assessment of the Impacts of Sisal Processing Industries on Water Resource in Rongai Sub-County, Kenya

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ABSTRACT

Sisal farming is one of the major large scale cash crops farming in Rongai Sub County with over 1000 hectares of land used for sisal farming. Residents of Rongai Sub County depend on the resultant sisal processing industries for income and raw materials. Various waste disposal strategies have been adopted by the sisal industries to mitigate environmental effects of processed wastes. Sisal processing industries are heavy consumers of water, as a result most sisal industries are located in close proximity to natural streams and rivers. The association between the large amounts of wastewater produced and the close proximity of the sisal industries to rivers forms the basis for the research problem. There have been concerns that waste water from the sisal industries directly or indirectly pollutes the rivers, however this has yet to be scientifically proven. This study seeks to assess the effects of sisal processing industries on the water quality in Rongai Sub County, Kenya.

The study will adopt a descriptive research design with data being analyzed using descriptive statistics. Data will be collected through surveys, key informant interviews and water analysis. Three key sisal processing industries, two major rivers and the surrounding communities will provide data for this research. The findings of this study will provide information to researchers and sisal farmers in Kenya on the best practices to be used to negate the negative impacts of sisal industries, provide information on impact of sisal waste on water resources and provide environmentalists with information on environmental impacts of large scale sisal industries.

Keywords: sisal industries, water quality, waste disposal, rivers

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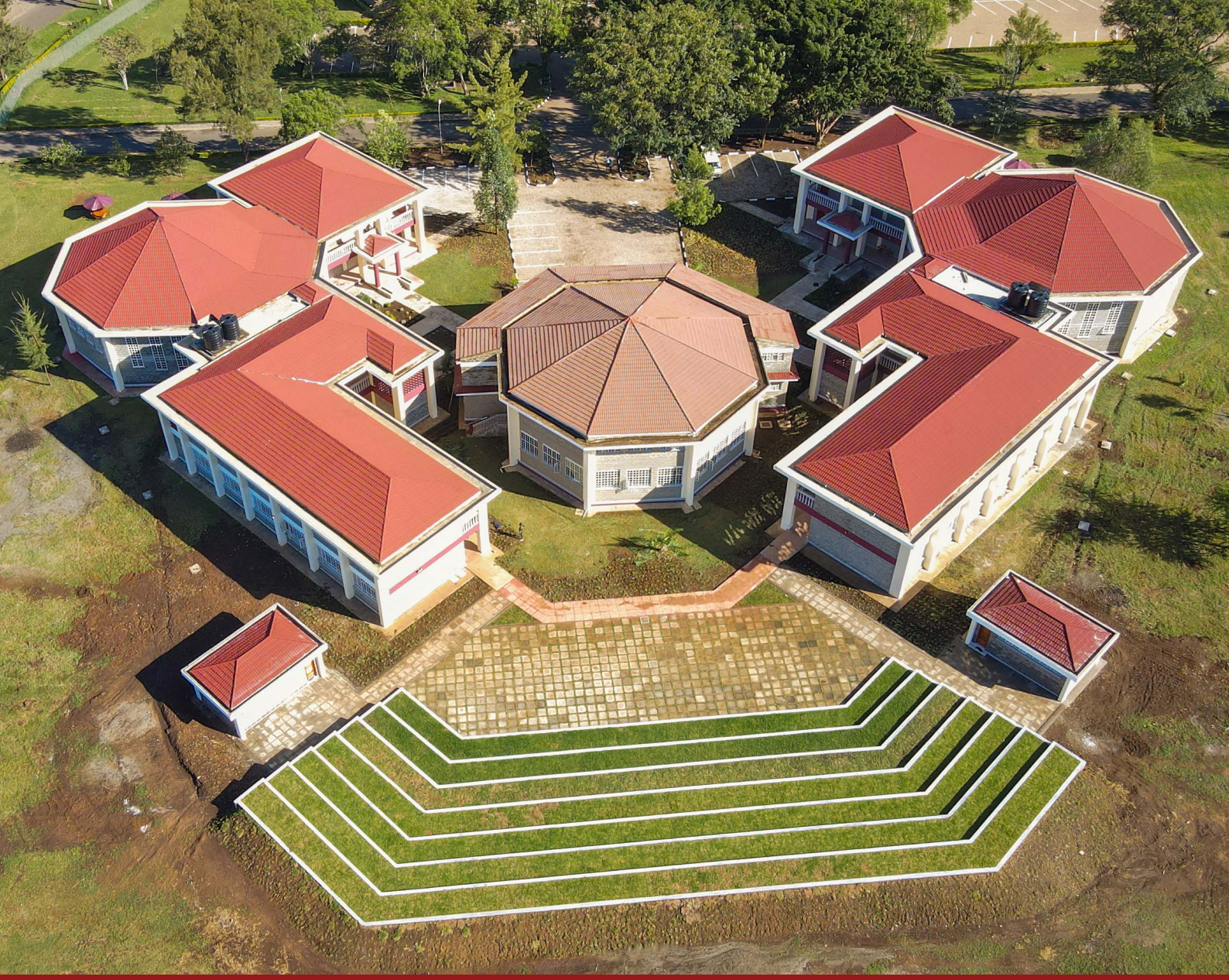

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Moral Code

As members of Kabarak University family, we purpose at all times and in all places, to set apart in one's heart, Jesus Christ as Lord. (1 Peter 3:15)