أكاديمية كاوست
KAUST ACADEMY

جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

KAUST ACADEMY 2025 SPECIALIZATION

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KAUST ACADEMY 2025 SPECIALIZATIONS IN NUMBERS

297

Talented university students from **16** nationalities in **16** different training locations.

45%

total **female** student percentage

134

different projects students worked on.

71
Artificial Intelligence

25
Bioinformatics

15
Cybersecurity

23
Energy Transition

94 DIFFERENT **PROJECT MENTORS**

55 DIFFERENT **LOCAL AND INTERNATIONAL UNIVERSITIES** STUDENTS

ABOUT US

The KAUST Academy specializations program represents a strategic response to Saudi Arabia's Vision **2030** objectives, specifically addressing the critical need to develop local talent in emerging technologies that will drive the Kingdom's economic diversification. By offering comprehensive training in artificial intelligence, bioinformatics, cybersecurity, and energy transition, the program directly targets the four key pillars of Vision 2030's research and development priorities: sustainable environment and essential needs, energy and industrial leadership, health and wellness, and economies of the future. This initiative recognizes that Saudi Arabia's transformation from an oil-dependent economy to a knowledge-based one requires a skilled workforce capable of competing in high-tech industries and research sectors.

The program's multi-stage structure creates a natural bridge between undergraduate education in Saudi universities and advanced professional competency in cutting-edge fields. Rather than leaving recent graduates to navigate this transition independently, KAUST Academy provides a systematic pathway that begins with foundational online coursework through Coursera, progresses through intensive in-person training at universities across the Kingdom, and culminates in international summer programs at prestigious institutions like Oxford, Cambridge, Duke, and University of Toronto. This scaffolded approach ensures that students from diverse academic backgrounds can build upon their undergraduate foundation while gaining practical, industry-relevant skills, with the program having successfully trained over 16,000 students across multiple specializations.







This booklet serves as a comprehensive showcase of the remarkable achievements and outcomes that KAUST Academy's 297 graduating students in 2025 have accomplished through their international summer programs at world-renowned universities. These graduates represent more than mere statistics—they demonstrate the tangible impact of Saudi students engaging with cutting-edge research and advanced methodologies at institutions across the globe. Their success validates the program's effectiveness in not only bridging the gap between traditional university education and specialized knowledge required for Saudi Arabia's emerging technology sectors, but also in positioning Saudi graduates as competitive contributors to international research and innovation networks.

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Site

women & energy

رزم للاستثمار
RZM INVESTMENT

TEAM MEMBERS

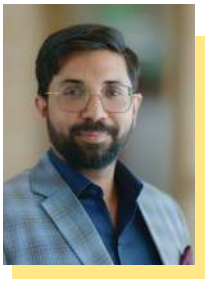


Sultan Albarakati

King Abdullah University of Science and Technology

Doctor of Philosophy in Electrical Engineering

Associate Vice President, Saudi Talent Development

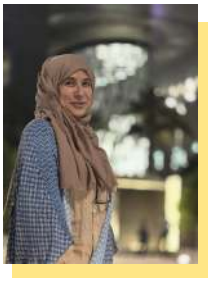


Naeemullah Khan

King Abdullah University of Science and Technology

Doctor of Philosophy in Electrical Engineering

Instruct. Assoc. Professor, Deputy Director KAUST Academy



Oroba Al Nasr

Al Dammam University

Human Research

Promotions & Outreach Specialist

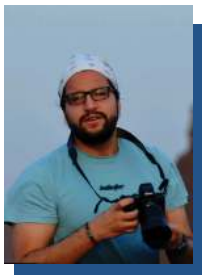


Abdulrahim Alghamdi

Curtin University

Human Research

Master of Commerce, Logistics, Materials, and Supply Chain Management



Abdulaziz Altelmissani

King Abdulaziz University

Medical Laboratory Sciences

Program Coordinator



Ahmed Alhawsawi

Western Kentucky University

Communication Studies and Business Administration

Program Coordinator



Ali Habibullah

King Abdulaziz University

Computer Science

Research Engineer

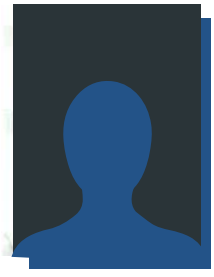


Asim Abdulfattah

Florida Institute

Aeronautical Science, Flight

Program Administrator Pre-University programs



Doa'a Aburayya

King Abdulaziz University

Computer Science

Research Enginner - AI



Emad Surour

Taibah University

Computer Science information systems

Academy Programs Administrator



Farhanaz Beg

National University of Singapore

Computer Science and Engineering

Admissions Lead



Fatma Karabulut Ilter

Istanbul Kültür University

MBA

Program Administrator



Mahmoud Ellouh

King Fahd University of Petroleum and Minerals - KFUPM

Computer Engineering & Cybersecurity

Research Enginner - Cybersecurity

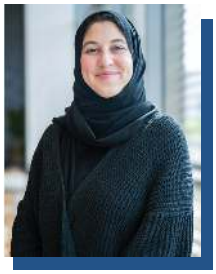


Majed Alghamdi

Beirut Arab University

English Literature

Digital Channels Specialist



Mariam Yaghmour

UC San Diego/KAUST

Chemistry/Molecular Synthesis

Program Administrator, Pre-University programs



Mohamed Nazar O. AlAli

Saudi Electronic University

Business and Finance MSc.

Academy Programs Manager



Saad Alhusainan

Sultan Qaboos University, Sultanate of Oman

Mass and Communication

Development Programs Specialist



Salman Alomari

University of Indianapolis

MBA

Program Coordinator



Tarek Shehata

Tanta University

Mathematics

Manager, Pre-University Programs

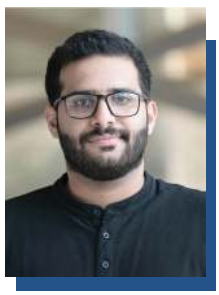


Venu Kas

North Dakota State University

Doctor of Philosophy in Biochemistry

Academic Development Specialist



Yazan Alshuaibi

King Abdulaziz University

Computer Science

Research Enginner - AI



Yubin Huang

Tianjin University

Material Physics and Chemistry

Program Administrator



Energy Transition Specialization

2025


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Maram Abdullah Alghamdi

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Energy Transation Summer Internship, Imperial, London, England



Aml Hussain Abdullah Al Nasir

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SHAHAD AL GAMDI

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Energy Transation Summer Internship, Imperial, London, England



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Mzoun Muteib Almutairi

Imam Abdulrahman bin Faisal University

Energy Transation Summer Internship Imperial, London, England



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King Abdulaziz University

Energy Transation Summer Internship, UCL, London, England



Shouq Abdulrhman Fairaq

University of Jeddah

Energy Transation Summer Internship, Imperial, London, England



Reem Sultan Albalawi

Fahad bin Sultan University

Energy Transation Summer Internship, KAUST, Thuwal KSA



Roba Faisal Alnushayri

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Energy Transation Summer Internship, KAUST, Thuwal KSA



Washeel omarhashim

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Energy Transation Summer Internship, KAUST, Thuwal KSA



Shahad Alasbali

King Khalid University

Energy Transation Summer Internship, KAUST, Thuwal KSA



Muruj Zakaria Kassem

Umm Al-Qura University

Energy Transation Summer Internship, KAUST, Thuwal KSA

OPTIMIZING BIOI THICK FILMS FOR X-RAY DETECTION APPLICATIONS.

This project focuses on optimizing BiOI thick films for X-ray detection applications. BiOI is a promising material due to its high atomic number and suitable electronic properties. The films are fabricated under varying conditions to enhance their structural and functional performance. Characterization techniques include X-ray Diffraction for crystallinity, a profilometer for thickness and surface profile analysis, and other methods to assess morphology, optical properties, and electrical response under X-ray exposure.

PROJECT MENTOR: Robert Hoye

PROJECT MEMBERS: Alzahra Abbas Al Ensaif

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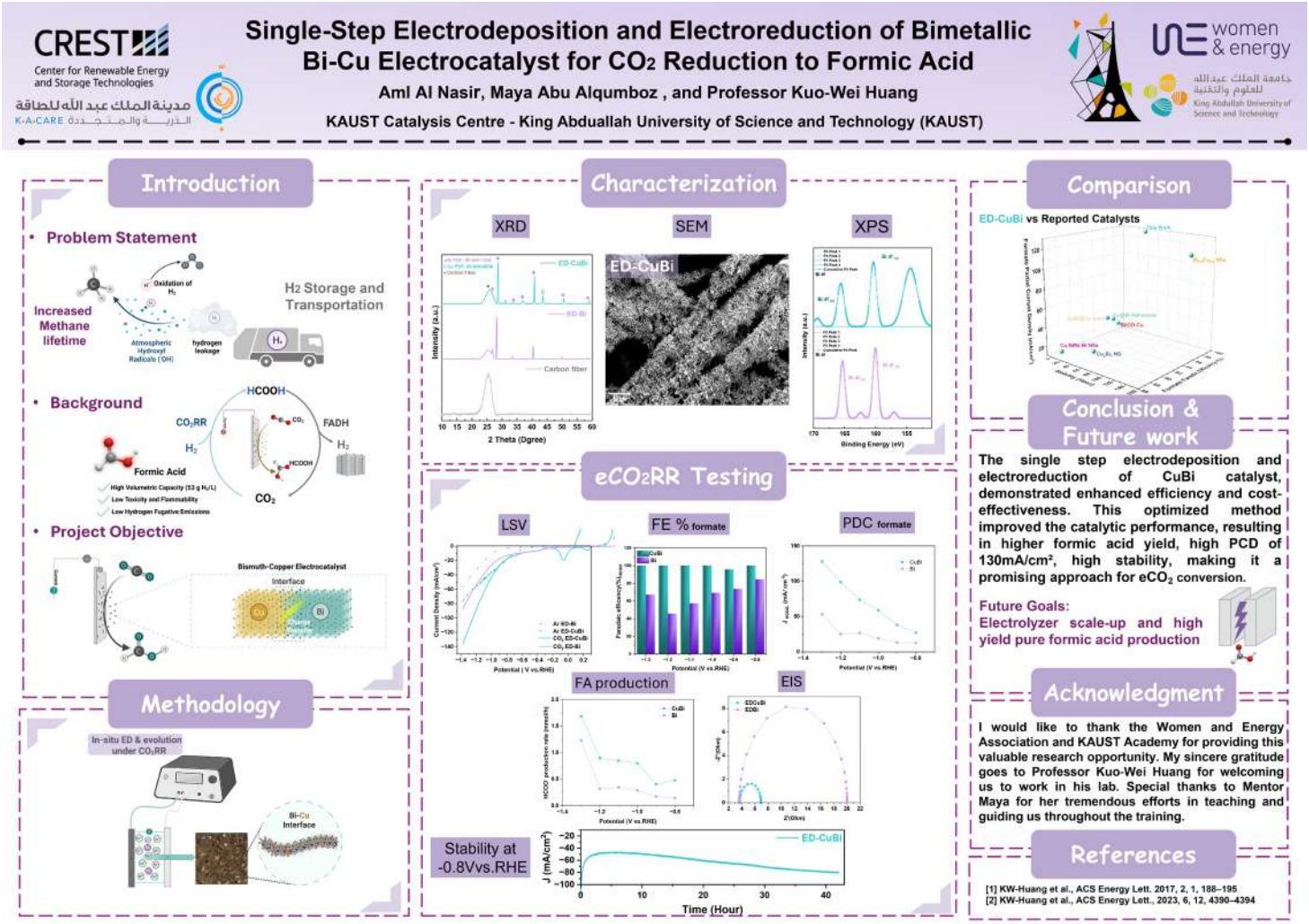
CO_2 ELECTROREDUCTION TO FORMIC ACID.

Electrocatalyst prepared via a new method for CO_2 conversion to formic acid.

General topic: electrochemical conversion of CO_2 to formic acid.

PROJECT MENTOR: Maya abualqumboz

PROJECT MEMBERS: Aml Hussain Abdullah Al Nasir

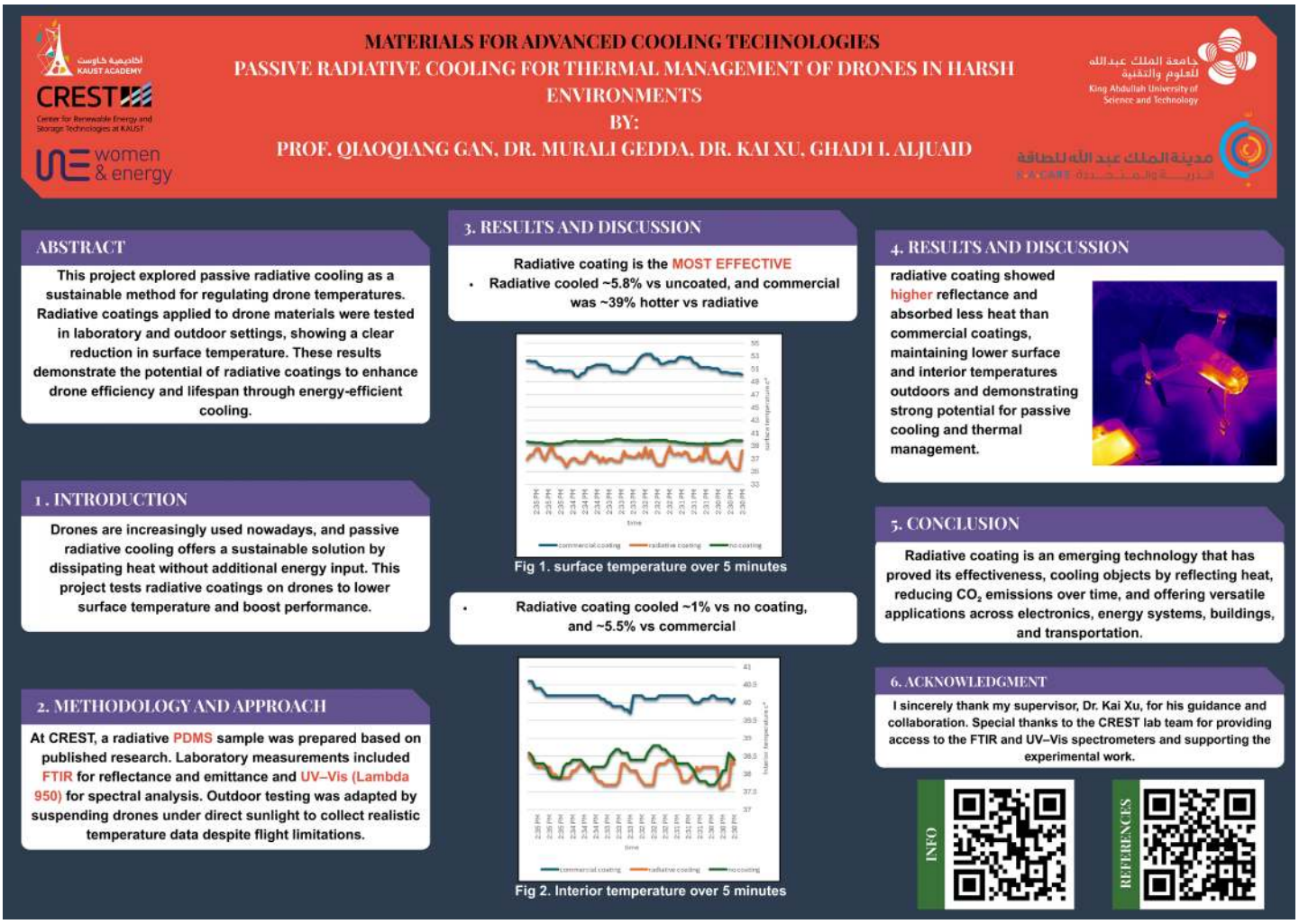


MATERIALS FOR ADVANCED COOLING TECHNOLOGIES

Passive Radiative Cooling for Thermal Management of ones in Harsh Environments

PROJECT MENTOR: Murali Gedda & Kai xu

PROJECT MEMBERS: Ghadi Ibrahim Aljuaid



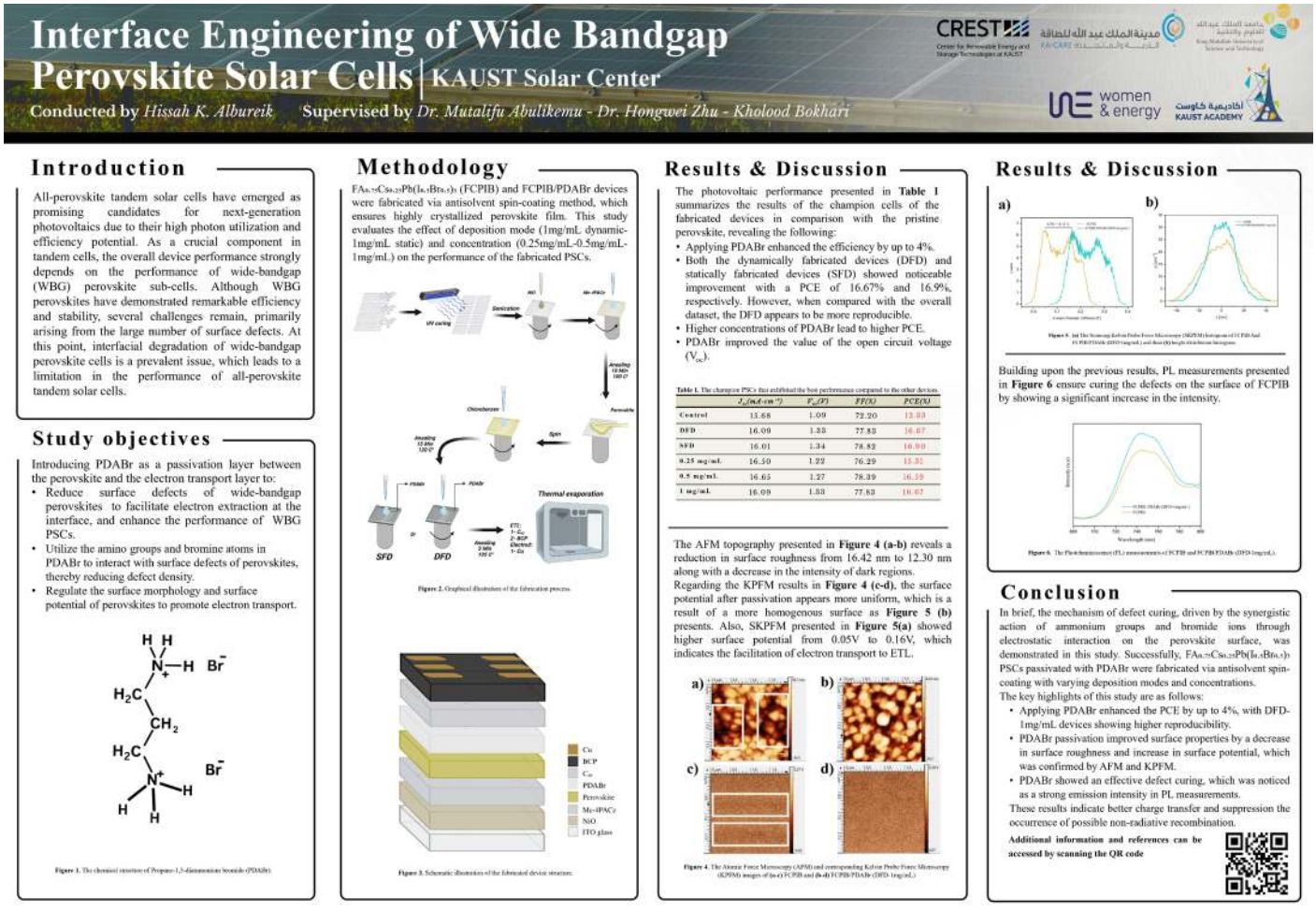
INTERFACE ENGINEERING OF WIDE-BANDGAP PEROVSKITE SOLAR CELLS

Wide-bandgap (WBG) perovskite solar cells (PSCs), essential sub-cells in tandem solar cells (TSCs), play a key role in determining overall device performance. Achieving the desired bandgap typically involves incorporating bromide alongside iodide, enabling WBG PSCs to exhibit high efficiency and stability. Nevertheless, their performance is often limited by surface defects caused by incomplete material coordination. These defects hinder carrier transport, reduce the open-circuit voltage (Voc), promote non-radiative recombination, and induce phase segregation, compromising device stability.

This study aims to enhance the stability and quality of $FA_{0.75}Cs_{0.25}Pb(I_{0.5}Br_{0.5})_3$ perovskite surfaces using PDABr (propane-1,3-diammonium bromide) as a passivation layer. This approach is intended to mitigate surface defects, promote uniform crystallization, and improve both the stability and performance of the resulting solar cell devices.

PROJECT MENTOR: Mutalifu abulikemu - Hongwei Zhu

PROJECT MEMBERS: Hissah Khalid Albureik

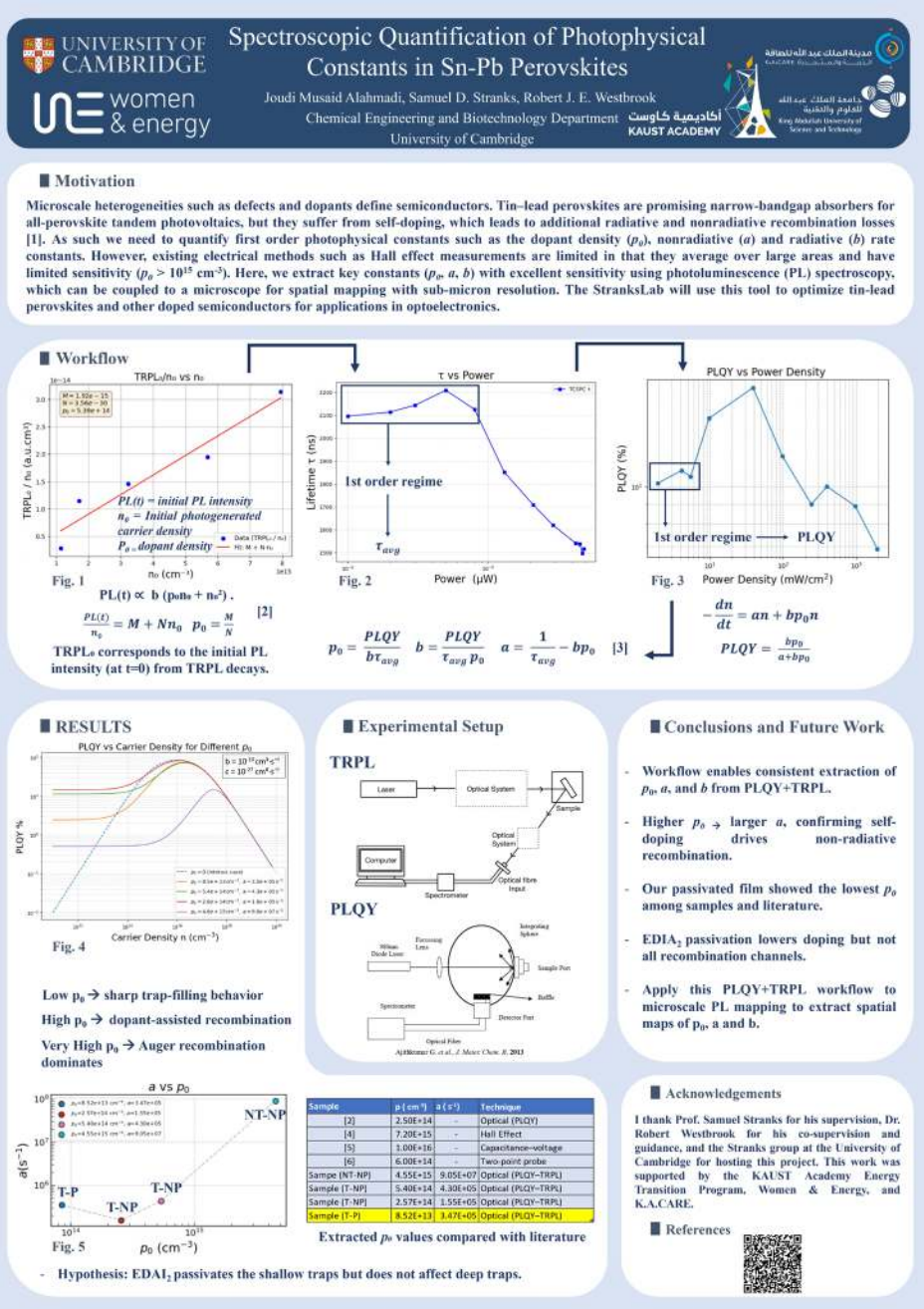


EXPLORES TIN/LEAD PEROVSKITE USING ADVANCED OPTICAL SPECTROSCOPY TO UNDERSTAND AND IMPROVE THEIR PERFORMANCE AND STABILITY

I investigate stability and self-doping in tin/lead perovskites by studying photoluminescence (PL), PL quantum yield (PLQY), and carrier lifetimes to understand how dopants and processing treatments impact defects and device performance.

PROJECT MENTOR: Sam Stranks

PROJECT MEMBERS: Joudi Musaid Alahmadi



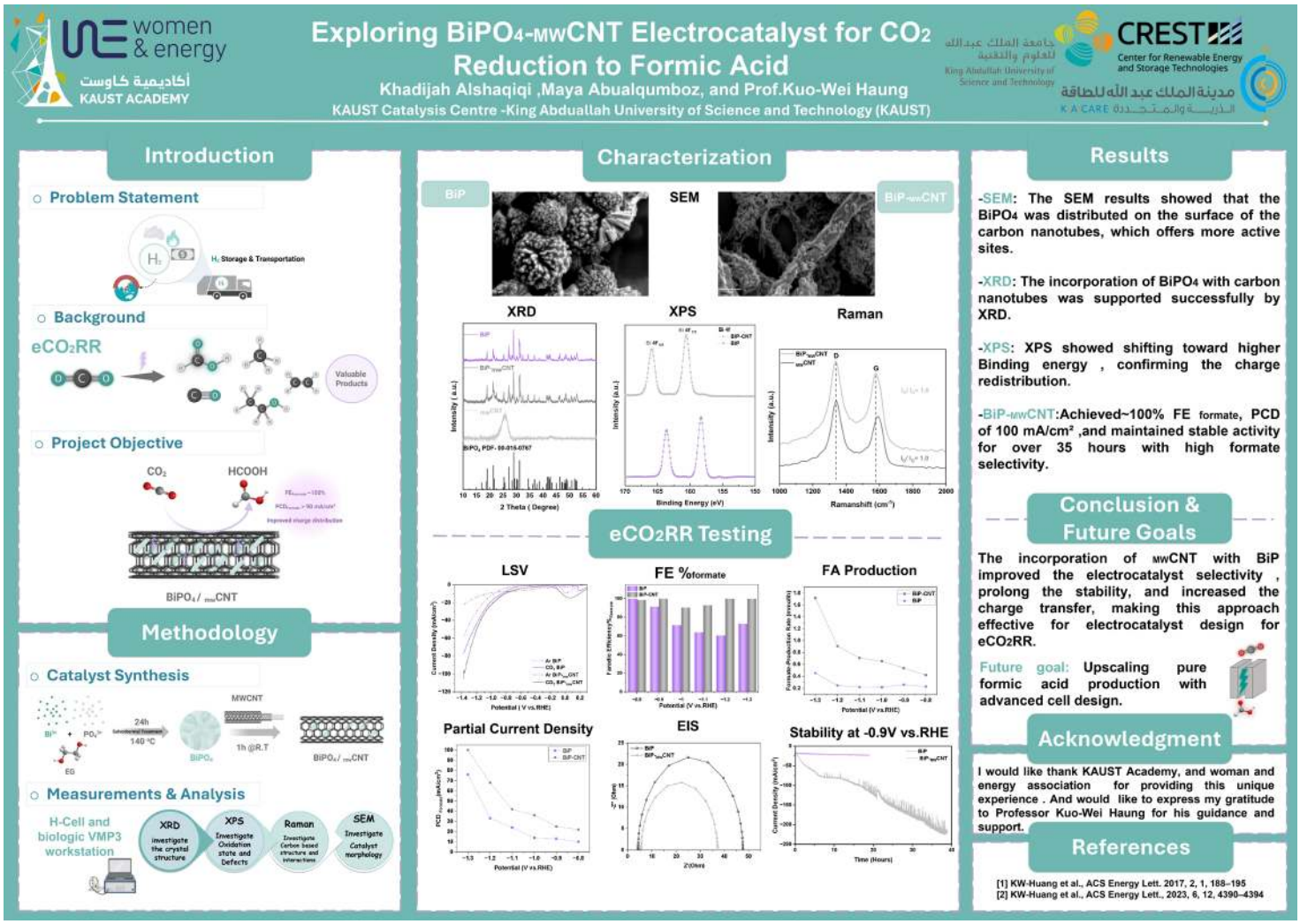
Sample	p (cm⁻³)	a (s⁻¹)	Technique
[2]	2.50E+14	-	Optical (PLQY)
[4]	7.20E+15	-	Hall Effect
[5]	1.00E+16	-	Capacitance-voltage
[6]	6.00E+14	-	Two-point probe
Sampe (NT-NP)	4.55E+15	9.05E+07	Optical (PLQY–TRPL)
Sample (T-NP)	5.40E+14	4.30E+05	Optical (PLQY–TRPL)
Sample (T-NP)	2.57E+14	1.55E+05	Optical (PLQY–TRPL)
Sample (T-P)	8.52E+13	3.67E+05	Optical (PLQY–TRPL)

E-FUEL

Development of an efficient electrocatalyst for CO2 reduction into formic acid

PROJECT MENTOR: Maya Abu Alqumboz

PROJECT MEMBERS: Khadijah Alshaqiqi



MAPPING SURFACE DYNAMICS IN SOLAR CELL MATERIALS USING ULTRAFAST SEM

Aligned with Saudi Arabia's Vision 2030, renewable energy has become a national priority, placing solar technologies at the forefront. Enhancing solar cell efficiency requires a fundamental understanding of how free carriers, electrons and holes, behave at the surface where most light absorption occurs. Our research utilizes a one of a kind Ultrafast Scanning Electron Microscopy (USEM) to probe charge carrier dynamics at high spatial and temporal resolutions. By comparing GaAs and CdTe, two leading photovoltaic materials, we aim to uncover critical surface level processes that influence device performance. This research aims to provide insights that could enhance the performance and efficiency of solar cells based on these materials.

PROJECT MENTOR: Razan Nughays

PROJECT MEMBERS: Khawla Khalid Alqurashi, Afnan Saleh Alsulami

Mapping surface dynamics in solar cell materials using Ultrafast SEM

Khawlah K. Alqurashi , Afnan S. Alsulami, Razan O. Nughays , Omar F. Mohammed*

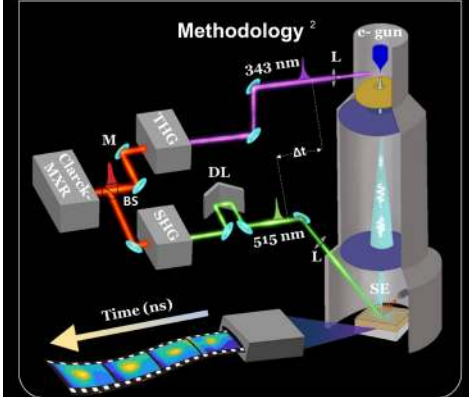
ABSTRACT

This study employs ultrafast scanning electron microscopy (USEM) to investigate carrier dynamics in two important photovoltaic materials, GaAs and CdTe. Comparing their electronic responses provides valuable insight into factors influencing their performance in solar energy applications.

INTRODUCTION

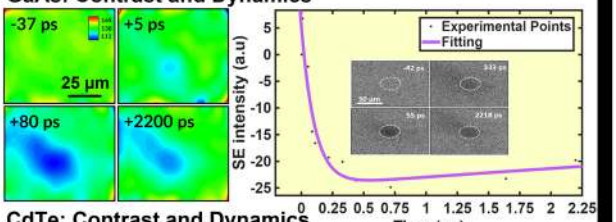
Solar cells convert sunlight into electricity using semiconductor absorbers. GaAs and CdTe, with band gaps of 1.42 eV and 1.50 eV, are among the top materials for solar applications. GaAs delivers record efficiencies for space and concentrator photovoltaics, while CdTe offers strong light absorption and cost-effective large-scale production for thin-film panels[1].

Methodology [2]

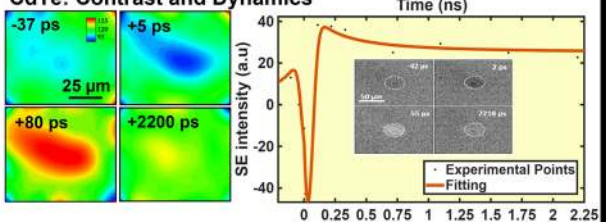


RESULTS & DISCUSSIONS

GaAs: Contrast and Dynamics



CdTe: Contrast and Dynamics

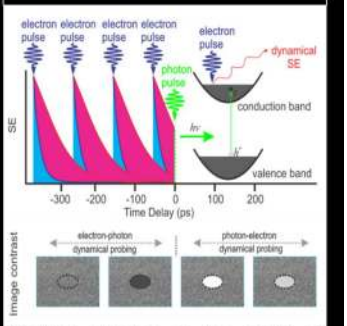


Colored map of time-resolved SEs snapshots for GaAs and CdTe obtained at different time delays. On the right, charge carrier dynamic of both samples exhibiting distinct carriers dynamics.

CONCLUSION

- USEM was utilized to study two photovoltaic materials, GaAs and CdTe, to track charge carriers at the surface.
- GaAs showed a longer decay time (~500 ps) than CdTe (~250 ps), indicating extended carrier lifetimes, while CdTe exhibited faster recovery and better carrier diffusion.
- These results highlight distinct electronic advantages in each material, informing strategies for improved solar cell performance.

RESULTS & DISCUSSIONS



Contrast changes at the center of illumination reflect surface charge carrier behavior[3].
It provides valuable dynamical information, include: carrier generation, separation, transport, and recombination.

REFERENCES

1. NREL, *Best Research-Cell Efficiencies*, August 2025.
2. *Adv. Optical Mater.* 2023, 11, 2300190
3. *J. Phys. Chem. Lett.* 2015, 6, 3884−3890

CONTACT INFORMATION

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afnansalehj@gmail.com

HYOGEN PRODUCTION BY ELECTROLYSIS - LAYAN

This project focuses on synthesizing $BaCe_{1-x}Y_xO_{3-\delta}$ (x = 0.05, 0.10, 0.15) via solid-state reaction using $BaCO_3$, CeO_2, and Y_2O_3. The powders will be calcined at 1000 °C, characterized by XRD, SEM, and TGA, then pressed into dense pellets (sintered at 1200 °C). Proton conductivity will be measured between 300–600 °C under y and wet air conditions.

PROJECT MENTOR: Rohit Rai

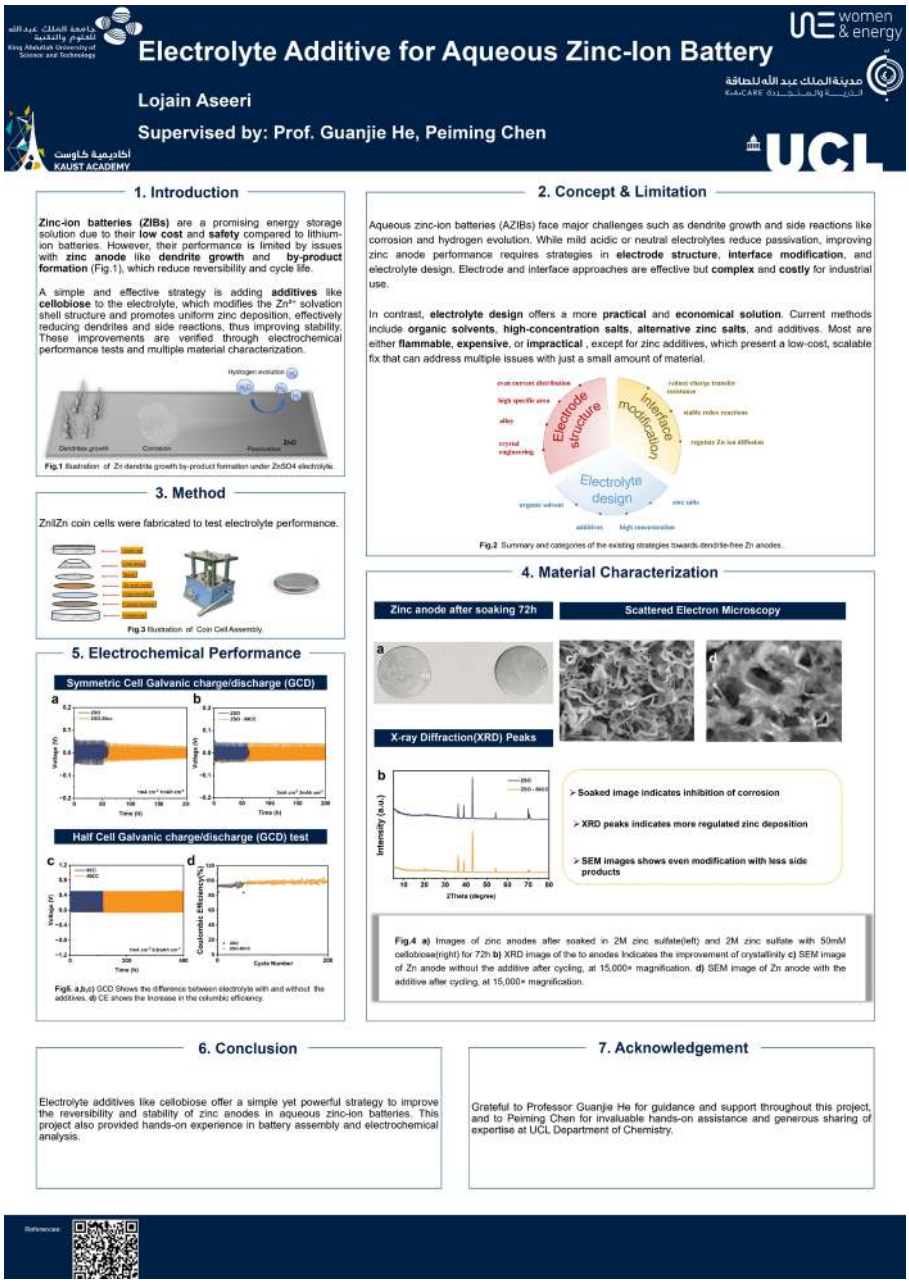
PROJECT MEMBERS: Layan Abdullah Alharbi

ELECTROLYTE ADDITIVE FOR AQUEOUS ZINC ION BATTERY

This project is an introduction to the study of electrolyte additives for aqueous zinc ion batteries(AZIBs). The AZIB is one of the emerging technologies in the energy storage industry, and the inefficient zinc anode hinders its further application. Electrolyte additives are among the most promising strategies for enhancing zinc anode performance. In the project, we conducted the fabrication and testing of zinc batteries, along with the common characterisation of AZIBs. This project aims to illustrate the fundamental knowledge of battery making and electrochemical tests.

PROJECT MENTOR: Guanjie He

PROJECT MEMBERS: Lojain Khalil Aseeri



LITHIUM EXTRACTION FORM SEA WATER

Synthesis of COFs and use COFs to extract Lithium from seawater

PROJECT MENTOR: Shuhao An

PROJECT MEMBERS: Maysoon Abu onq, Ghadeer Menwer Aljohani

women & energy

مدينة الملك عبد الله للطاقة الذرية والمتجددة K·A·CARE

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جامعة الملك عبدالله للعلوم والتقنية King Abdullah University of Science and Technology

CREST Center for Renewable Energy and Storage Technologies at KAUST

Lithium Extraction From Seawater

Ghadeer M Aljohani, Maysoon Abu Onq, Dr. Shuhoa An, and Prof. Zhiping Lai

Contact: ghadeermaljohani@gmail.com / maissma@hotmail.com

Introduction

Within today's world, lithium has become as one of the most significant elements, especially with the growing global demand for batteries and electric vehicles. However, the limited supply of lithium resources may become an issue with the rapid growth of lithium consumption. Seawater contains around 230 billion tons of lithium, nearly 5,000 times more than land-based reserves, but at low concentrations (~0.2 ppm) and significant amounts of competing ions. Our research uses covalent organic frameworks (COFs), which are highly porous and tunable materials, to selectively adsorb lithium ions from challenging water sources such as seawater and oilfield brine.

Objectives

- Develop COFs for efficient lithium extraction from seawater.
- Compare the performance of TpPa-COF and TpPa-SO_3H in lithium uptake.
- Enhance selectivity and capacity for lithium over other ions.

Methodology

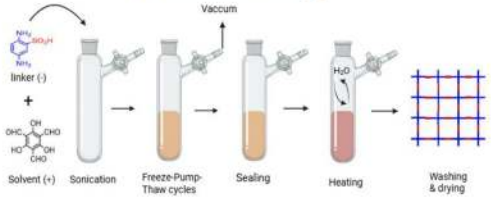


Fig. 1 Synthesis of COFs

Results

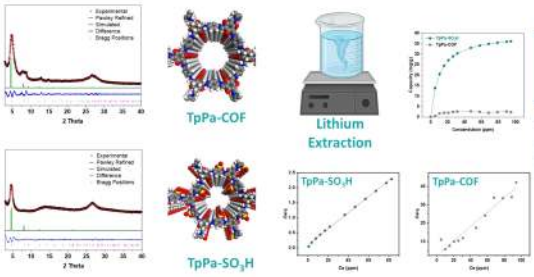


Fig. 2 PXRD Analysis of COFs

COF	Langmuir model		
	Qm (mg/g)	K_L	R_L^2
TpPa-SO3H	37.5	0.258	0.998
TpPa-COF	2.56	0.145	0.94

Fig. 3 Langmuir model shows TpPa-SO_3H exhibits ~15× higher lithium capacity (Qm = 37.5 mg/g) compared to TpPa-COF (Qm = 2.56 mg/g), along with better affinity and model fit (R^2 = 0.998)

Conclusions

- Covalent Organic Frameworks (COFs) offer a promising platform for lithium extraction from challenging brine sources.
- The designed TpPa-COF and sulfonated TpPa-SO_3H demonstrated high porosity and tunable chemistry for selective lithium adsorption. The results indicate that TpPa-SO3H exhibits superior lithium uptake (~40 mg/g), while control materials show negligible capacity (~2–3 mg/g).
- Future work will focus on device integration and real-brine testing.

Reference

1- Huang, N., Wang, P., & Jiang, D. (2016). Covalent organic frameworks: a materials platform for structural and functional designs. Nature Reviews Materials, 1(10), 1-19.

2- Christmann, P., Gloaguen, E., Labbé, J. F., Melleton, J., & Piantone, P. (2015). Global lithium resources and sustainability issues. In Lithium process chemistry (pp. 1-40). Elsevier.

COSOLVENCY-DRIVEN GROWTH OF $MAPbI_3$ SINGLE-CRYSTAL SOLAR CELLS USING INVERSE TEMPERATURE CRYSTALLIZATION (ITC)

We demonstrated the growth of $MAPbI_3$ single crystals using a cosolvent-assisted inverse temperature crystallization (ITC) method. By adding methoxyethanol to γ-butyrolactone (GBL), we achieved larger and higher-quality crystals, which improved the performance of perovskite single-crystal solar cells.

PROJECT MENTOR: Mudeha Khan

PROJECT MEMBERS: Munira Alruwaili

women & energy

Cosolvency-Driven Growth of $MAPbI_3$Single-Crystal Solar Cells using inverse temperature crystallization method (ITC)

CREST Center for Renewable Energy and Storage Technologies at KAUST

Munira Alruwaili, Mudeha Khan, and Prof. Osman M. Bakr

Kaust Solar Center- King Abdullah University of Science and Technology (KAUST)

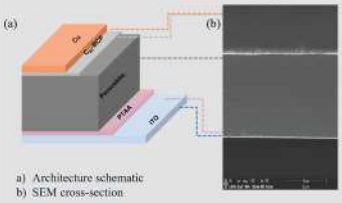
Abstract

We demonstrate the growth of $MAPbI_3$ single crystals using a cosolvency-assisted inverse temperature crystallization (ITC) method. While γ-butyrolactone (GBL) alone yielded moderate results, the addition of methoxyethanol as a cosolvent enhanced precursor solubility, producing larger, higher-quality crystals. Devices fabricated from these crystals showed improved efficiencies compared to those grown in GBL only. This work highlights co-solvency as a simple and effective strategy to control crystallization and advance high-performance perovskite single-crystal solar cells.

Introduction

Perovskite single crystals have attracted significant attention in recent years due to their exceptional optoelectronic properties and potential for high-performance solar cells. Compared to polycrystalline films, single crystals exhibit **low defect densities**, **longer carrier diffusion lengths**, and **extended carrier lifetimes**, which are crucial for improving device efficiency. Inverse temperature crystallization (ITC) is a widely used method for growing perovskite single crystals, offering simplicity and scalability. However, controlling crystal size, morphology, and quality remains challenging. Recent approaches, such as cosolvency-assisted crystallization, have shown promise in enhancing precursor solubility and regulating crystal growth. In this study, we explore a cosolvent strategy to improve the growth of $MAPbI_3$ single crystals, aiming to produce uniform, high-quality crystals suitable for efficient solar cell applications.

Device architecture and SEM image



a) Architecture schematic
b) SEM cross-section

Methodology

Precursors & Solvents: MAI and PbI_2 dissolved in a γ-butyrolactone (GBL)/2-methoxyethanol (2-ME) cosolvent for controlled nucleation and stable growth.

Crystal Growth (ITC): Solution confined between PTAA-coated ITO substrates. Temperature increased from 60 °C to 130 °C at 2 °C h^{-1} to induce crystallization. Crystals cooled to room temperature in a nitrogen glovebox.



Device Fabrication: Cleaned ITO substrates by sequential ultrasonic bath and UV–ozone treatment. Spin-coated PTAA as the hole transport layer. Deposited C60 and BCP layers, followed by Cu electrodes via thermal evaporation.

Characterization: Morphology analyzed by optical microscopy and SEM; device performance evaluated by I–V measurements under nitrogen.

Results

Using a GBL/2-methoxyethanol (2-ME) cosolvent significantly improved single-crystal solar cell performance compared to GBL alone. The devices showed higher short-circuit current density (Jsc, 20.82 → 22.36 mA cm^{-2}), open-circuit voltage (Voc, 1.01 → 1.10 V), and fill factor (FF, 66.75% → 75.48%). These enhancements lifted the power conversion efficiency (PCE) from 14.12% to 18.58%. The improvements are attributed to more controlled crystallization and better interfacial contact, demonstrating the effectiveness of the cosolvency-assisted growth strategy.

J–V curve

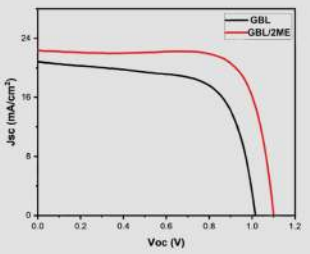


Table 1. Results from JV Measurements

Solvent	Jsc	Voc	FF	PCE
GBL	20.82	1.01	66.75	14.12
GBL/2ME	22.36	1.1	75.48	18.58

Conclusion

The use of a GBL/2-methoxyethanol cosolvent effectively improved the growth of $MAPbI_3$ single crystals, resulting in larger and higher-quality crystals. Devices fabricated from these crystals exhibited enhanced photovoltaic performance, with Jsc, Voc, and FF increasing and **the power conversion efficiency rising from 14.12% to 18.58%.** These improvements demonstrate that cosolvency enables more controlled crystallization and better interfacial contact, providing a straightforward and effective strategy to enhance perovskite single-crystal solar cell performance.

Acknowledgements

I am grateful to **Women and Energy** and the **King Abdullah City for Atomic and Renewable Energy**, as well as **KAUST Academy** and the **Center for Renewable Energy and Storage Technologies (CREST)**, for their support, mentorship, and the opportunity to explore beyond my field.

Reference

(1)Moazzezi, P. et al. **J. Am. Chem. Soc.** 2025, 147, 10203–10211.

(2)Khan, M. et al. **ACS Mater. Lett.** 2025, 7, 1603–1611.

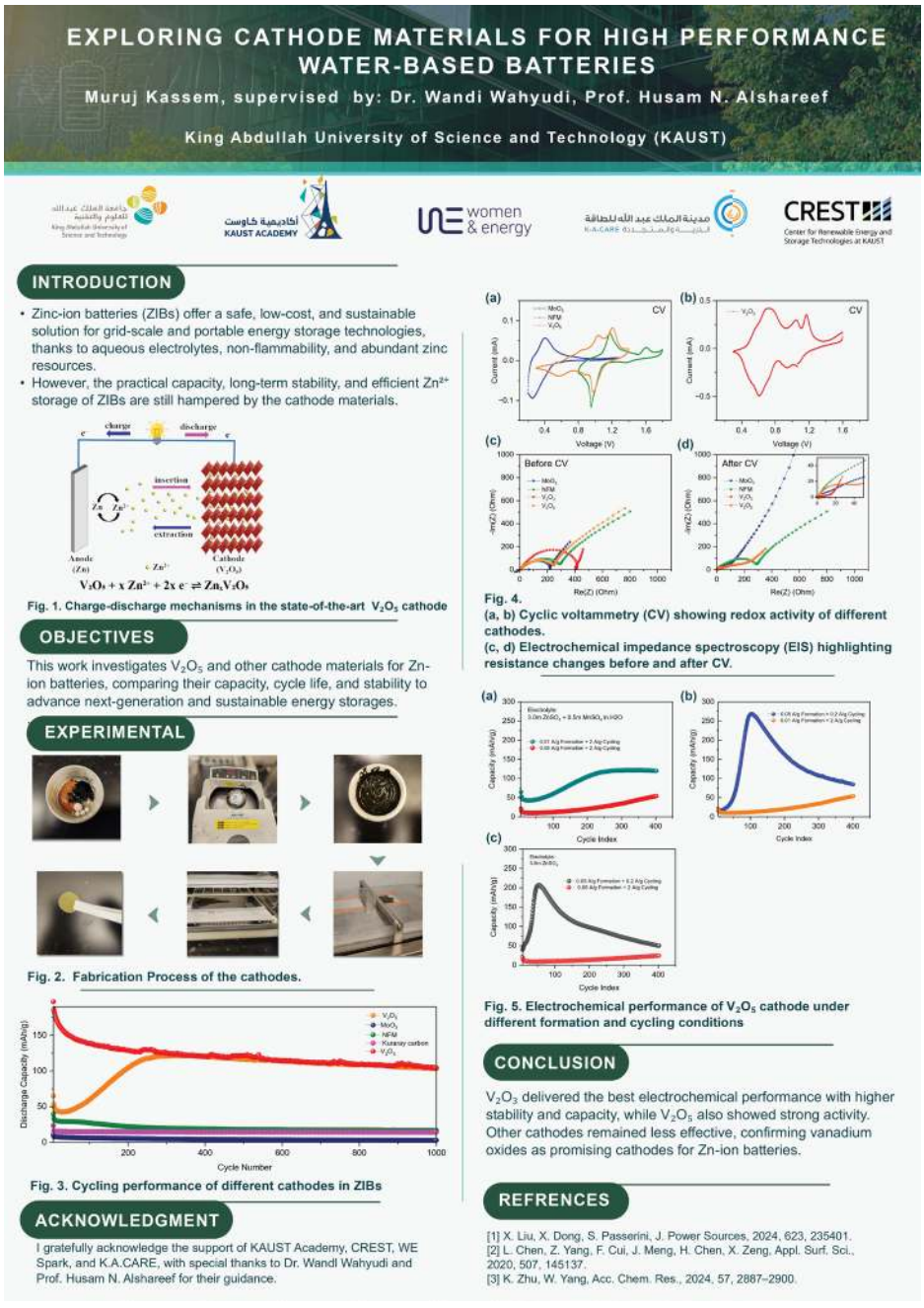
(3)Chen, Z. et al. **ACS Energy Lett.** 2019, 4, 1258–1259.

EXPLORING CATHODE MATERIALS FOR HIGH-PERFORMANCE WATER-BASE BATTERIES

This work investigates vanadium oxides and other cathode materials for Zn-ion batteries, comparing their capacity, cycle life, and stability to advance next-generation sustainable energy storage. The goal is to identify the best-performing cathode material with the highest capacity and longest cycle life by optimizing cycling conditions through systematic testing at various voltages and current densities.

PROJECT MENTOR: Wandi Wahyudi

PROJECT MEMBERS: Muruj Zakaria Kassem

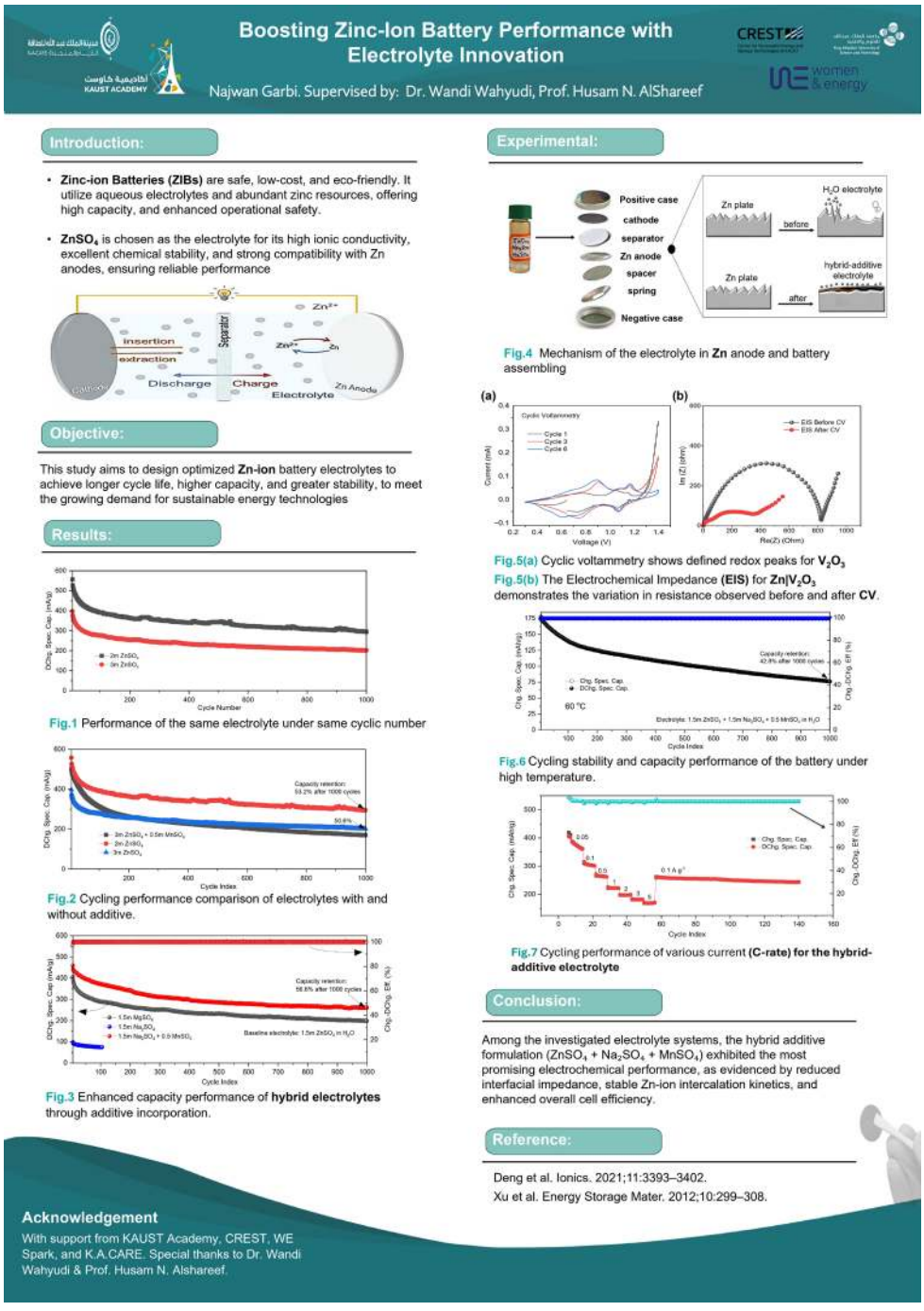


BOOSTING ZN-ION PERFORMANCE WITH ELECTROLYTE INNOVATION

The project aims to improve zinc-ion batteries by testing and evaluating ZnSO4 electrolyte with. Different other materials to make the electrolyte Hybird, additive or both and enhancing their performance for safer and more efficient energy storage with higher capacity and longer life cycles

PROJECT MENTOR: Wandi Wahyudi

PROJECT MEMBERS: Najwan Nazih Garbi

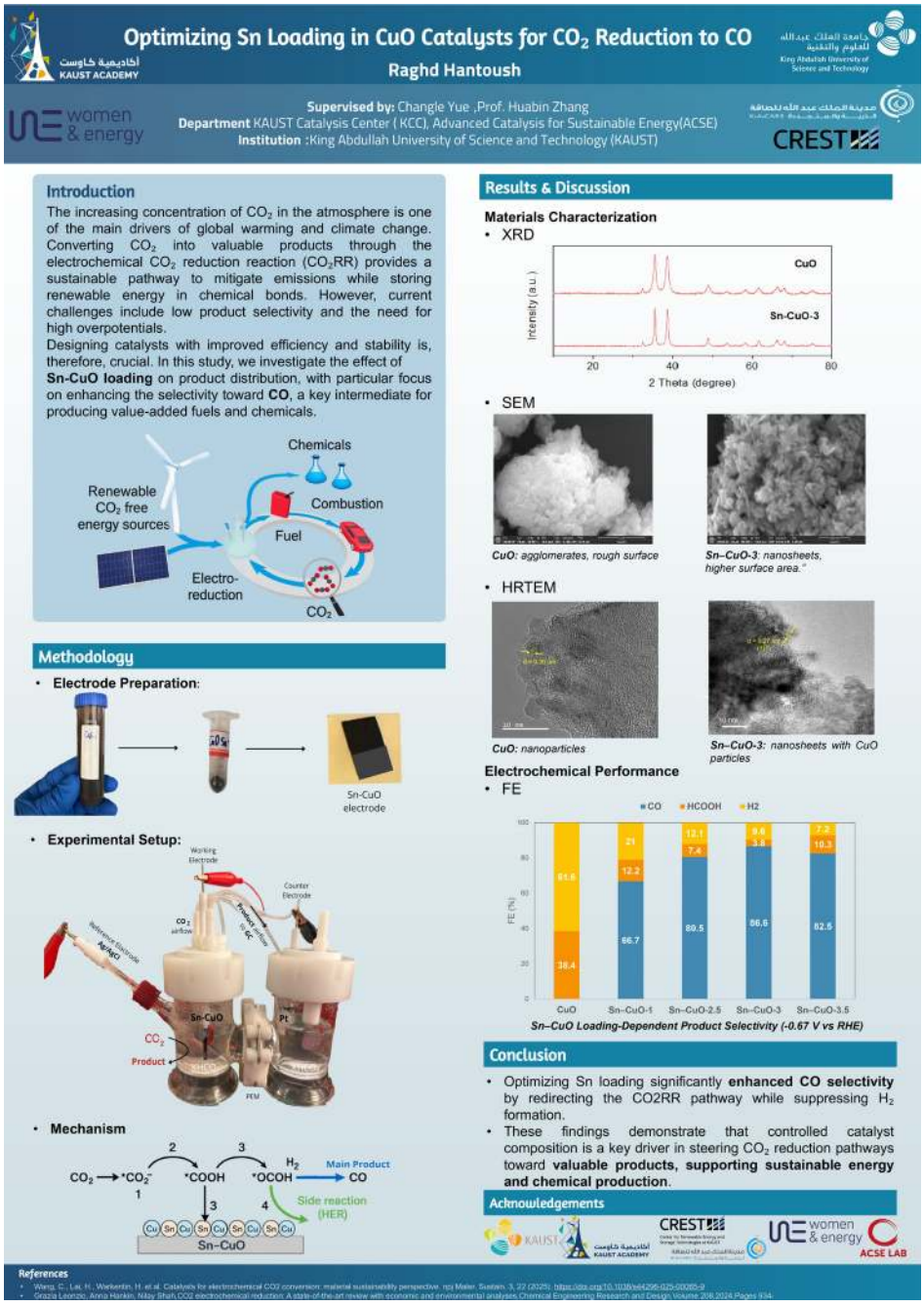


OPTIMIZING SN LOADING IN CUO CATALYSTS FOR CO_2 REDUCTION TO CO

Project focuses on developing and evaluating novel catalysts for the electrochemical reduction of carbon dioxide (CO_2) into value-added products. Various materials are synthesized and characterized to understand their structure–activity relationships, followed by electrocatalytic testing under different operating conditions. The goal is to identify efficient, selective, and stable catalysts that can enable sustainable CO_2 conversion, contributing to carbon-neutral energy solutions

PROJECT MENTOR: Xiangyun Xiao (Tony)

PROJECT MEMBERS: Raghd Abdullah Saleh Hantoush

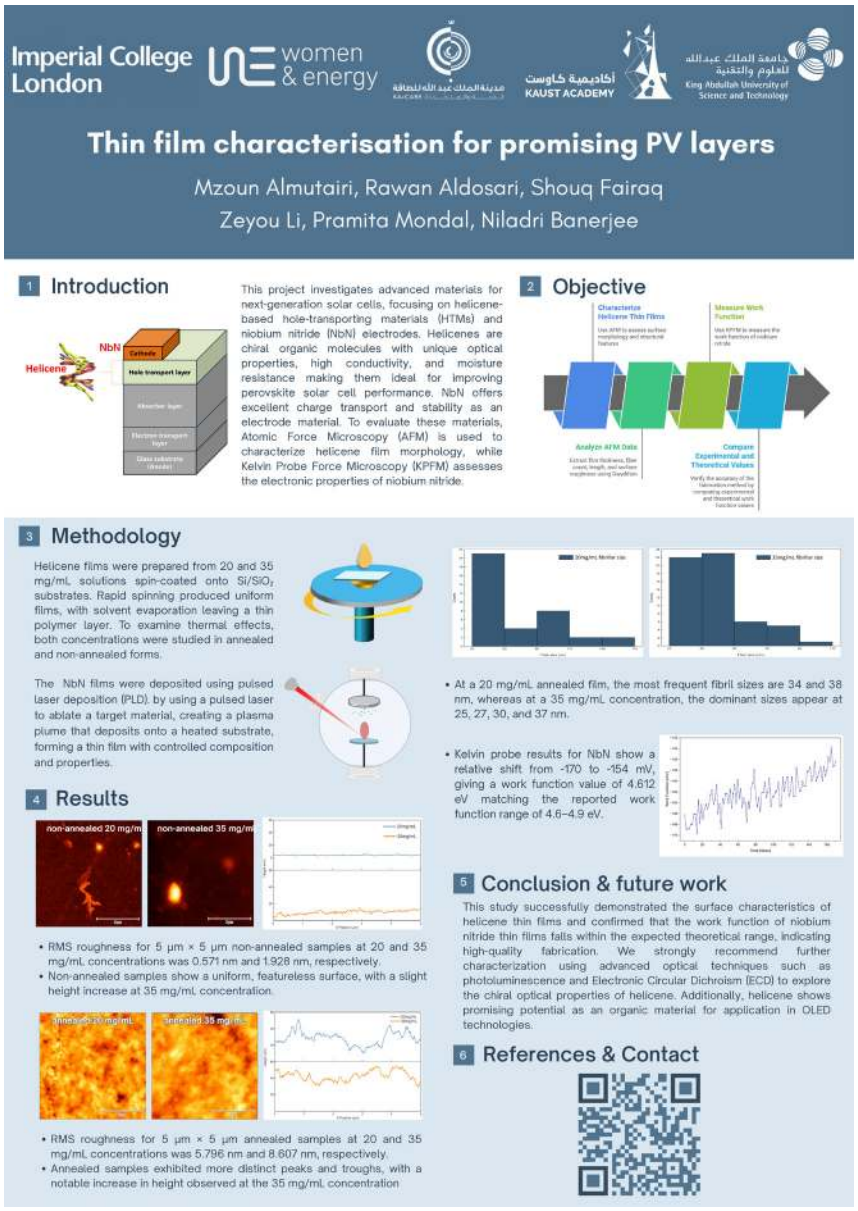


THIN FILM GROWTH FOR APPLICATIONS IN PHOTOVOLTAICS

Thin film photovoltaic devices are complex and challenging to make as different materials need to be grown on top of one another in thin film form with minimal defect density. Defects in these thin films can act as trap centres leading to unwanted carrier recombination thereby reducing the efficiency of these devices. In this project we will understand how a thin film grows, what defects could it have and what factors affect the density of these defects. You will attempt to develop a model of growth of thin films and see for yourself how defects naturally occur and then propose strategy of how to minimise defect density to improve efficiency of photovoltaics.

PROJECT MENTOR: Nilai Banerjee

PROJECT MEMBERS: Rawan Saeed Al Dosari, Shouq Abdulrhman Fairaq Mzoun Muteib Almutairi



HYDROGEN PRODUCTION BY ELECTROLYSIS

This project focuses on synthesizing BaCe₁⊠⊠Y⊠O₃⊠δ (x = 0.05, 0.10, 0.15) via solid-state reaction using $BaCO_3$, CeO_2, and Y_2O_3. The powders will be calcined at 1000 °C, characterized by XRD, and SEM, then pressed into dense pellets (sintered at 1200 °C). Proton conductivity will be measured between 300–600 °C under dry and wet air conditions.- Finally do the integration with CSP

PROJECT MENTOR: Rohit Rai

PROJECT MEMBERS: Reem Sultan Albalawi

Synthesis and Characterization of $BaCe_{1-x}Y_xO_{3-\delta}$ Electrolytes Materials: A Proton-Conducting Electrolyte in CSP-Powered Hydrogen Production.

Reem Albalawi, Supervisors: Dr. Rohit Rai, Yuvraj Vaishnav, Prof. Yoji Kobayashi

King Abdullah University of Science and Technology (KAUST), KCC Division, Saudi Arabia

Objective

Hydrogen is central to the clean energy transition. Protonic Ceramic Electrolysis Cells (PCECs) operate efficiently at 400–600 °C, offering high hydrogen purity, lower electrical demand, and improved stability.
$BaCeO_3$ perovskites, with corner-sharing CeO_6 octahedra (Figure 1), provide pathways for proton transport with low migration energy barriers (~1.14–1.19 eV).
In this poster, $BaCe_{1-x}Y_xO_{3-\delta}$ (x = 0, 0.15) was synthesized to create more oxygen vacancies, thereby enhancing proton conductivity. The materials were characterized for application in CSP-powered electrolysis systems, aiming to enable green hydrogen production in off-grid configurations.

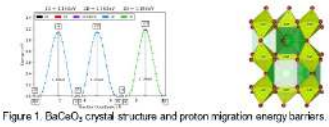


Figure 1. $BaCeO_3$ crystal structure and proton migration energy barriers.

Synthesis method

Samples of $BaCe_{1-x}Y_xO_{3-\delta}$ were synthesized with different Y-doping levels to investigate the impact of dopant concentration on proton conductivity.



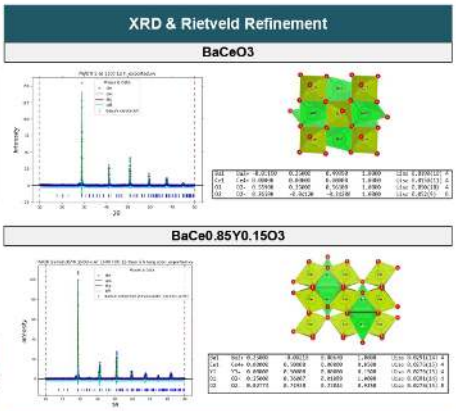
Different compositions of $BaCe_{1-x}Y_xO_{3-\delta}$ (x = 0, 0.15) were prepared by stoichiometric mixing of $BaCO_3$, CeO_2, and Y_2O_3 powders.

Powders were formed into tube-like shapes using manual pressing

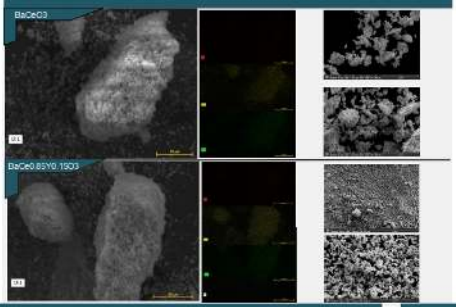
Samples were calcined in a furnace at 1000 °C for 10 hours in air

XRD, SEM, and proton conductivity measurements were performed.

XRD & Rietveld Refinement

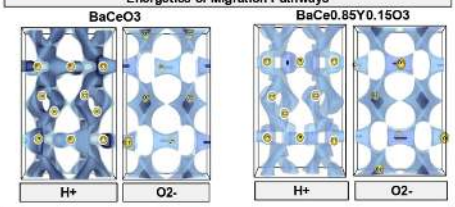


Microstructure – SEM & EDS



Ion Transport and Hydration Behavior

Energetics of Migration Pathways



Conductivity

As shown in Figure 2, the EIS Nyquist spectrum of $BaCe_{0.85}Y_{0.15}O_{3-\delta}$ at 500 °C was fitted with an Rs–CPE–Rp model. The extracted polarization resistance (Rp = 936 Ω) corresponds to a proton conductivity of 6.3×10^{-4} S·cm^{-1}, consistent with reported values for Y-doped $BaCeO_3$ and confirming efficient proton transport at intermediate temperature.

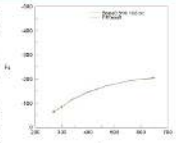


Figure 2. Nyquist plot and equivalent circuit fit at 500 °C.

Application

Concentrated Solar Power (CSP) uses mirrors to concentrate sunlight into receivers, generating high-temperature heat (400–600 °C or more) that can be stored and converted into electricity. These conditions align directly with the operating window of Protonic Ceramic Electrolysis Cells (PCECs) based on $BaCe_{1-x}Y_xO_{3-\delta}$, which require intermediate-to-high temperatures for efficient proton conduction. By coupling CSP with these electrolytes, solar heat reduces external heating demand while solar electricity drives the electrolysis process. This integration enables the direct production of green hydrogen from only sunlight and water, providing a sustainable pathway for large-scale hydrogen generation in sun-rich regions.

Acknowledgement

I would like to sincerely thank Professor Yoji Kobayashi for his mentorship, guidance, and support throughout the course of this research. I am also grateful to Dr. Rohit Rai and Yuvraj Vaishnav for their valuable technical insights, constructive feedback, and assistance with instrumentation. This work was conducted at the KAUST Catalysis Center (KCC) and further supported by the KAUST Academy and the Women and Energy initiative. Their collective contributions were essential to the successful completion of this project.

Summary

Summary$BaCe_{1-x}Y_xO_{3-\delta}$ electrolytes (x = 0, 0.15) were synthesized and characterized to study the effect of Y-doping on proton conduction. XRD confirmed the perovskite phase, while SEM/EDS showed improved densification at intermediate doping. Proton conductivity increased with Y content, reaching an optimum at x ≈ 0.10. Coupling these electrolytes with CSP provides both heat and electricity, enabling efficient solar-driven green hydrogen production.

ENHANCING ENERGY DENSITY AND LIFESPAN OF V_2O_3-BASED ZINC-ION BATTERIES

The project aims to improve zinc-ion batteries by testing and evaluating better cathode materials and enhancing their performance for safer and more efficient energy storage with higher capacity and longer life cycles

PROJECT MENTOR: Wandi Wahyudi

PROJECT MEMBERS: Roba Faisal Alnushayri

Enhancing Energy Density and Lifespan of V_2O_3-Based Zinc-Ion Batteries

Roba Faisal Alnushayri , Supervised by: Dr. Wandi Wahyudi, Prof. Husam N. Alshareef
King Abdullah University of Science and Technology (KAUST)
Renewable Energy Program, KAUST Academy

Introduction

Water-based zinc-ion batteries (ZIBs) offer a safe, low-cost, and sustainable energy storage solution, yet their practical application is limited by challenges in energy density and cycling stability. Vanadium(III) oxide (V_2O_3) has emerged as a promising cathode material due to its high capacity and structural versatility, which facilitate zinc-ion intercalation [1]. This work systematically investigates the impact of different formation protocols on the electrochemical performance of V_2O_3-based ZIBs, with the goal of optimizing both capacity retention and cycle life.

Fabrication and Methodology

The cell was fabricated through six steps shown in Figure 1: first, the V_2O_3 cathode was placed, followed by a fiberglass separator. Next, 120 µl of 3m $ZnSO_4$ in H_2O electrolyte was added, and the zinc anode was positioned. A spring and a spacer were then inserted, and finally the cell was sealed to complete the assembly.

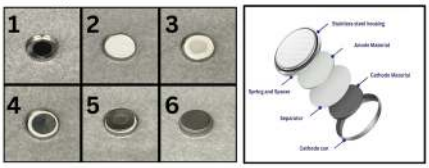


Figure 1- Fabrication process and cell component

The assembled cells will be tested under different current densities to determine the best conditions for maximizing capacity. To validate these results, electrochemical impedance spectroscopy (EIS) will be measured at three current levels. Finally, various formation protocols will be compared to identify the most effective method for enhancing capacity and lifespan.

Acknowledgments

This work was supported by King Abdullah University of Science and Technology (KAUST), with additional support from KAUST Academy, CREST, WE Spark, and K.A.CARE. Special thanks to Dr. Wandi Wahyudi and Prof. Husam N. Alshareef for their guidance and mentorship.

Different current

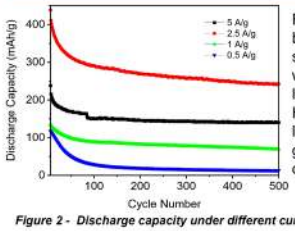


Figure 2- shows the best capacity and stability at 2.5 A/g, while 0.5 A/g quickly loses performance. Higher (5 A/g) and lower (1 A/g) currents give moderate but less optimal results.

Figure 2 - Discharge capacity under different currents

Impedance measurements

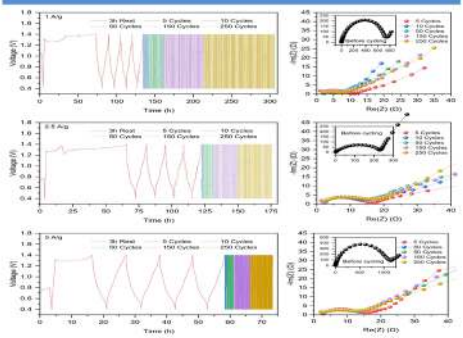


Figure 3- (EIS) results for three different currents 1A/g, 2.5A/g and 5A/g

This cycling test further confirms the electrochemical impedance and the data shown previously. Just as the Nyquist plots indicated 2.5 A/g had the lowest resistance and most stable impedance response, this long-term cycling test demonstrates that 2.5 A/g also delivers the best balance of high capacity and cycling stability, reinforcing that it is the optimal operating current density.

Formation Process

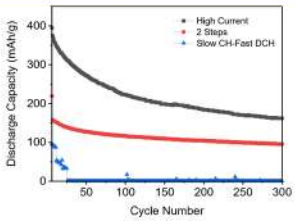


Figure 4 – Discharge capacity for different formation process

1.High Current (1A/g): This single-step protocol achieved the highest capacity, retaining ~160 mAh/g after 300 cycles at 2.5 A/g, making it ideal for high-energy applications.
2. 2-Step (0.1 A/g to 1.0V, then 0.05 A/g to 1.4V): This stepped process provided the best stability, with a gradual capacity fade to ~95 mAh/g, offering optimal performance for long-cycle-life requirements.
3.Slow Charge-Fast Discharge (0.05 A/g charge, 2.5 A/g discharge): This asymmetric protocol failed dramatically, with rapid capacity decay, rendering it unsuitable for this material.

Conclusions

V_2O_3 shows strong potential as a cathode for ZIBs, where charge conditions and cycling protocols greatly influence the performance. Optimized current density and formation improved capacity, stability, and lifespan. Further study is recommended on the slow charge–fast discharge process for solar systems, and on testing at higher temperatures to confirm stability.

References

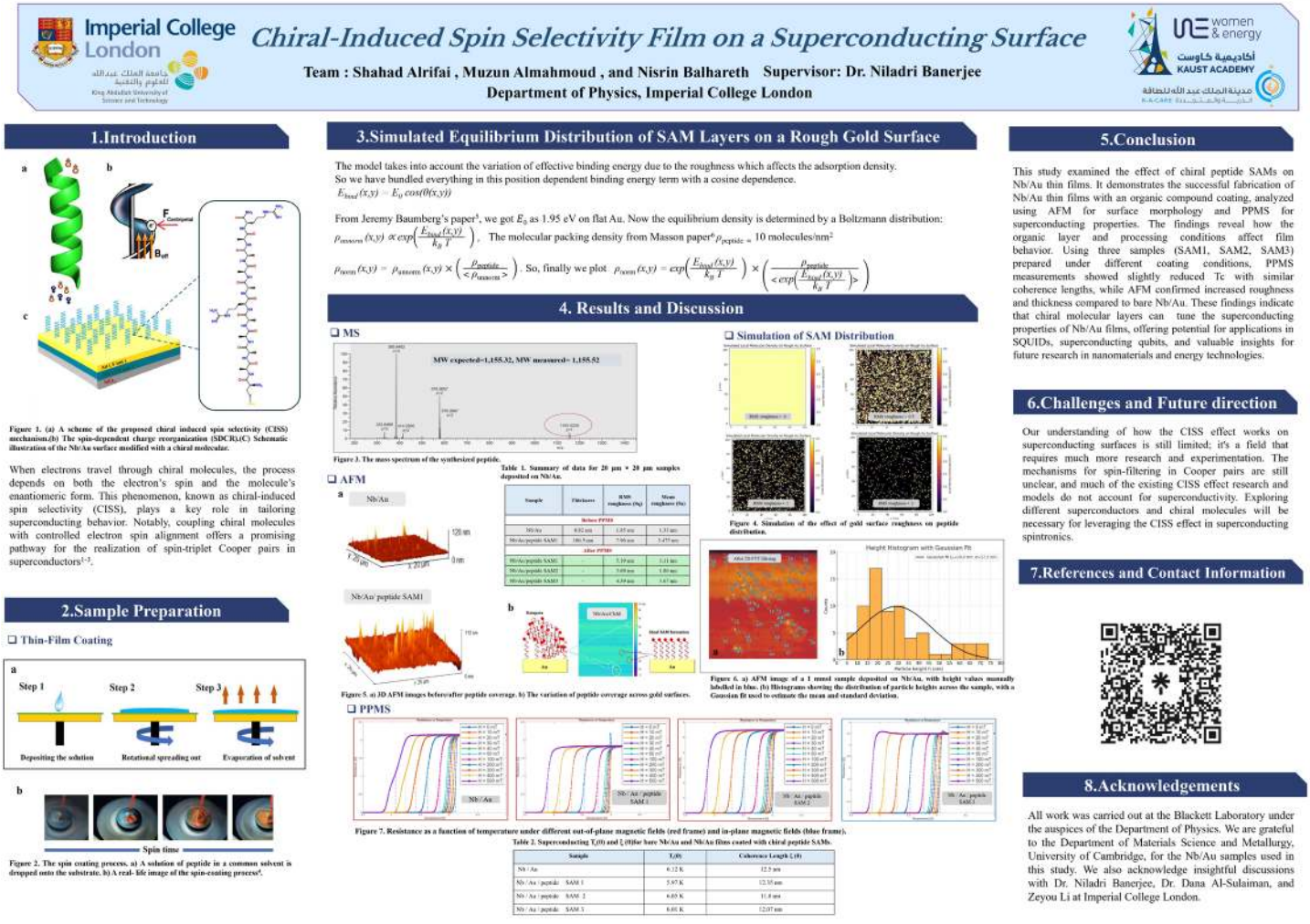
[1] K. Zhu *et al.*, "Defect engineering on V2O3 cathode for long-cycling aqueous zinc metal batteries," *Nature Communications*, vol. 12, no. 1, Nov. 2021
[2] Y. Li *et al.*, "Corrigendum to 'V2O5 nanopaper as a cathode material with high capacity and long cycle life for rechargeable aqueous zinc-ion battery' [Nano Energy 60 (2019) 752–759]," *Nano Energy*, vol. 63, p. 103839, Sep. 2019

CHIRAL-INDUCED SPIN SELECTIVITY FILM ON A SUPERCONDUCTING SURFACE

Chiral organic molecules adsorbed on top of a superconductor. These chiral molecules have been proposed to convert a spin-zero Cooper pair to a spin-one Cooper pair thereby allowing spintronics to be integrated with superconductivity. The project will involve understanding how the CISS effect works in the normal state without superconductivity. Once this understanding is developed, the project will explore how Cooper pairs with zero net spin can convert to spin-polarised Cooper pairs on passing through these molecules. Here, we will also handle some data from real experiments that was performed in Imperial labs recently.

PROJECT MENTOR: Nilai Banerjee

PROJECT MEMBERS: Shahad Abdulrahman Alrifai, Muzon Mahmoud Almahmoud
Nisrin Mohammad Balhareth



ADVANCED CATALYSIS OF SUSTAINABLE ENERGY

I am currently conducting research at the KAUST Catalysis Center at King Abdullah University of Science and Technology (KAUST), under the supervision of Huabin Zhang and in collaboration with PhD student Abdulrahman Allangawi, as part of a broader initiative supported by Aramco. The focus of my project is the synthesis and development of g-C_3N_4 (graphitic carbon nitride) — a highly promising material for both photocatalysis and electrocatalysis. We are synthesizing this material entirely from scratch and exploring its performance in CO_2 reduction to methanol, as well as its potential for water splitting and hyogen production. My work involves extensive hands-on lab experience, including operating advanced characterization instruments and conducting catalytic reaction experiments. We hold weekly meetings to evaluate our lab progress and plan next steps. Zhang has expressed his appreciation for my dedication and performance, and has also indicated the possibility of continuing this work within his research group during my master's studies. This project has significantly strengthened my practical skills in material synthesis, catalyst testing, and clean energy applications aligning closely with my passion for sustainable energy and environmental innovation.

PROJECT MENTOR: Huabin Zhang , Abdulrahman Allangawi Ph.D. Student

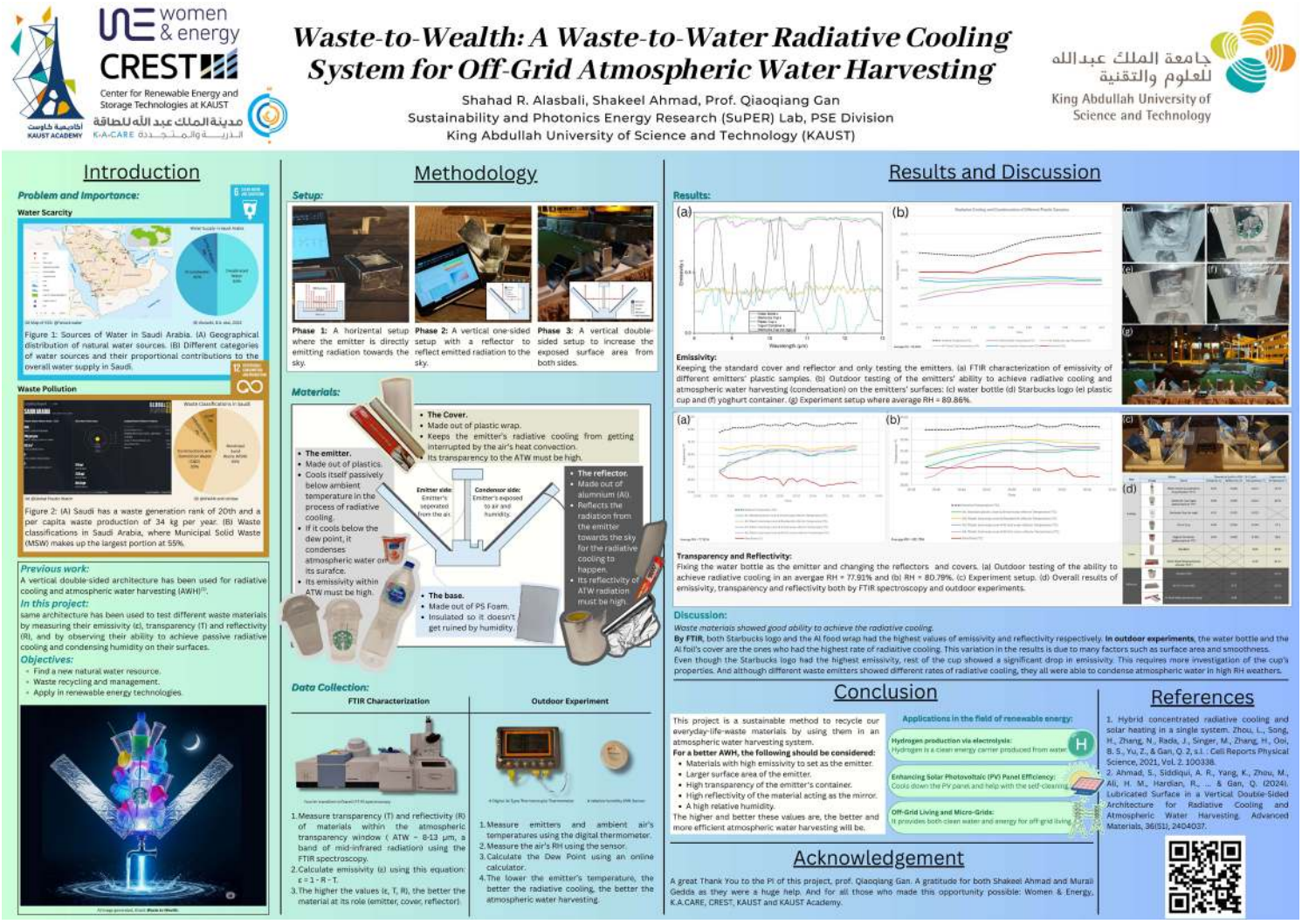
PROJECT MEMBERS: SHAHAD AL GAMDI

A WASTE-TO-WATER RADIATIVE COOLING SYSTEM FOR OFF-GRID ATMOSPHERIC WATER HARVESTING

This project aims to harness atmospheric water from humidity through the principle of radiative cooling, utilizing various repurposed waste materials, primarily plastics. The entire system is designed to be constructed from a diverse range of recycled and upcycled components, emphasizing a sustainable approach to resource management. Furthermore, this innovative system is engineered for remote, passive operation, meaning it is entirely energy-free and requires no external power input. Its functionality is inherently dependent on the intrinsic thermophysical properties of the chosen materials, making it a truly self-sustaining solution for water harvesting.

PROJECT MENTOR: Shakeel Ahmad, Murali Gedda

PROJECT MEMBERS: Shahad Alasbali

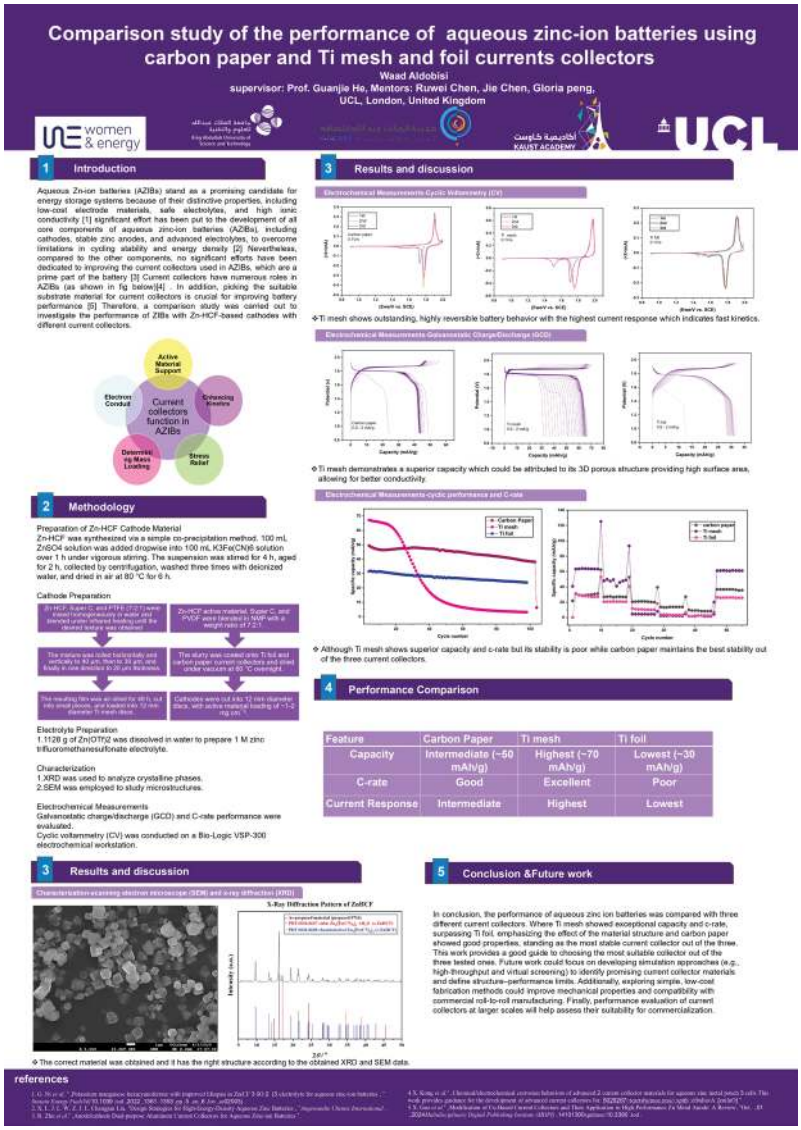


COMPARISON STUDY OF THE PERFORMANCE OF ZINC-ION BATTERIES USING CARBON PAPER AND TI MESH CURRENTS COLLECTORS

While much research on aqueous zinc-ion batteries (ZIBs) has focused on cathodes, zinc anodes, and electrolytes to improve performance, little attention has been given to current collectors, even though they are a key component of the battery. Therefore, this project is a comparison study to investigate the performance of Zinc-ion batteries (ZIBs) with Zn-HCF-based cathodes with different current collectors, which are carbon paper, Ti mesh, and Ti foil. Where Ti mesh showed exceptional capacity and c-rate, surpassing Ti foil, emphasizing the effect of the material structure, and carbon paper showed good properties, standing as the most stable current collector out of the three. This work provides a good guide to choosing the most suitable collector out of the three tested ones.

PROJECT MENTOR: Guanjie He

PROJECT MEMBERS: Waad Wahab Aldobisi



DEVELOPMENT OF PHOTOELECTROCATALYTIC MATERIALS FOR HYOGEN AND CO_2 CONVERSION

This project explores the development of advanced photoelectrocatalytic materials for solar-iven hyogen production and CO_2 reduction, aiming to support Saudi Arabia's Vision 2030 for sustainable energy. Under the supervision of Yun Hau Ng and mentorship of s. Rohul Adnan, Naveen M H, and Aliyah Fakim, I am working in the Catalysis for Alternative and Renewable Energy Lab at KAUST.The research focuses on synthesizing and optimizing three main materials:$BiVO_4$ photoanode for simultaneous H_2 and H_2O_2 generationCu_2O photocathode for CO_2 reduction and urea productionCovalent Organic Frameworks (COFs) as emerging platforms for future experimentsThe work involves material layering techniques to enhance efficiency, characterization using X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM), and photocurrent testing under simulated sunlight. Each material's activity is monitored over time to assess performance stability and energy conversion potential.This hands-on research has deepened my understanding of photoelectrochemical systems and strengthened my commitment to finding innovative solutions for renewable energy.

PROJECT MENTOR: Yun Hau Ng - Rohul Adnan Naveen M H Aliyah Fakim

PROJECT MEMBERS: Washeel omarhashim, Zahra Sami Q. Malaekah

THIN FILM MEMBRANES FOR CO_2 SEPARATION AND CAPTURE

Thin films are essential in CO_2 applications such as gas separation membranes, reduction catalysts, and sensors. They are tailored for high permeability, selectivity, catalytic activity, or conductivity to enable efficient CO_2 capture, conversion, and detection.

PROJECT MENTOR: Nilai Banerjee

PROJECT MEMBERS: Zainab Hussain Alhaddaf, Maram Abdullah Alghamdi

أكاديمية كاوست
KAUST ACADEMY

جامعة الملك عبدالله
للعلوم والتقنية
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Science and Technology

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