i-SPiKE 2023

INTERNATIONAL EXHIBITION & SYMPOSIUM ON PRODUCTIVITY, INNOVATION, KNOWLEDGE & EDUCATION

"Optimizing Innovation in Knowledge, Education and Design"

EXTENDED ABSTRACT

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EXTENDED ABSTRACT

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CATEGORY: AST ACADEMIC INVENTOR

Assalamualaikum warahmatullahi wabarakatuh,

First and foremost, I would like to express my gratitude to the organizing committee of i-Spike 2023 for their tremendous efforts in bringing this online competition a reality . I must extend my congratulations to the committee for successfully delivering on their promise to make i-Spike 2023 a meaningful event for academics worldwide.

The theme for this event, 'Optimizing Innovation in Knowledge, Education, and Design,' is both timely and highly relevant in today's world, especially at the tertiary level. Innovation plays a central role in our daily lives, offering new solutions for products, processes, and services By adopting a strategic approach to 'Optimizing Innovation in Knowledge, Education, and Design,' we have the potential to enhance support for learners and educators, while also expanding opportunities for learner engagement, interactivity, and access to education.

I am awed by the magnitude and multitude of participants in this competition. I am also confident that all the innovations presented have provided valuable insights into the significance of innovative and advanced teaching materials in promoting sustainable development for the betterment of teaching and learning. Hopefully, this will mark the beginning of a long series of i-Spike events in the future.

It is also my hope that you find i-Spike 2023 to be an excellent platform for learning, sharing, and collaboration. Once again, I want to thank all the committee members of i-Spike 2023 for their hard work in making this event a reality I would also like to extend my congratulations to all the winners, and I hope that each of you will successfully achieve your intended goals through your participation in this competition.

Professor Dr. Roshima Haji Said
RECTOR
UiTM KEDAH BRANCH

WELCOME MESSAGE (i-SPiKE 2023 CHAIR)

We are looking forward to welcoming you to the 3rd International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2023 (i-SPiKE 2023). Your presence here is a clear, crystal-clear testimony to the importance you place on the research and innovation arena. The theme of this year's Innovation is "*Optimizing Innovation in Knowledge, Education, & Design*". We believe that the presentations by the distinguished innovators will contribute immensely to a deeper understanding of the current issues in relation to the theme.

i-SPiKE 2023 offers a platform for nurturing the next generation of innovators and fostering cutting-edge innovations at the crossroads of collaboration, creativity, and enthusiasm. We enthusiastically welcome junior and young inventors from schools and universities, as well as local and foreign academicians and industry professionals, to showcase their innovative products and engage in knowledge sharing. All submissions have been rigorously evaluated by expert juries comprising professionals from both industry and academia.

On behalf of the conference organisers, I would like to extend our sincere thanks for your participation, and we hope you enjoy the event. A special note of appreciation goes out to all the committee members of i-SPiKE 2023; your dedication and hard work are greatly appreciated.

Dr. Junaida Ismail
Chair
3rdInternational Exhibition & Symposium Productivity, Innovation, Knowledge, and Education 2023 (i-SPiKE 2023)

2DAMP: THE NOVEL OF (2D)-AMINOETHYL METHACRYLATE PEROVSKITE FOR AMMONIA GAS SENSOR

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ABSTRACT

2DAMP is a novel class of materials based on (2D)-Aminoethyl Methacrylate Perovskite with better stability and great potential for the ammonia gas sensor. **2DAMP** is introduced as a strategy to promote and explore a sustainable green economy. Malaysian government recognises ammonia as a gaseous and vaporous inorganic substance (Category 4) under the Environmental Quality (Clean Air) Regulations 2014, in which the primary source of ammonia usually comes from intensive livestock production and industrial activity. The exploration of **2DAMP** towards SDG 3 (Good Health and Well-Being), as we believe that this material advancement will lead to the creation of sustainable communities. Besides, it will contribute to comfortable environments through the provision of sensor products that consider energy and environmental conservation. In conclusion, **2DAMP** is a novelty product with easy and low-cost production for the future of material sensors.

Keywords: perovskite, stability, ammonia, sensor

INTRODUCTION

One of the major research areas in material science is the search for novel materials for gas sensing that operate at room temperature, are cost-efficient, and are easy to use for quick and selective detection of dangerous contaminants. In this project, **2DAMP** was synthesised from novel lead-based perovskite materials with the new alkyl methacrylate derivatives for detecting ammonia gas. The novel of two-dimensional (2D) aminoethyl methacrylate perovskites $(H_2C{=}C(CH_3)CO_2CH_2CH_2NH_3)_2PbCl_2X_2$ wherein X is an anion (I^- or NO_3^-) using lead (II) iodide and lead (II) nitrate as precursors of inorganic materials were synthesised via a one-step sequential reaction. These 2D materials were found to have better stability and unique structures as compared to the three-dimensional (3D) present perovskite materials. The fabrication in this project was easy and simple, with low-cost tools that potentially explored

its capability in the fabrication of mass-produced gas sensor devices without the use of the typical and complicated glove box. The materials could promise better properties for material stability and their application for gas detection that have never been reported before. Therefore, **2DAMP** materials for ammonia gas sensors were tested byanalyzing their conductivity and sensitivity values.

PROBLEM STATEMENT & OBJECTIVES

The context of this innovation is based on the production of an ammonia gas sensor prototype from synthesised materials, which opens the possibility of perovskite-based gas sensing applications. The continuous monitoring of gas pollutants is necessary to prevent environmental deterioration. Various types of instruments that are available to monitor harmful gases are time-consuming, expensive, and rarely used in real-time. In addition, the complexity of the preparation of gas sensor materials requires the use of expensive sensor equipment and setup (a glove box filled with inert gases). Malaysian government also recognises ammonia as a gaseous and vaporous inorganic substance (Category 4) under the Environmental Quality (Clean Air) Regulations 2014 that contributes to the acidification and eutrophication of ecosystems as well as climate change. There are 2 main objectives of the project which are, to synthesis and compare the stability of novel 2D-aminoethyl methacrylate perovskite (**2DAMP**) using different lead-based materials throughout time at very low cost operation. Then, to measure the conductivity and sensitivity values for electrical measurements of **2DAMP** towards the detection of ammonia gas as gas sensor applications.

PRODUCT DEVELOPMENT

Based on the **Figure 1**, the development of **2DAMP** system were involve of one-step sequential reaction that used spin-coating method (1) to produce **2DAMP** prototype materialsthat coated on Indium Tin Oxide (ITO) glass (2). The **2DAMP** was then exposed toammonia gas at 100 ppm (3) in order to generate gas sensitivity performances using a Keithley electrometer (4). With low-cost and high-sensitivity ammonia gas sensors with a wide range of detection capabilities could be a significant inventive step forward that mitigates the power requirement needed for conventional gas sensors.

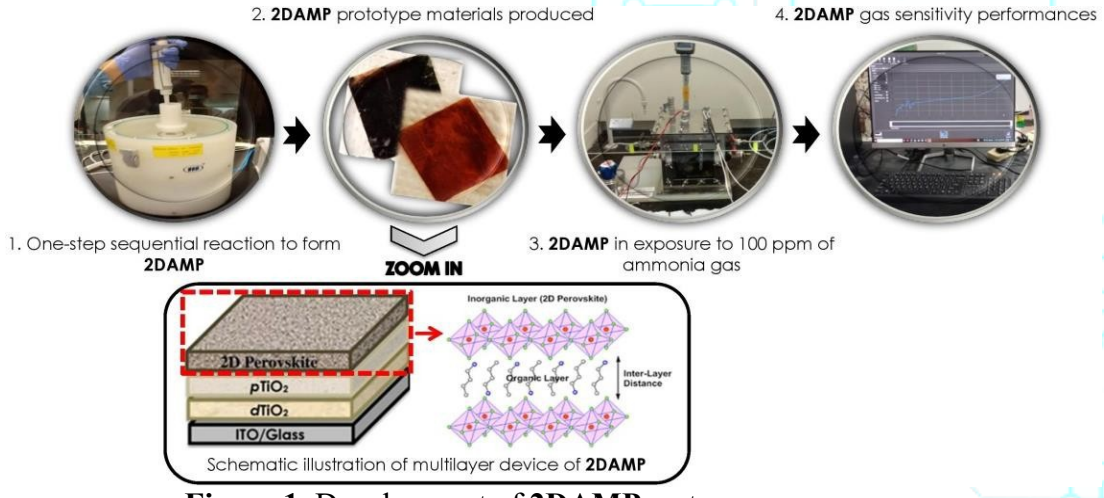

Figure 1. Development of **2DAMP** system

SYSTEM PERFORMANCE

***I*-AMP** and ***N*-AMP** were successfully prepared as **2DAMP** based on material identification by an XRD diffraction spectrometer as shown in **Figure 2**.

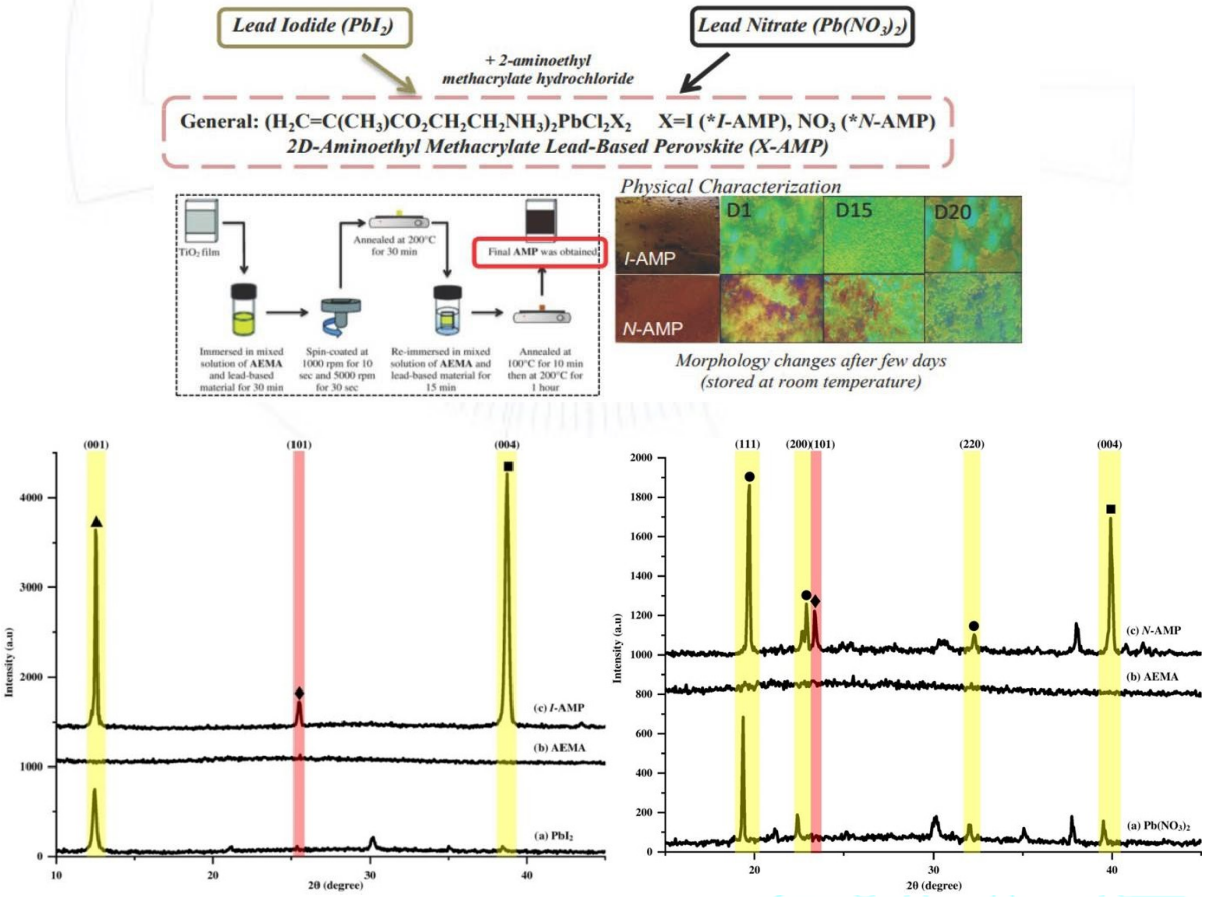

Figure 2. Findings of **2DAMP** using different lead-based materials.

Both **2DAMP** show promising potential as ammonia gas sensors based on the ability of the gas to detect at different time exposures, and sensitivity values were found to decrease as time exposure increased as shows in **Figure 3**. An increasing trend of resistance values showed the conductivity to decrease as there was no availability of free sites on the surface materials.

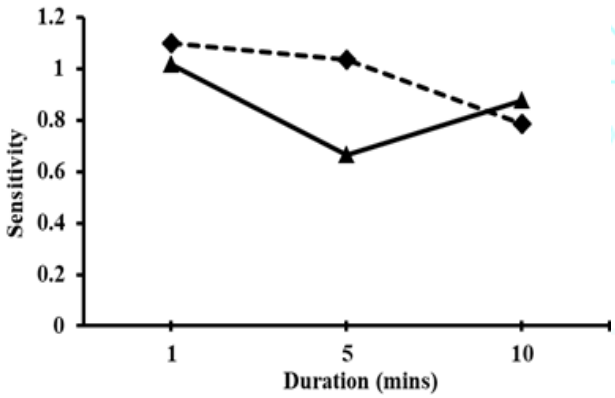

Figure 3. Sensitivity values of **2DAMP**.

ADVANTAGES

The materials fabrication was easy and simple, with low-cost tools without the use of the typical and complicated glove box that has an impact on health applications, environmental monitoring , and socioeconomic impact. **2DAMP** is introduced as a strategy topromote and explore a sustainable green economy. By offering sensor products that consider energy and environmental conservation, the exploration of **2DAMP** for SDG 3 (Good Health and Well-Being), which leads to sustainable communities, contributes to creating comfortable environments. At the educational level, the concept of an Internet-of-Things (IoT) monitoring system should be introduced for students' exposure to IR4.0 technology - based on air quality assessment. With this approach, Malaysian education will be more future-oriented, and the students will be ready for future careers. Meanwhile, gas industry authorities should possess skill sets to adapt, manage, and take advantage of Industry 4.0, and they must be able to see beyond what IR 4.0 technology can offer and its implications for society.

NOVELTY & INVENTIVENESS

The novelty of **2DAMP** may be highlighted by the following points, which is 2**DAMP** was synthesized using new alkyl methacrylate derivatives as a novel lead-based perovskite materials for better stability and great potential as an ammonia gas sensor. Furthermore, the spin-coating method for the preparation of **2DAMP** was introduced due to its ease of use, simplicity, and low cost in a one-step sequential reaction, as shown in **Figure 4**.

Figure 4. Spin-coating method.

2DAMP in two-dimensional (2D) structure better stability compared to conventional three-dimensional (3D) structures due to a long alkyl chain acts as organic spacer cations in the middle of structure 2D. In addition, sensitive nature of novel materials offers ability for gas sensor applications.

COMMERCIALIZATION

The Technology Readiness Level (TRL) of **2DAMP** is in the discovery stage, which is at TRL 4 (Feasibility Demonstration), which is related to lab-scale development and integration **2DAMP** has great potential to commercial in the future from TRL 5 to TRL 9.

ACHIEVEMENTS

To date, findings based on this prototype were published at the Web-of-Science (WoS)and international level (Scopus). Another paper, a review article, is nearing completion and will be published soon.

1. Muhamad Yuzaini Azrai Mat Yunin, Norfatihah Mohd Adenam, Wan M. Khairul, Abdul Hafidz Yusoff, Hasyiya Karimah Adli. "Effect of Stability of Two-Dimensional (2D) Aminoethyl Methacrylate Perovskite Using Lead-Based Materials for Ammonia Gas Sensor Application" *Polymers*, 2022, 14(9), 1853. [Indexing: WoS (Q1) / IF: 4.329]
2. Norfatihah Mohd Adenam, Muhamad Yuzaini Azrai Mat Yunin, Wan M. Khairul, Abdul Hafidz Yusoff, Hasyiya Karimah Adli. "Three-dimensional (3D) and Two-dimensional (2D) Lead Iodide-based Perovskite Materials: A Comparison of Material Stability and Ammonia Gas Sensitivity" *Chemical Physics Impact*, 2022, 100116. [Indexing: Scopus (Q2)]

This research study also have the paper was presented at the international level at the Hybrid International Conference-Current Trends In Islamic Technology (CTILT 2022) in Brunei Darussalam on 9th June, 2022. The title of the paper is Synthesis of Lead Halide Perovskite by using 2-Step Sequential Deposition Method.

For graduate employability, two master students as human capital from the project, one of whom has completed their studies, and the other is awaiting the viva-voce. An undergraduate student also participated in this research project as Final Year Project (FYP) and completed the study in 2021 (graduated).

Besides, the prototype was registered for copyright with the application number (LY2022C02816). The project also has received Gold Award in the Carnival Research and Innovation (CRI) 2023 exhibition that conducted by Universiti Malaysia Kelantan (UMK). In addition, Sani Gas Sdn. Bhd. located in Terengganu sent the letter of interest for further collaboration.

ACKNOWLEDGEMENTS

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Mat Yunin, M. Y. A., Mohd Adenam, N., Khairul, W. M., Yusoff, A. H., & Adli, H. K. (2022). Effect of Stability of Two-Dimensional (2D) Aminoethyl Methacrylate Perovskite Using Lead-Based Materials for Ammonia Gas Sensor Application. Polymers, 14(9), 1853.

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