

Welcome to the Newsletter e-Science Putra. This issue presents the research activities from September to December 2024 which highlight the latest research findings by the selected faculty members.

HIGHLIGHTS

- Enhancing The Stability of Bismuth Based Halide Perovskite Through Synthesis Approach
- Bandwidth Modulation and Pulse Characterization of Passively Q-Switched Erbium-Doped Fiber Laser
- Investigation Of Chemically Modified $Ba_{1-x}Sr_x(Zn_{1/3}Nb_{2/3})O_3$ Perovskites as Novel Functional Electroceramics
- KAP-Based Strategies for Effective Dengue Prevention
- Innovating Statistics Learning with Interactive Games and Tools

ENHANCING THE STABILITY OF BISMUTH BASED HALIDE PEROVSKITE THROUGH SYNTHESIS APPROACH



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Recently, metal halide perovskites have garnered significant attention due to their exceptional properties, including optoelectronic performance, superconductivity, versatility, ferroelectricity, tunability, and photophysical characteristics (Fig.1). These features make them highly suitable for various optoelectronic device applications. Most perovskite-based devices rely on lead-halide perovskite systems. However, the presence of lead (Pb) in these devices poses a serious challenge due to its bioaccumulative toxicity to humans and poor stability against light, heat, and humidity, which limit their practical applications and future commercialization. Among the potential strategies for substituting Pb, the trivalent bismuth cation (Bi^{3+}) stands out due to its similar electronic configuration to Pb^{2+} . Several emerging Bi-based perovskites and derivatives have been experimentally characterized, demonstrating optoelectronic properties comparable to Pb-based perovskites while offering lower toxicity and improved stability.

Our research group has recently explored Bi-based halide perovskites (Fig. 2), focusing on synthesis approaches to enhance their stability. These approaches include modifying the organic chain, adjusting precursor ratios, investigating substitution effects, optimizing solvent selection, altering ligand composition, controlling pH, and fine-tuning reaction temperature and duration. Fig. 3 illustrates samples prepared with varying substitution effects, highlighting that the stability of the samples depends strongly on the synthesis method.

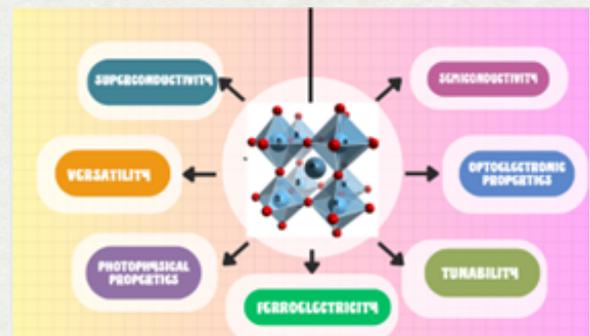


Figure 1: Superior properties of metal halide perovskite

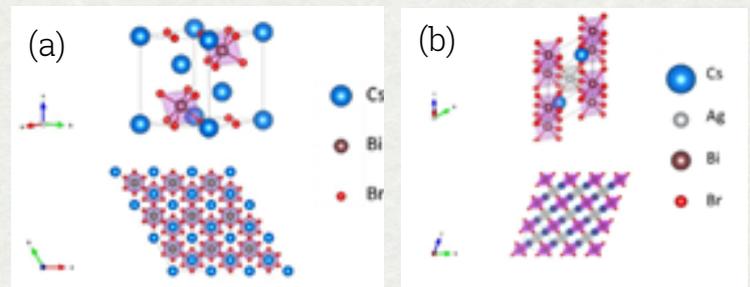


Fig. 2: Lattice Structure of (a) $Cs_3Br_2Br_9$ and (b) $Cs_2AgBiBr_6$

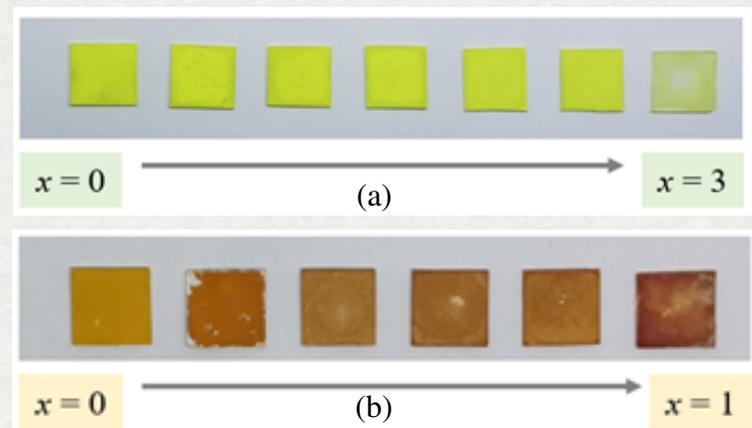


Fig. 3: Physical appearance of (a) $Cs_{2-x}MA_xAgBiBr_6$ b) $Cs_{2-x}MA_xAgBiBr_6$ as MA^+ composition increases.

References

- [1]. Synthesis of cesium silver bismuth bromide double perovskite nanoparticles via a microwave-assisted solvothermal method, *Materials Today Chemistry*, 29, 101477 (2023)
- Investigation of CsBr: BiBr₃ precursor ratio concentration on cesium bismuth bromide perovskite formation, *Chemical Physics*, 566, 111791 (2023).
- Strain-Induced Cesium Bismuth Bromide Perovskite/Bismuth Oxide Bromide Composite with Enhanced Optical Properties, *Materials Today: Proceedings*, 60(2), 1068 (2022).

BANDWIDTH MODULATION AND PULSE CHARACTERIZATION OF PASSIVELY Q-SWITCHED ERBIUM-DOPED FIBER LASER



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The modulation of laser bandwidth by utilizing an ultranarrow tunable bandpass filter in a passively Q-switched erbium-doped fiber laser has been demonstrated. The passive Q-switch mechanism is enabled by using carbon nanotubes as saturable absorber at a Q-switched threshold of 35.5 mW. Based on spectral filtering effect introduced by the ultranarrow tunable bandpass filter, the 3dB laser bandwidth can be tuned from 0.016 nm to 0.478 nm at a fixed pump power of 75.9 mW. The corresponding pulse behavior for each different bandwidth is characterized, and the results reveals that the pulse width can be as well tuned from 7.8 to 2.6 μ s against the laser bandwidth, which agrees with the rule of time-bandwidth product.

Correspondingly, the pulse repetition rate and the pulse energy vary from 16.23 kHz to 26.16 kHz and from 0.67 to 1.03 μ J respectively across the laser bandwidth. Further investigation of the pulse performance is performed against the pump power increment up to 107.2 mW. To the best of our knowledge, this is the first demonstration of spectrum bandwidth modulation in a passively Q-switched fiber laser, which can be useful for fully exploiting the possibilities of Q-switched pulse applications

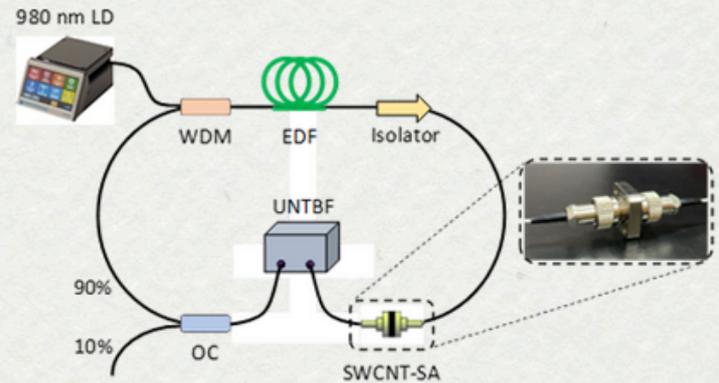


Figure 1. Experimental setup of SWCNT-based Q-switched EDFL with tunable bandwidth.

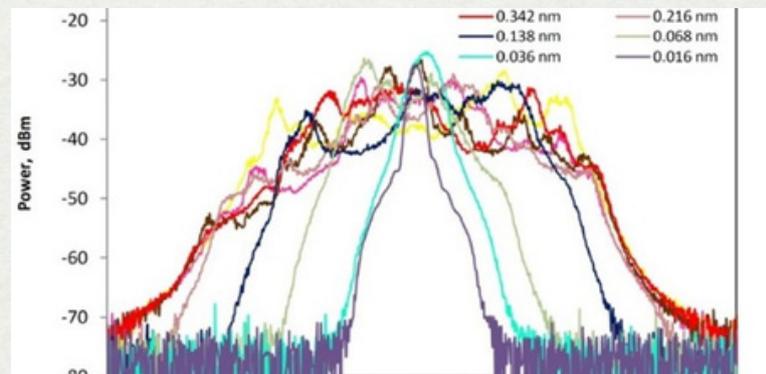


Figure 2. Bandwidth tunable Q-switched EDFL output spectra

References

- [1]Jasem I N, Abdullah H H and Abdulrazzaq M J 2024 Passively Q-switched erbium-doped fiber laser based on two-dimensional boron carbide nanoparticles as saturable absorber *Opt Quant Electron* 56 571
- [2]Albaqawi H S, Hedhili F, Chebaane S, Meftah A and Al-Shomar S M 2024 Q-switched fiber laser generation utilizing metal oxide-based saturable absorber in the region of 1.0 μ m and 1.5 μ m *Optik* 298 171597
- [3]Zhang C, Wu T, He S, Zhang C and Fu B 2024 Multiplexed dual combs in a bidirectional nanotube-mode-locked fiber laser *Opt. Laser Technol.* 168 109865

INVESTIGATION OF CHEMICALLY MODIFIED $Ba_{1-x}Sr_x(Zn_{1/3}Nb_{2/3})O_3$ PEROVSKITES AS NOVEL FUNCTIONAL ELECTROCERAMICS

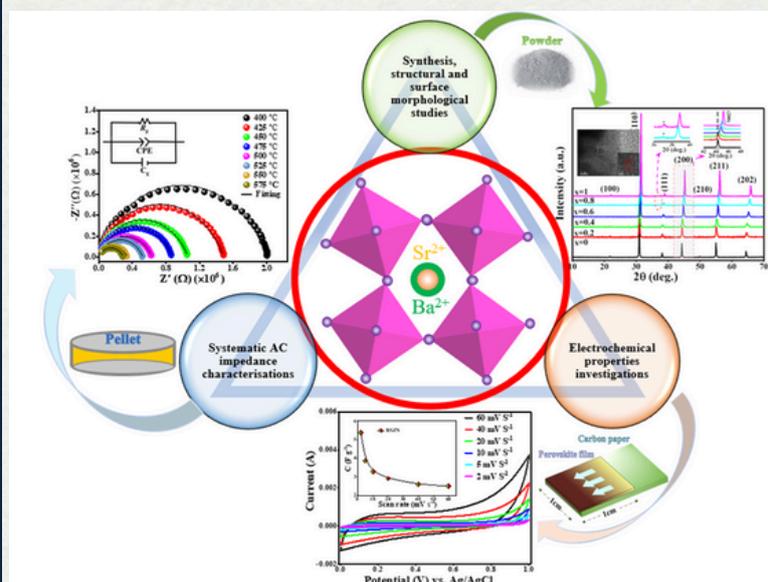


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The growing need for renewable energy and the miniaturisation of electronic devices have prompted exhaustive research into functional ceramics suitable for various energy storage systems including batteries, supercapacitors and dielectric capacitors [1-3]. Perovskite-structured oxides, with their flexible crystal-chemical structure, compositional variables and highly tunable electrical properties, have been meticulously studied for a broad spectrum of applications due to their intriguing paraelectric, ferroelectric and electrochemical properties [1-2]. Notably, $Ba(Zn_{1/3}Nb_{2/3})O_3$ (BZN) perovskite has emerged as a promising candidate owing to its moderately high dielectric constant ($\epsilon' = 41$), exceptionally low dielectric loss ($\tan \delta \approx 10^{-4}$) and cost-effectiveness. Consequently, we undertake a systematic investigation of Sr-doped BZN perovskites, meticulously examining their phase formation, solid solubility, structural, dielectric and electrochemical properties.

Herein, we present a detailed report on the structural, dielectric and electrochemical characteristics of $Ba_{1-x}Sr_x(Zn_{1/3}Nb_{2/3})O_3$ (BSZN, $0 \leq x \leq 1$) solid solution synthesised via solid-state reaction. Our comprehensive analysis confirms the formation of a complete substitutional solid solution, with BSZN cubic perovskites exhibiting the $Pm\bar{3}m$ space group for $x \leq 0.6$ while the pseudo-cubic phases emerge at $x > 0.6$. Furthermore, we employ both Scherrer and Williamson-Hall analyses to ascertain the nano-sized crystallites, corroborating the presence of large polyhedral grains ranging from 0.1 to 0.3 μm , as observed through FE-SEM.

Upon investigating the dielectric properties, we discern a consistent variation in both ϵ' and $\tan \delta$ with increasing dopant concentration. However, an anomalous observation arises for the composition $x = 0.6$, exhibiting the lowest $\tan \delta$ of 0.078 and the highest ϵ' of 28. This intriguing phenomenon can be attributed to the synergistic effects of larger grain size, higher relative density and enhanced polarisation per molar volume. The impedance analysis revealed that these BSZN perovskites exhibit negative temperature coefficient of resistance (NTCR) behaviour. Moreover, the combined plots of imaginary modulus (M'') and impedance (Z'') against frequency reveal the short-range movement of localised charge carriers, suggesting a non-Debye-type relaxation process.



References

- [1] A. Žužić, A. Ressler, J. Macan, *Ceram Int.*, 48, 2022, 27240
- [2] K. Kannan, K.B. Tan, Z. Zainal, C.C. Khaw, S.K. Chen, O.J. Lee, *Results Phys.*, 19, 2020, 103374
- [3] Y. Feng, K.B. Tan, S.K. Chang, Y. Sulaiman, H.N. Lim, M. Lu, Y. Wang, *Prog. Solid State Chem.* 76, 2024, 100495

KAP-BASED STRATEGIES FOR EFFECTIVE DENGUE PREVENTION



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Dengue remains a critical public health issue in Malaysia, with over 120,000 cases reported in 2024, reflecting a 15% increase from the previous year. Selangor, a highly urbanized state, consistently records the highest number of cases. A recent study conducted in Selangor (Mustapha et al., 2023) compared dengue-related knowledge, attitudes and practices (KAP) between eight hotspot and eight non-hotspot areas, involving 320 respondents. Hotspots, defined as areas with dengue outbreaks lasting over 30 days, showed significantly better awareness and participation in preventive measures. Despite high levels of knowledge, the majority (83.1%) of residents in hotspot areas were unaware that a person could be infected with dengue more than once, while 62.8% agreed that dengue patients could recover without treatment. Attitudes toward dengue were significantly higher in hotspot areas (mean 32.0 ± 4.60) compared to non-hotspot areas (mean 28.78 ± 5.51). Preventive practices were also more prevalent in hotspot areas, with 94.4% engaging in fogging activities compared to 81.9% in non-hotspots. These findings demonstrate how repeated exposure to outbreaks and targeted health interventions influence community behaviors.

While hotspots showed stronger KAP scores, critical gaps remain across both types of communities. For instance, the use of insecticide-treated nets was poor in hotspot areas, with only 7.5% adopting this measure. Non-hotspot areas, with their lower frequency of outbreaks, displayed greater complacency, leaving them vulnerable to future outbreaks. The study identified a positive correlation between knowledge, attitudes, and practices, underscoring the importance of translating awareness into effective action. To improve dengue prevention, KAP-based strategies must address persistent misconceptions, promote effective practices like fogging and stagnant water removal and encourage individual responsibility.

Hotspot communities, with their higher engagement levels, provide a model for broader, scalable interventions. Lessons from more affected communities highlight that KAP-based strategies, supported by consistent public health efforts and proactive community involvement, are essential in combating dengue effectively.

	Hotspot	Non-Hotspot	P-value
Awareness of repeated dengue infections	83.1%	68.1%	0.002*
Recognition of Aedes mosquito characteristics	96.9%	87.5%	0.002*
Knowledge of dengue symptoms (rash)	86.9%	76.9%	0.02*
Belief in dengue prevention (mean scores)	32.0	28.8	<0.05*

Table 1: Significant differences in Knowledge and Attitudes between Hotspot and Non-Hotspot Areas in Selangor

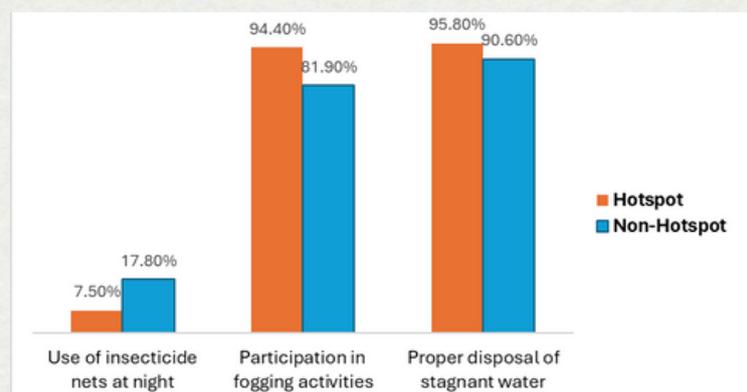


Figure 1: Differences in practices between hotspot and non-hotspot areas in Selangor

References

Mustapha, I., Nor, S., Shohaimi, S., Adam, M. B., Nallappan, M., Ab Rahman, A. H., & Salari, N. (2023). A Comparative Study on Dengue-Related Knowledge, Attitude and Practice in Hotspot and Non-Hotspot Areas in Selangor. *Pertanika Journal of Science & Technology*, 31(1).

INNOVATING STATISTICS LEARNING WITH INTERACTIVE GAMES AND TOOLS



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As technology advances, Gen Z's learning preferences are evolving. Accustomed to digital interaction, they seek engaging, dynamic experiences that traditional methods like PowerPoint slides, white boards and paper exams can't fully capture. With a preference for instant feedback, visual stimuli, and interactivity, AI-driven, gamified tools and mini apps offer ideal solutions to enhance their education.

The interactive wheel quiz game (Figure 1) presents a new statistical question with each spin, instantly testing the player's knowledge. It offers positive feedback for correct answers, shows the correct answer for mistakes, and displays the total score at the end.

Learning statistics, often seen as complex or daunting, can greatly benefit from modern approaches like interactive games and apps. These tools transform data analysis, probability, and hypothesis testing into fun challenges, improving memory retention by actively engaging the brain. With visual stimuli, problem-solving, and instant feedback, students are more likely to retain key concepts and strengthen neural connections. This approach motivates students by celebrating successes and encouraging reflection on mistakes.

The diabetes risk assessment tool (Figure 2) use user inputs to provides instant feedback, showing how statistics apply to real-life health decisions. Using statistical modelling, it predicts disease outcomes and highlights preventive factors. These tools blend learning and entertainment, allowing students to practice key concepts in an engaging, empowering way. With gamification and simulations, they make statistics relatable and deepen understanding, offering a future-focused approach for a generation that values speed, efficiency, and technology.

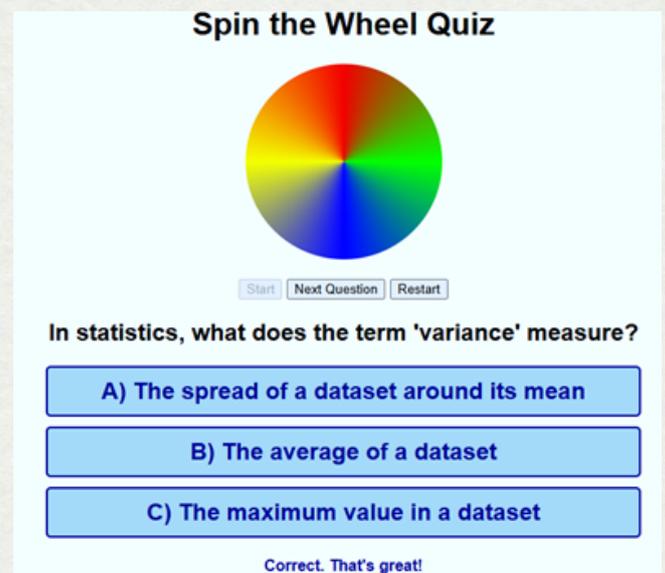


Figure 1: Statistics Wheel Quiz

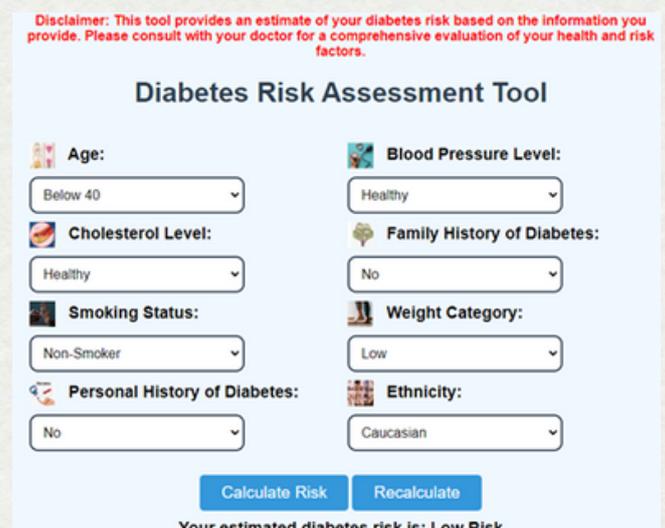


Figure 2: Diabetes Risk Assessment Tool

References

[1] Jayanthi, A. (2021). Quick Statistical Applications with SPSS, UPM Press.

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It is a way of THINKING.**

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