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# ISETC2025

2<sup>ND</sup> INTERNATIONAL SCIENCE,  
ENGINEERING AND TECHNOLOGY  
COLLOQUIUM



## THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A  
SUSTAINABLE WORLD

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Faculty of Applied Sciences,  
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## **PREFACE**

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

Ms. Nurul Nazwa Mohammad

Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

## DETERMINING OPTIMAL DOPANT CONCENTRATION IN HOLE BLOCKING LAYER IN ALUMINIUM GALLIUM NITRIDE BASED DEEP-ULTRAVIOLET LIGHT EMITTING DIODE

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**Abstract:** Dopant concentration of layers plays a critical role in enhancing deep-ultraviolet light emitting diode (DUV-LED). The hole blocking layer (HBL) has been modified to have various dopant concentration to find the optimal concentration. The performance of high concentration,  $1 \times 10^{19}$ , is best with internal quantum efficiency (IQE)  $\sim 0.5\%$  which is more than 200% higher compared to lower concentrations.

**Keywords:** DUV-LED, HBL, concentration, radiative recombination, IQE

### INTRODUCTION

Across the decades AlGaN based DUV-LED has seen great improvements and demands for its low activation power, long lasting, and clean environment technologies. In this work, 6 DUV-LEDs of different silicon (Si) doping concentrations ranging from  $1 \times 10^{15} \text{ cm}^{-3}$  to  $1 \times 10^{20} \text{ cm}^{-3}$  are simulated and analysed to investigate the effects of dopant concentrations in HBL on a DUV-LED. The simulated epilayers is performed using the one-dimensional drift-diffusion charge control (1D-DDCC) solver program in MATLAB software developed by Yuh-Renn Wu (Aman et al., 2022).

### MATERIALS AND METHODS

The epitaxial structure include a 500nm thick  $\text{Al}_{1.00}\text{Ga}_{0.00}\text{N}$  substrate, a 500nm  $\text{Al}_{1.00}\text{Ga}_{0.00}\text{N}$  and a 500nm  $\text{Al}_{0.95}\text{Ga}_{0.05}\text{N}$  buffer layers, a 3000nm  $\text{Al}_{0.90}\text{Ga}_{0.10}\text{N}$  electron injection layer (EIL), a 20nm thick HBL with material composition  $\text{Al}_{0.85}\text{Ga}_{0.15}\text{N}$ , 3 quantum wells (QW) and 4 quantum barriers (QB) with thickness 4nm and 12nm, and composition  $\text{Al}_{0.70}\text{Ga}_{0.30}\text{N}$  and  $\text{Al}_{0.80}\text{Ga}_{0.20}\text{N}$  respectively, 20nm  $\text{Al}_{0.85}\text{Ga}_{0.15}\text{N}$  electron blocking layer (EBL), 15nm  $\text{Al}_{0.75}\text{Ga}_{0.25}\text{N}$  hole injection layer (HIL), and 35nm  $\text{Al}_{0.00}\text{Ga}_{1.00}\text{N}$  contact. N-side is doped with Si and p-side is doped with magnesium (Mg).

### RESULTS AND DISCUSSION

The graph of left current shows lower value at higher dopant concentrations such as D20 with low current value for the increasing voltage which indicates high series resistance while the lower concentrations indicate lower series resistance.

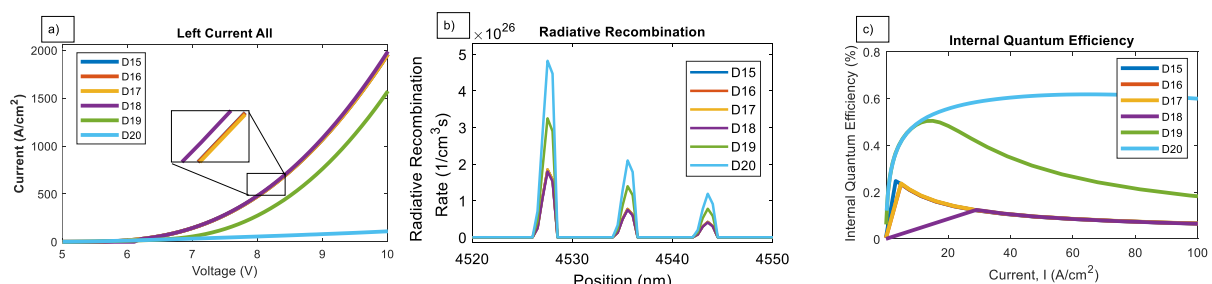


Figure 1. The left current, radiative recombination, and IQE of all DUV-LED (D15-D20)

Typically, lower left current would indicate lower radiative recombination but D20 shows the highest radiative recombination rate followed by D19 and the rest that show similar performance. In terms of IQE D20 also shows highest efficiency at ~0.6% and D20 at ~0.5 which are more than 200% improvement compared to the other DUV-LEDs. Despite D20 performance, it is realistically impossible to achieve due material defects it causes (Kinoshita et al., 2013) but is included as part of this work to show how it would perform should it be possible.

## CONCLUSION

AlGaIn DUV-LEDs modified with various HBL n-dopant concentrations is analyzed through a numerical framework to study the effects of dopant concentrations in HBL to DUV-LED performance. In conclusion, performance increases with dopant concentrations up to  $1 \times 10^{19} \text{ cm}^{-3}$  with a higher radiative recombination and IQE, since  $1 \times 10^{20} \text{ cm}^{-3}$  is impossible to achieve.

## ACKNOWLEDGEMENT

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Prof. Madya Dr. Nur Hisham Ibrahim  
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Sekian, terima kasih.

**"BERKHIDMAT UNTUK NEGARA"**

Saya yang menjalankan amanah,

*Setuju.*

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