ISETC2025

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ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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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

STRUCTURE AND MORPHOLOGY CHARACTERISTICS OF COPPER GALLIUM OXIDE SPUTTERED ON DIFFERENT SUBSTRATES

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Abstract: Transparent p-type semiconductor thin films exhibiting significant optical and electrical represent a promising material for applications in semiconductor devices. The quality of the films' structures also critically influences the performance of this transparent semiconductor. Thus, this study investigates the structure and morphology of p-type semiconductor of $CuGaO_2$ thin films fabricated onto different substrates such as the ITO, glass and quartz using RF Sputtering technique. From the X-Ray Diffraction (XRD) analysis, the $CuGaO_2$ thin film on the ITO substrate has the most noticeable crystalline with the significant peaks have been observed at around $2\theta = 35^0$. In contrast, the $CuGaO_2$ on the glass and quartz substrates, both the XRD profiles demonstrated broad hump around $2\theta = 15^0$ to $3o^0$. The absence of distinct peaks for both substrates confirming a poor crystalline of $CuGaO_2$ thin films. Meanwhile, the morphology of the $CuGaO_2$ thin films examined by the Atomic Force Microscopy (AFM) shows that films deposited on the ITO substrate had the rougher surface (R_a = 2.920 nm; R_q = 3.670 nm) as compared to the films on the glass and quartz substrate. From these findings, it indicates that the crystalline structure of the $CuGaO_2$ is strongly influenced by the substrate material. These results provide the role of substrate selection in dictating the crystalline quality of $CuGaO_2$ thin films, suggesting that ITO substrates promote better crystallinity, which may enhance the films' electrical and optical functionalities.

Keywords**:** *Copper gallium, transparent semiconductor, crystalline, thin films*

INTRODUCTION

$CuGaO_2$, a delafossite structured Cu-based transparent oxides (TCOs) is a p-type semiconductor. It has a larger lattice constant, a = 2.98Å, exhibits p-type conductivity and energy band gap of 3.6 eV (Alias et.al., 2019). The efficiency and performance of $CuGaO_2$ thin films in semiconductor applications are largely dependent on their structural characteristics. Sputtering technique has been used as a method of $CuGaO_2$ film deposition either through reactive (Yu et al., 2018) single or dual sputtering using Cu and Ga_2O_3 targets (Bharath et.al, 2024). It is still difficult to produce high-quality p-$CuGaO_2$ films with the appropriate structural and morphological features. Enhancing films' quality requires optimizing sputtering parameters since the properties of the thin film significantly influenced by the deposition parameters (Ashok et.al, 2023) including the type of substrate. Therefore, the purpose of this paper is to examine how the selection of substrates (ITO, quartz and glass) affects the structural and morphological characteristics of $CuGaO_2$ thin films.

MATERIALS AND METHODS

Prior to fabrication of $CuGaO_2$ thin films, the substrates thoroughly cleaned to remove any impurities that might affect the quality of the thin films. First, the substrates soaked in decon-90 for 24 hours. Then, it was placed inside the GT Sonic bath for 15 minutes. Finally, substrates were rinsed with distilled water before dried with dry nitrogen gas. The $CuGaO_2$ thin films were fabricated using an RF magnetron sputtering machine with the sputtering parameters employed are shown in Table 1.

After deposition the structural properties of $CuGaO_2$ thin films were determined using X-Ray Diffraction technique. The X-ray source was set to 40kV and 50mA with a scanning speed of 4° per minute and a step size of 0.02° and

scanning range 2θ was adjusted from 10° to 80°. Meanwhile, an Atomic Force Microscope (AFM) in tapping mode was used to examine the surface morphology of $CuGaO_2$ thin films.

Table 1. Deposition parameters using RF magnetron sputtering technique

Parameters	Values
Target	$CuGaO_2$ (99.99%)
Substrate	Indium Tin Oxide (ITO), Quartz and Glass
Chamber Pressure	10^{-5} Torr
Sputtering Pressure	9 milliTorr
Sputtering Power	100 W
Substrate Temperature	Room Temperature
Deposition Time	30 minutes

RESULTS AND DISCUSSION

Structure Analysis by XRD

Figure 1 demonstrates the XRD profiles of the $CuGaO_2$ thin films on various substrates, with no post-deposition treatment applied to any of all the thin films. Films grown onto the ITO substrate has sharp and strong peaks that indicate crystallinity structure. In contrast, the thin films grown on glass and quartz substrates show broad peaks implying a nearly complete amorphous structure. The absence of significant peaks due to the insufficient energy to promote the crystalline phases of thin films on those substrates (Saikumar et. al., 2022).

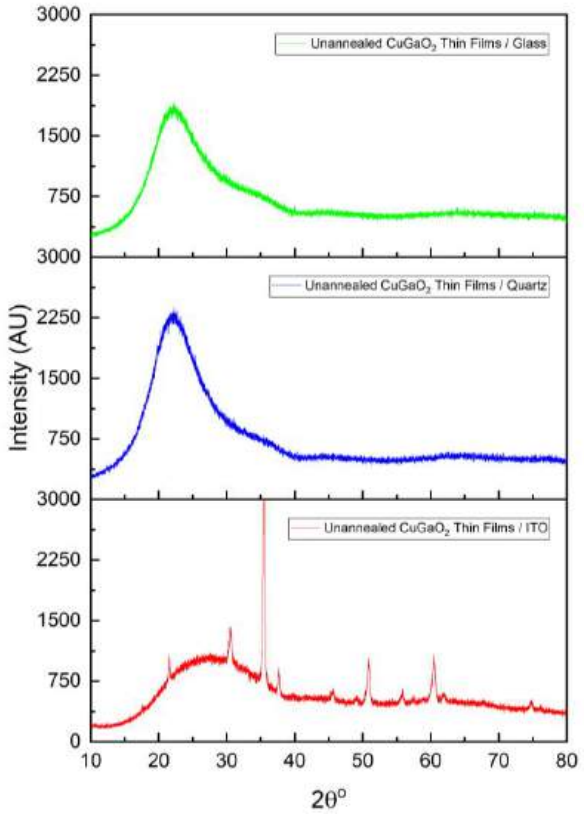


Figure 1. Comparison of XRD profiles of the as-deposited $CuGaO_2$ thin films

Surface Morphology by AFM

The $CuGaO_2$ films grown onto the ITO substrate exhibited the highest surface roughness with the average roughness (R_a) and the root mean square (R_q) of 2.920 nm and 3.670 nm, respectively. This finding reflecting enhanced crystallinity which in agreement with the peaks observed on the XRD pattern. Meanwhile, the film deposited on the glass substrate showed the smoothest surface morphology, with R_a of 0.282 nm and R_q of 0.361 nm, as summarized in Table 2. The roughness of sample on the quartz presents a slightly difference with the R_a films on the quartz. This results imply that the CuGaO2 films having lesser crystallinity than those fabricated on ITO.

Table 2. Roughness parameters of $CuGaO_2$ thin films deposited on different substrates

Substrate	R_q (nm)	R_a (nm)	R_{max} (nm)
ITO	3.670	2.920	31.40
Quartz	0.440	0.347	4.40
Glass	0.361	0.282	3.16

CONCLUSIONS

The $CuGaO_2$ thin films have been successfully fabricated using RF Magnetron Sputtering. The influence of substrates on the structure and morphology of the films have been characterized and reported. The presence of distinct peaks of $CuGaO_2$ on the ITO substrate from the XRD pattern, suggests that the crystallinity of $CuGaO_2$ has improved compared to other substrates. The morphology of the film also supports the favorable of ITO substrate in promoting the growth of high-quality $CuGaO_2$ thin films.

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Sekian, terima kasih.

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