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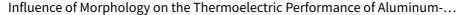
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# Influence of Morphology on the Thermoelectric Performance of Aluminum-Doped Zinc Oxide (AZO) on Diverse Substrate Material

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Source JURNAL KEJURUTERAAN

Volume: 37 Issue: 7 Page: 3279-3288

DOI: 10.17576/jkukm-2025-37(7)-13

Published OCT 2025

Indexed 2025-11-25

**Document Type** Article

Abstract Aluminum-doped zinc oxide (AZO) thin films for thermoelectric

solar energy conversion are investigated in this work. It examines

how different substrates and sputtering powers affect the

morphology and thermoelectric characteristics of AZO thin films. Polyimide, quartz, and fused silica were selected as substrates to explore this interaction. Utilizing radiofrequency (RF) magnetron

sputtering, AZO thin films were deposited onto the substrates.

varying it between 200 W, 250 W, and 300 W. The distance

between the target and substrate was kept at 5 cm, the argon gas

The impact of the sputtering power on the films was examined by

flow rate was kept at 10 sccm, and the sputtering period was fixed at one hour. All other deposition parameters were kept constant. The SEM study showed that thicker AZO thin films and a rougher surface texture were the outcomes of increasing the sputtering power. On the other hand, the EDS analysis confirmed that all predicted components were consistently present in the AZO composition for every substrate that was examined. In addition, the Seebeck coefficient, electrical conductivity, and thermoelectric power factor (PF) were measured using a specially designed experimental setup to characterize the thermoelectric properties. The results revealed that the substrate material significantly influenced the morphology of the AZO thin film, which subsequently impacted their thermoelectric properties. Fused silica yielded the most promising results, achieving a power factor of 9.362 nW/mK2, conductivity of 2.817 S/m, and Seebeck coefficient of-56.58 mu V/K at 150 degrees C and a sputtering power of 300 W. The study highlights the critical role that substrate selection and deposition parameters play in optimizing the thermoelectric performance of oxide-based thin films. Higher sputtering power generally improved film thickness and conductivity but also introduced surface roughness that varied depending on substrate smoothness. Polyimide, due to its naturally rougher surface, exhibited more irregular AZO film growth compared to quartz and fused silica. These structural differences translated into noticeable variations in the thermoelectric behavior. The findings suggest that optimizing both deposition power and substrate type can enhance the efficiency of AZO thin films in solar-thermal energy harvesting applications. This work contributes to ongoing efforts to develop cost-effective, non-toxic, and stable thermoelectric materials suitable for integration in flexible and transparent energy systems.

### **Keywords**

**Author Keywords:** Aluminum Zinc Oxide thin film; fused silica; quartz; polyimide; power factor (PF)

Keywords Plus: POWER

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Categories/ Classification

Research Areas: Engineering

Web of Science Categories

Engineering, Multidisciplinary

**Language** English

Accession

WOS:001616871400009

Number

**ISSN** 0128-0198

**eISSN** 2289-7526

IDS Number 9WT4E

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