THESIS

DEVELOPMENT OF A THERMOELECTRIC GENERATOR BASED ON Cu-DOPED ZnO SEMICONDUCTOR

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PHYSICS STUDY PROGRAM
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JAWA TIMUR
SURABAYA

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Submitted to fulfill part of the requirements
In obtaining a Bachelor of Science
Physics Study Program

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APPROVAL SHEET

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Hereby declare that in this scientific document of this Thesis does not include any part of another scientific work that was previously submitted to earn an academic degree at any Higher Education institution. Additionally, this document does not contain any work or opinions written or published by other individuals or institutions, except for those that are properly cited in the text and fully listed in the references.

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Surabaya, 6 May 2026

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ABSTRACT

This study aims to develop a thermoelectric generator using ZnO as a semiconductor material. It will use ZnO as one component and Cu-doped ZnO (ZnO:Cu) as the complementary component. The ZnO:Cu samples were synthesized using the sol-gel method followed by a pelletizing process. Characterization techniques included XRD to analyze phase formation, FTIR to identify functional groups, UV-Vis spectroscopy to determine band gap energy, and SEM to observe particle shape and distance between particles. In addition, the electrical performance of the TEG was evaluated by measuring the output voltage under temperature variations. The results indicate that Cu doping in ZnO is integrated into the ZnO lattice. Additionally, Cu doping lowered the band gap energy from 3.28 eV (pure ZnO) to 2.65 eV (ZnO:Cu). This change also affected the crystal structure and shape of ZnO, which may improve its properties as a semiconductor material for thermoelectric applications. Voltage measurements at temperatures of 40°C, 50°C, and 60°C showed average values of 0.7 mV, 1.1 mV, and 1.4 mV, respectively. The highest voltage occurred at 60°C. The optimal Seebeck coefficient was also measured at 60°C, ranging from 0.05 to 0.06 mV/°C.

Keywords: Thermoelectric generator, semiconductor, sol-gel, ZnO, doping.

PREFACE

First, I want to express my gratitude to Allah SWT for his blessings, grace, and guidance, which allowed the author to complete this undergraduate thesis titled **"Development of a Thermoelectric Generator Based on Cu-Doped ZnO Semiconductor"** as a partial fulfillment of the requirements for obtaining a Bachelor of Science degree in the Physics Study Program, Faculty of Engineering and Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur.

This thesis was prepared to describe the research plan for the synthesis and characterization of semiconductor materials and their use in a thermoelectric generator (TEG) system. This research is expected to help improve renewable energy materials, particularly in improving the efficiency of heat-to-electricity energy conversion.

In the preparation of this thesis, the author realizes that it would not have been completed without the assistance, support, and guidance of many people. Therefore, the author would like to sincerely thank to:

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The author realizes that this thesis is not perfect. Therefore, constructive feedback and suggestions for improvement are welcome. It is hoped that this thesis will be beneficial for the author and for others who are engaged in the same field of study.

Surabaya, 5 March 2026

The Author

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