EFFECT OF MAIZE HUSK REINFORCEMENT ON THE MECHANICAL PROPERTIES OF 1170 ALUMINIUM

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIESOF COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA IN PARTIALFULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER IN ENGINEERING (M.Eng) DEGREE IN MECHANICAL ENGINEERING, IN THE DEPARTMENT OF MECHANICAL ENGINEERING, COLLEGE OF ENGINEERING, COVENANT UNIVERSITY, OTA.

JUNE 2022

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the degree of Master in Mechanical Engineering in the Department of Mechanical Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria.

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Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, **WILLIAMS, JOSEPH AJUWAEZE (20PCM02103)** declare that this research work titled **"EFFECT OF MAIZE HUSK REINFORCEMENT ON THE MECHANICAL PROPERTIES OF 1170 ALUMINIUM"** was carried out by me under the supervision of Prof. Roland Tolulope Loto of the Department of Mechanical Engineering, College of Engineering, Covenant University, Ota, Nigeria. I attest that this dissertation has not been presented either wholly or partially for the award of any degree elsewhere, and the results of this research were obtained by tests carried out in the laboratory. All sources of data and scholarly information used in this dissertation are duly acknowledged.

WILLIAM, JOSEPH AJUWAEZE

Signature and Date

CERTIFICATION

We certify that this dissertation titled **"EFFECT OF MAIZE HUSK REINFORCEMENT ON THE MECHANICAL PROPERTIES OF 1170 ALUMINIUM"** is an original research work carried out by **WILLIAMS, JOSEPH AJUWAEZE (20PCM02103)** in the Department of Mechanical Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria under the supervision of Prof. Roland Tolulope Loto. We have examined and found this work acceptable as part of the requirements for the award of a Master's (M.Eng) degree in Mechanical Engineering.

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(External Examiner) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DEDICATION

I dedicate this research work first to The Almighty God, my Everlasting Father, creator, and source of my strength, inspiration and knowledge. My parents, Mr. Francis Ajuwaeze Williams & Mrs. Ruth Emilomo Williams, and my siblings for their continuous prayers, love, support, and encouragement towards my work. Also, to my lecturers and instructors, friends, and colleagues of the Department of Mechanical Engineering, Covenant University who were instrumental in ensuring that this work was a success. Thank you, and God bless you all immensely.

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LIST OF EQUATIONS

ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AMC	Aluminium Matrix Composite
AIW	Agro-Industrial Waste
AISI	American Iron and Steel Institute
ASTM	American Society for Testing and Materials
BHN	Brinell Hardness Number
C_d	Corrosion Current Density
C_P	Corrosion Potential
C_R	Corrosion Rate
CFRP	Carbon Fibre Reinforced Polymers
CMC	Ceramic Matrix Composites
CFA	Coal Fly Ash
CSA	Coconut Shell Ash
CMP	Coconut Shell Micro Particles
CoF	Coefficient of Friction
CNT	Carbon Nanotubes
DRAM	Dynamic Random Access Memory
ES	Egg Shell
EDS	Energy Dispersive X-ray Analysis
EIS	Electrochemical Impedance Spectroscopy
EFM	Electrochemical Frequency Modulation
E_R	Electrical Resistance
FVW	Fruits and Vegetable Waste
FE-SEM	Field Emission Scanning Electron Microscopy
FSP	Friction Stir Processing
GFRP	Glass Fibre Reinforced Polymers
GSA	Groundnut Shell Ash
GDP	Gross Domestic Product

HSS	High Strength Steel
HSLA	High Strength Low Alloy
KFRP	Kevlar Fibre Reinforced Polymers
LPR	Linear Polarization Resistance
MMC	Metal Matrix Composites
MMHC	Metal Matrix Hybrid Composite
NP	Nano Particles
OMC	Organic Matrix Composites
PMC	Polymer Matrix Composites
PKS	Palm Kernel Shell
RHA	Rice Husk Ash
SDG	Sustainable Development Goals
SEM	Scanning Electron Microscopy
ULSAB	Ultra-Light Steel Auto Body
WFA	Wood Fly Ash
Wt. %	Weight Percentage
XRD	X-ray Diffraction
XRF	X-ray Fluorescence
η	Inhibition efficiency
μ	Micron

ABSTRACT

The growing global population is increasing waste generation, and agricultural and industrial food processing waste is a major ecological risk. These wastes, improperly disposed of by uncontrolled landfill disposal, incineration, or indiscriminate dumping, constitute a threat to society. In order to decrease the environmental degradation and pollution burden of these wastes, they are being aimed toward recycling and reuse as a possible resource in fulfilling the rising need for lightweight, high-quality, high-performance, and low-cost materials for a variety of applications. The majority of the population in West Africa and Nigeria consumes maize as a staple diet, which presents an opportunity for waste generation. Apart from the seeds, the remaining parts of the maize (the cob and husk) are not commonly eaten. Recent green reinforcement research has focused on the usage of husks from rice, coconut, and even palm kernel. Thus, this study investigates the development of an Aluminium Matrix Composite (AMC) using maize husk particle (MH_P) as a reinforcement to the 1170 aluminium alloy. Stir casting is chosen as the composite fabrication process route due to its relatively low costs and efficiency. The mechanical properties of the MH_P reinforced aluminium composite are compared to those of the unreinforced metal. All specimens were mechanically characterized for tensile, hardness, thermal conductivity properties, corrosion rate, potentiodynamic polarization, and open circuit potential analysis. The tensile tests demonstrated that raising the wt.% decreased the specimen's tensile modulus whilst increasing the wt.% of finer particles of smaller grain sizes of reinforcement increased its hardness properties. Thermal conductivity improved as reinforcement wt.% increased. Compared to the control specimen, the corrosion rates determined from the weight loss investigation indicated variations in the corrosion properties of the specimens in the various solutions. The varying mix percentages influenced the properties of the specimens. It was observed that the presence, particle size and quantity of reinforcement in the matrix positively affects the corrosion behaviour of composite materials through the creation of corrosion-resistant oxides.

Keywords: Material Innovation, Reinforcement, Composites, Aluminium matrix composites (AMCs), green additives, stir casting