

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

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JUNE 2022

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PROPERTIES OF 1170 ALUMINIUM**

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE
STUDIES OF COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA IN
PARTIAL FULFILMENT 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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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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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.

ACKNOWLEDGMENT

First and foremost, my profound gratitude goes to our Father in heaven for His preservation over my life, His blessing upon me each day, and the provision of all that was required to complete this dissertation. To him alone be all the glory now and forever. I express my appreciation to my parents, Mr Francis Ajuwaeze Williams & Mrs. Ruth Emilomo Williams for their love, sacrifice and prayers. I gratefully appreciate my supervisor, Prof. Roland Tolulope Loto, for his guidance and patience throughout this research project in ensuring its timely completion and to Dr. Philip Babalola for his input.

My sincere appreciation goes to the Chancellor, Covenant University, Dr. David O. Oyedepo, a father and teacher whose words have always been a constant reminder that anything is possible and achievable. Thank you very much sir, your labour of love will not be in vain and may your legacy outlive you. Also, to the Vice-Chancellor, Prof. Abiodun H. Adebayo, the Dean School of Postgraduate Studies, Prof. Akan B. Williams, thank you sirs and God bless you. My appreciation also goes to the Head of the Department of Mechanical Engineering, Prof. Joshua O. Okeniyi, and the Post Graduate Coordinator, Department of Mechanical Engineering, Dr F. Joseph, for their input and encouragement towards the successful completion of this dissertation.

I would also like to appreciate some members of the Faculty and Staff of the Department of Mechanical Engineering such as Prof. Ajayi, Prof. Oyedepo, Dr. Enesi, Dr. Dirisu, Engr. Adeoye, Mr. John Morounfolu, Mr. Segun and every other Staff and Faculty in the Department of Mechanical Engineering for their warm reception and encouragement throughout the course of my programme.

Also, to Ilesanmi Bello, Yinka, Daniel Ayoola, Michael Aluko, Marvelous Akomolafe, Ogechi Nnamba, ThankGod Oghenevwegba, and Engr. Fisayo, members of the class of 2020/2021 MEng. Mechanical Engineering, I say thank you for your support and being the best colleagues, anyone could ask for. To my friend turned brother, Musa Dauda, I say thank you for your guidance and assistance always

I want to also thank my siblings (Chukwuemeke, Onyekachukwu, David & Emmanuel), and my friends (Joseph, Toyin, Young, Fejiro, Jessa, Joy Ogbe, Honey, Esther Ayomide, Faith), and the others which I in no way take for granted, and well-wishers for their motivation and support throughout the course of my study at Covenant University. God bless you all.

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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