NIGERIAN INSTITUTE OF MINING AND GEOSCIENCES (NIMG)
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Closing Date:
Completed Applications must reach the office of the Director/CEO, not later than six (6) weeks from the date of publication.

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Nigerian Metallurgical Society

NATIONAL ANTHEM

Arise, O Compatriots, Nigeria’s call obey
To serve our fatherland
With love and strength and faith
The labour of our heroes past, shall never be in vain
To serve with heart and might
One nation bound in freedom, peace and Unity

O God of creation, direct our noble cause
Guide our leaders right
Help our youth the true to know
In love and honesty to grow
And living just and true
Great lofty height attain
To build a nation where peace and justice shall reign

NATIONAL PLEDGE

I pledge to Niger my country
To be faithful, loyal and honest,
To serve Nigeria with all my strength,
To defend her unity
And uphold her honour and glory
So help me God
Nigerian Metallurgical Society

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Nigerian Metallurgical Society

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It is with great delight that I warmly welcome you all, on behalf of the Executive Council and the entire members of the Nigerian Metallurgical Society (NMS) to the 35th Annual Conference and Annual General Meeting holding in the ancient city of Ilorin popularly known as AFONJA

This year’s theme of the Conference “Role of Metallurgical Industries in Sustainable Development Goals” was carefully chosen as the choice of this year’s theme after considering the derivable benefits that could be obtained from the metallurgical industries with a view to contributing meaningfully in sustainable development goals.

The Government of the Federal Republic of Nigeria commenced the development of the steel sector since the late 1970s, with the commencement of the Delta Steel Company Limited and Ajaokuta Steel Company Limited. In the early 1980s, construction of Rolling Mills started at Oshogbo, Jos and Katsina. Whereas the Rolling Mills and the Delta Steel Company were completed and commenced operations; the Ajaokuta Steel Company Limited was never completed. The Steel Sector is the bedrock for industrialization and completion and operation of the Government Steel Industries in Nigeria will boost the economy of the Nation. Ajaokuta Steel Company alone can generate 15,000 direct jobs and over 300,000 jobs upstream and downstream even in the informal sector. Imagine if Ajaokuta Steel Plant was completed in 1987 and all the steel used for construction of Abuja came from there. Note however that running a Steel Plant is capital intensive and cannot be left totally to the private sector.

With the beginning of bilateral relationships between Nigeria and the USSR in 1967, the Federal Government commissioned a team of Soviet experts to conduct feasibility studies on the setting up of an integrated iron and steel company in Nigeria. Based on the recommendation of the Soviet team that the Blast Furnace System of Steel Making should be adopted because of the relatively poor quality of our Ore Concentrates (deposits) located in some specific areas in the country. Messrs Techno-export, an agency of the USSR Government, in collaboration with the geological surveys was sponsored by the Federal Government to undertake detailed exploration of Nigerian ore deposits. Their investigations revealed an abundance of raw materials in reasonable quantities suitable for steel production. These include iron ore deposits estimated at over three hundred million (300 million) tonnes at Itakpe Hill near Okene, Coking Coal estimated at over one hundred million (100 million) tonnes at Lafia–Obi in Plateau State, Jakura Marble, Ubo Marble, Mfamosing Lime stone, Burum Dolomite, Osara Dolomite, Onibode / Oshiele refractory clays etc.

With the above assuring raw materials discoveries, the Nigerian Government became more seriously committed towards the development of an indigenous steel industry. Therefore, in April 1971 the Nigerian Steel Development Authority (NSDA) was established by decree No.19 of 14th April 1971. The body was charged with responsibilities ranging from planning, construction and operation of steel company, down to conducting of geological surveys and Metallurgical research.

Meanwhile, a rapidly increasing rate of growth in the domestic demand for steel, especially, the long products used in the construction industry prompted the Federal
Government to decide to establish more steel company in the country. A bold and giant step in the steel sector was taken in the 1975 / 1980 development plan in which the Federal Government disclosed its intention to set up additional steel company based on the Direct Reduction Processes. This was to take advantage of the vast natural gas resources, which were being flared away in some oil fields in the country (Niger Delta region). Studies were intensified in this direction and a number of international companies were invited to submit proposals based on specifications given by the then NSDA. After thorough consideration, the Midrex Direct Reduction process was chosen and company was proposed for Ovwian Aladja, in the then Bendel State (now known as Delta State) to be erected by consortium of Germans and Austrians. Complementary to the setting up of the Delta steel company, Federal Government also decided on the establishment of Rolling Mills at three key market centres of the country. Thus, three inland Rolling Mills, each of 210,000 tonnes annual capacity were planned for Kastina, Jos and Oshogbo. These steel polices were being executed by the now defunct NSDA whose last major assignment was the signing on 13th July 1979, of the Global contract with TPE for the establishment of the Ajaokuta steel company limited (Known as an Integrated Steel Company).

Thereafter, the Authority was dissolved with the emergence of the National Steel Council on 19th September 1979. In consequence, the various steel companies now existing in the country were set up duly incorporated. It is worthy to note that a lot of efforts have always been made in the private sector by companies or regional levels and State Governments to establish steel mills in the country. For instance, it will be recalled that the former Eastern Region Government established a mini-mill (steel), with a capacity of 12,000 tonnes of structural steel per annum at Emene near Enugu in 1962, which was, in partnership with private concerns. Also, in 1970, two more scrap based mini-mills, namely;
(a) The continental Iron and Steel Company, and,
(b) The Universal Steel Company both were established by private companies. Obviously, because fully integrated steel companies are heavily capital intensive, most of these private steel mills have facilities for melting and casting steel scraps only and their total capacities could in no way cope with the rapidly expanding demands for steel products in the country. This, therefore, explains why the Federal Government decided to take a giant stride to establish steel companies so as to take care of the nations ever-increasing demand for steel products.

In historical perspective, the need for the establishment of an iron and steel industry in Nigeria was first expressed in 1958. Further action that was taken by the immediate post-independence Government as was evidenced in the 1st National Development Plan (1962 - 1969), which states inter-alia “Substantial progress had been made in plans for a steel complex which will utilize Nigerian raw materials.” From the onset therefore policy formulation as regards the establishment of an iron and steel industry envisaged the availability, locally of at least the major raw material inputs. In 1967, the Military Government (Headed by General Yakubu Gowon) invited the Government of USSR to assists in setting up the steel company based on the availability of iron ores from Agbaja-Koto Karfi deposits. These deposits did not meet the specifications for use in the Ajaokuta Blast Furnace (BF). As a follow up, the government with the support of USSR sponsored an extensive aeromagnetic survey of over 22% of the whole country. Ground magneto metric surveys and drilling for more suitable ones were subsequently undertaken. Exploration for iron ore was then concentrated at Birnin Gwari and Ayagba (Kaduna State), Ejigbo (Oyo State), Itakpe, Chokochoke, Ajabano and Agbado-Okudu (Kogi State). Investigations for
coking coal centered around Afuze (Edo State), Lafia/Obi (Nasarawa State) and Gombe/Danduya (Gombe State).

Initial results of this joint effort prepared the ground for the signing of contract 1717 (4th November 1970) between Nigeria and V/O Techno-export (USSR) and the subsequent establishment of NSDA in 1971. In collaboration with the technical partners, the Exploration Division of NSDA (now National Steel Raw Materials Exploration Agency) commenced actual detailed and systematic exploration for the ores and other minerals in 1971. It was based on the strength of the recommendations of NSDA following the establishment of proven iron ore reserve at Itakpe and other deposits that Government sited the iron and steel company at Ajaokuta in 1975. The National Steel Council was established subsequent to the promulgation of Decree 60 of 1979 to regulate and coordinate the activities of two integrated steel companies, three inland rolling mills and an Iron Ore Mining Company. Consequent upon this, the Ajaokuta Steel Company, Delta Steel Company, Oshogbo Steel Rolling Company, Jos Steel Rolling Company, Katsina Steel Rolling Company, and the National Iron Ore Mining Company, Itakpe were established. Several other agencies were also set up to support and complete the activities of the steel companies. The metallurgical industries established by government were conceived primarily to achieve a set of objectives, some of which are:

(1) To provide the base for processing our mineral resources, and to open up new export frontiers for additional foreign exchange earnings.
(2) To provide the technological base for the industrialization of the country.
(3) To spur local industrial progress through import substitution and conservation of foreign exchange.
(4) To create additional employment opportunities for eligible Nigerians.

**IMPORTANCE OF STEEL IN NATIONAL ECONOMY**

Steel has played major role in industrial transformation of nations and the relationship between steel and other sectors of the economy cannot be over discussed. It is necessary to identify the global perspective on the metallurgical industries for developing countries. In its annual report of 1985, the United Nations Industrial Development Organization stated thus: whether a developing country should develop its own metallurgical industries depend upon various factors. Undoubtedly, it is advantageous for a country to develop its own iron and steel industry if the necessary raw materials are available (Technological Perspectives In Machine Tools Industry and their Implication for developing countries, UNIDO, 1985):

- For strategic and economic reasons;
- Avoid continued dependence on foreign sources for such a primary material as steel.
- Basic raw materials and manpower resources are available;
- Development of the steel industry has the potential for proliferation of a wide range of upstream and downstream industries; Promoting technology transfer, and creating jobs: It estimated that for every job created in a steel plant, there are about twenty new jobs upstream and downstream.

**Why Metallurgical Industries?**

The products from metallurgical industries like steel serves as the Material Backbone of Economic Development, and also steel produced from metallurgical industries are the material backbone of economic development because of its passive use in all spheres of economic life such as: Creation of high productive capacity in mechanized farming and the processing, preservation and storage of food products; Development of buildings, roads, railways, harbours, power generation, telecommunication facilities etc. The apparent steel consumption per capita is normally regarded as a fairly accurate indicator of economic development.
Steel Production from Metallurgical Industries as the Hub of Industrialization

Steel production occupies a central place in the process of industrialization through: Supply of vital industrial materials to the other industrial systems; Development of virtually all types of industrial or production techniques.

Provision of a veritable base for scientific and technological research for industrial application
Metallurgical Industries serve as an Economic Trigger. The existence of a viable steel plant must, of necessity, give rise to: Numerous ancillary industries upstream and downstream to feed and to be fed by the steel plant; Development of social and economic infrastructure. Some Scientific researches and technological development programmes undertaken in a continuous manner in solving local and specific problems. Statistical evidence indicates that: The steel industry is the biggest generator of employment. Example; were Ajaokuta Steel Plant to become operational (1st phase), up to 10,000 people would have been directly employed. Another 200,000 would have been in employment in the upstream and downstream ancillary industries. Multiplier effect of the employment is created on the other sectors of the economy increases in geometric progression.

Steel as an Index of Power
The building of a powerful, effective and highly dependable military system must be based on the development of an indigenous military industrial complex that will produce the necessary armaments and other military hardware using locally produced steel; All countries that can be reckoned with in terms of military capability have well protected special steel plant units, within their steel plants, called “Defense Cell”, exclusively for research in steel needs of the military.

The Scope of Metallurgical Industries in Nigeria
The objectives that were to be achieved as articulated in the Plan document includes: The provision of a sound industrial base for the stimulation and growth of Industries; Full exploitation of local raw materials….; the acquisition of technology by Nigerians to enhance rapid industrial development of the country; Savings in foreign exchange.; Provision of mass employment to the people.

Industrial Linkages to Metallurgical Industries and Multiplier Effects on the Economy
Metallurgical Industries have the capacity to revolutionize the Industrial and Economic sectors of the Nigerian nation; it must be noted that: Everything for the convenience of man is made by machines. These machines are made of metals, which are mostly steel based.

Up-Stream Industrial Linkages
Development of Steel Industries like Ajaokuta Steel Project promotes: Exploitation and utilization of steel-based raw materials, such as iron ore, coal, limestone dolomite and refractory clay among others. Generation of employment opportunities; Petrochemical Industries involved in production of consumables for iron & steel production viz: Solar Oil, Sulphuric Acid, Ortho phosphoric Acid etc; Electric Power Companies; Transportation Companies to carry out the haulage of ASCL Products, raw materials and consumables; Institutions involved in research, exploration and development of raw materials.

Down-Stream Industries
These are industrial firms that process the output of other firms into finished or different products. Such products and by-products can be further processed into other high revenue yielding materials for industrial development. These types of industries are categorized as heavy medium and small scale industries. Heavy Scale Industries: these are industries where production of heavy equipment and machineries take place. Revenues are generated from the
capital goods produced for industrial growth and development. Medium Scale Industries are industries that produce goods that are used manufacturing purposes, such as tonnes, cans brake drums and discs, containers, auto spare parts and refrigeration etc. Small Scale Industries: These industries produce goods such as wires, fasteners, wire gauze, nails, bolts, nuts, hand tools, steel doors and windows for other industrial developmental growth.

**Sectors that would be impacted by Metallurgical Industries**

Importation of large quantities of steel for utilization in such strategic projects would lead to a great drain of our foreign resources to other economies.

**(a) Construction Sector:**
The demand for steel products in the construction industry includes I-beams, channels, Bars, Rods, Angles, Sections, Plates, Sheets, Strips, Pipes, Wires, Galvanizing and Corrugation etc.

**(b) Agricultural Sector:**
Most investors in the agricultural sector require some degree of reasonable Mechanization. Large scale farming efforts have no back up facilities for their imported mechanical devices, such as tractors, ploughs, riggers, planters, harrows, and of course the establishment of Fertilizer plants, etc. The road to meeting our own food needs as a nation lies in mechanized farming. The steel industry is primed to supply the input, iron & steel raw materials. Do many people know that, the Metallurgical Industries during Steel production will, also produce Ammonium Sulphate Fertilizer as a by-product?

**(c) Defence Sector:**
Defence capabilities of a nation have to a large extent, depends on the development of her steel industry. Examples are India and Pakistan. No nation will readily export her hi-tech military hardware to you.; It is not by accident of history that our Defence Industries Corporation experiment failed in the absence of a steel plant to support it. The application of steel to the defense sector includes production of arms, ammunition, collapsible bridges, structures, chains, military transport, weapons and weapons training, etc.

**(d) Transportation Sector:**

**Rails:**
The Metallurgical industries like the Medium Section and Structural Mill at Ajaokuta, which has an installed capacity of 560,000T can be expanded and slightly modified to produce rails. As estimated, the tonnage of rails required to meet the new rail programme of the FG as well as the rehabilitation of the existing ones will be able to produce about 955,680 tonnes. The new light rail tracks proposed by Lagos State government and the Federal capital territory will amount to significant tonnages. We cannot afford to make the same mistake twice. Abuja and Indeed Lagos were totally built on imported steel thus; we are wiser for others than for ourselves as a nation.

Tanker Bodies, Trailers, Barges, Fire Engine Bodies, Drilling Rigs, etc.

**Ships:**
Most parts of the huge tonnages of which ships are made are steel and related products. Niger Dock Company will be better off with indigenous steel plant.

**Automobiles:**
The accelerated flat steel programme of the Ajaokuta Steel Project, when implemented will boost the automotive industries in the country.

**Tar:**
Tar for the construction of our roads will be generated as a by-product during the production of steel at Ajaokuta.
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(e) Manufacturing Sector
Textile equipment, machinery, appliances, electrical power equipment, power generation equipment, food processing equipment, cement plants, petrochemical refining equipment, small scale machinery, etc. are made from steel or steel related products.

(f) Petroleum Sector
The main materials and spare parts needs of the petroleum industry are made of Stainless Steel, Heat Resistant, Anticorrosion materials, Flat sheets and plates, seamless pipes and other special steel alloys; Our foreign exchange goes to other countries and provide employment for their population.

(g) Other Prospects of Metallurgical Industries to the Economy:
Other prospects of Metallurgical Industries to the Economy include:

Provision of Infrastructure for Industrial Development:
The positive externalities that result from the development of steel plants act as incentives to entrepreneurs for the establishment of medium and small-scale industries;

Provision of Employment Opportunities:
The Metallurgical Industries are capable of generating over 50,000 jobs if only the Ajaokuta Steel Company Limited is completed. On completion of the 1st phase will generate about 10,000 jobs opportunity for our teeming youths. This will progressively increase to about 20,000 workforces at the 3rd phase and it is a known fact that for every job created in the steel plant, 20 other jobs are created upstream and downstream each.

The Development of Human Resources and Poverty Alleviation
The Metallurgical industries will contribute meaningfully to the development of human resources and further assist in controlling and reducing poverty. The contribution of the Metallurgical industries toward the realization of the aims and objectives of Government cannot be over emphasized. *There is this common cliché which states that one’s destiny is in ones hands*. One can therefore conveniently and confidently say that Nigeria’s Industrial Salvation is in Nigeria’s own hands. This is with reference to the completion, revitalization, resuscitation, commissioning and operationalization of all the metallurgical industries in Nigeria as functional and viable for sustainable development goals.

To industrialize, there is the need to have a sound industrial base. This will provide the solid foundation on which the industrial super-structure will be built. This industrial base is nothing other than a well-developed Metallurgical Industries, with competent and well-developed human resources that will be producing such critical industrial raw materials such as: *Cast Iron* (different grades); *Rods and bars* (low to high steel varieties and high tensile steels); *Wires* (in all ramifications); *Structural Steels* (light, medium and heavy); *Sheet steels* (plain and galvanized and in the entire spectrum classified as flats); *Stainless and other special alloyed steels*; and *Plates* (various sizes in width and thickness).

It is worthy to mention here that some developing countries have been able to lift their economies up and away from poverty and starvation levels, and which have seriously threatened the developed world in the economic wellbeing of their people. A few examples include South Korea, India, Pakistan, Egypt, Iran, Algeria, Libya and Turkey.

We should know that establishing Metallurgical industries are enormous tasks and capital intensive. It is a known fact that setting up such industries in all these countries in world map
of steel producing nations started as serious national companies with their Governments taking positive interest in the steel development. Pandit Nehru of India once referred to the giant structures coming up in Bhilai, Durgapur and Ruerkehela in the late 50s as the TEMPLES OF MODERN INDIA. Countries like Saudi Arabia, Algeria and Libya with their large oil reserves have also developed viable steel industries. Other developing oil producing countries also have very well-developed steel industries, these include: - Mexico, Indonesia and Venezuela. It is important to note that one other parameter for measuring development is the per capita consumption of Steel for any nation, whether the economists believe it or not, not just the GDP.

The high number of unemployed youth engaged and trained, meant that quite a population of unemployed people have been taken off the unemployment market.

According to Efobi (2002) The Ajaokuta steel company Limited requires some 10,000 personnel. If we are to consider the Steel communities, each Nigerian Staff is probably taking care of 10 other Nigerians, with the resultant effect that when you plan for 10,000 staff, you should indeed be providing facilities for over 100,000 people.

When you now consider the upstream and downstream multiplier effect of the metallurgical industries, plus the welfare facilities like schools, hospitals, markets and shopping complexes, filling stations, maintenance garages, eateries/restaurant, hotels and security personnel you will discover that you really should be planning for a township that should absorb some 300,000 people. With 300,000 people being taken care of by the Ajaokuta Steel Company Limited only, and considering the other metallurgical industries earlier mentioned like the Iron Ore Mining Company, Delta Steel Company, Oshogbo Steel Rolling Company, Jos Steel Rolling Company, Katsina Steel Rolling Company and Machine and tool shop Oshogbo, what further or greater poverty alleviation programme do we need?

Ladies and gentlemen, the conference this year should be able to come out with position papers and documents that will assist all the stakeholders in the Metallurgical Industries to see the need for revitalizing, resuscitation and operationalization of all the Metallurgical Industries for sustainable development goals for national growth and emancipation of our nation Nigeria. Once again, I sincerely welcome all our invited guests, stakeholders and the participants who had taken time out of their busy schedule to be with us today. I wish you a happy stay in this ancient city of Ilorin and this great University known as citadel of learning and I also wish to assure you that your stay in this great city will give you a long memoir that you will not forget in a hurry because of their level of hospitality.

Thank you and God bless you all

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Foreword by the Conference Organising Committee (COC) Chairman

It is my great pleasure on behalf of Conference Organising Committee (COC) to welcome you to the 35th Annual National Conference/AGM, holding at the great citadel of learning University of Ilorin, Ilorin, Kwara State.
The theme of this year conference is “The Role of Metallurgical Industries in Sustainable Development Goals”.
The theme was chosen to underscore the critical role of metal-based industries to support next level agenda of the Federal Government of Nigeria for sustainable economic development in order to achieve United Nation Sustainable Development Goals (UN SDGs).

In September 2015, the United Nation General Assembly adopted the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDGs). Building on the principle of “leaving no one behind”, the new Agenda emphasizes a holistic approach to achieving sustainable development for all. Most critical amongst these goals that affect Materials and Metallurgical Engineering are as follows:

**Goal 1: End poverty in all its forms everywhere**

**Targets**

- By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day.
- By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
- Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable.
- By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of 13 property, inheritance, natural resources, appropriate new technology and financial services, including micro-finance.
- By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
- Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions.
- Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions.
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Targets

- By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
- By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.
- By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
- By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.
- Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries. Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round.
- Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

Goal 3: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Targets

- Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
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- Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry’s share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries
- Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets
- By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
- Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending
- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States
- Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities
- Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020

All these goals cannot be achieved without strong and viable Metallurgical industries. Papers from academia, captains of industries, opinion leaders and technocrats will be presented at this conference. It is our sincere hope that this conference will be most rewarding not only to better understand relevant policies and strategies but also to identify and evaluate the different mechanisms in achieving SDGs through robust Metallurgical industries.

Our profound appreciations go to all the donors, host, exhibitors, sponsors and service providers for contribution towards the success of 35th conference. The COC/LOC sincerely appreciates the support and goodwill of the President, Engr. Prof. S.B. Hassan, FNMS and members of the Executive Council Members of the Society.

Please kindly endeavour to attend all the technical sessions, industrial visit and accept the assurances of our tremendous preparations for the successful conference.

Best wishes and warmest regards.

Engr. Dr. Salawu Abdulrahman Asipita, FNMS
Chairman,
Conference Organising Committee
On behalf of the President of the Nigerian Metallurgical Society (NMS), Engr. Prof. S.B. Hassan FNMS, it is my singular honour and privilege to receive and welcome you to the city of ILORIN and to University of ILORIN in particular and specifically to the 35th Annual Conference and Annual General Meeting of the Nigerian Metallurgical Society (NMS).

The Society has made significant contributions over these years in the Metal, Mineral and Mining industries and in the academic space. These contributions cannot be over emphasized. Consequently, I wish to express the Society’s gratitude to you for being part of NMS historic success story as we enjoin every one not to relent in the good works toward achieving more giant strides.

This year’s Conference theme “Role of Metallurgical industries in sustainable Development Goals” is very apt as it will give all stakeholders in the Engineering sector the ample opportunity to proffer solutions to this sector which is beneficial to our economic lives.

The plenary papers have been tailored to address those silent issues, institutional frameworks and situations why this sector is where and how it is today. The technical papers addresses specific issues in the Metallurgical industries with a view to bringing to focus the best possible way for transformation of Metallurgical industries for National development and sustainability through wealth creation, employment and revenue generation for the Nation.

We specially appreciate all the contributors, sponsors and participants who in one way or the other made this conference a huge success. May God Bless You All.

Engr. Dr, V.S. Aigbodion FNMS, MNSE, R.COREN
Technical Secretary and Chairman Technical Committee
## OPENING CEREMONY

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<tr>
<td>10.00 am</td>
<td>Arrival of Guests</td>
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<td>10.20 am</td>
<td>Introduction of the Special Guests and Dignitaries</td>
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<td>10.30 am</td>
<td>National Anthem</td>
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<td>10.33 am</td>
<td>Opening Prayer</td>
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<td>10.40 am</td>
<td>Welcome Address by the President, Nigerian Metallurgical Society Engineer Professor S.B. Hassan FNMS</td>
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<td>11.10 am</td>
<td>Keynote Address</td>
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<td>Goodwill Messages</td>
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<td>Lead Papers</td>
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<td>13.10 am</td>
<td>Vote of Thanks</td>
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<tr>
<td>13.20 am</td>
<td>Closing Prayer</td>
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<td>13.25 pm</td>
<td>Visit to Exhibition Stand</td>
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Nigerian Metallurgical Society

PROGRAMME

DAY ONE:
Wednesday, 30th October 2019
1. Arrival of Participants
2. Registration of Participants
3. Council Visits and Press Briefing
4. Council Meeting

DAY TWO:
Thursday, 31st October, 2019
1. 08.00 am – 16.00 pm Registration of Participants
2. 10.00 am – 11.30 am Opening Ceremony
3. 11.30 am – 12.00pm Exhibition / Tea Break
4. 12.00 pm – 14.00pm Plenary Session / Lead Papers
5. 14.00 pm – 15.00pm Lunch Break
6. 15.00 pm- 16.00 pm Workshop/Panel Discussion
7. 16.00 pm – 17.30 pm Technical Section A
8. 18.00 pm– 19.30 pm Students’ Nite

DAY THREE
Friday, 1st November, 2019
1. 07.30 am – 10.00 am Industrial Tour
2. 08.00 am– 16.00 pm Registration of Participants
3. 10.00 am – 11.00am Technical Sections B
4. 11.00 am– 11.30 am Tea Break
5. 11.30 am – 13.00 pm Technical Section C
6. 13.00 pm– 14.30 pm Lunch Break
7. 14.30 pm – 15.30 pm Communiqué Drafting
8. 16.00 pm – 18.00 pm AGM
9. 19.00 pm – 22.00 pm Annual Dinner

DAY FOUR:
Saturday, 02 November, 2019
1. 09.00 am -10.00 am Press Conference
2. 10.00 am Departure
ACHIEVING SUSTAINABLE DEVELOPMENT GOALS IN NIGERIA: THE METALLURGICAL INDUSTRIES IN FOCUS

A PAPER PRESENTED BY RETIRED AIR COMMODORE (DR) MUSIBAU SOLADOYE AT THE 2019 ANNUAL CONFERENCE/ANNUAL AND ANNUAL GENERAL MEETING OF THE NIGERIAN METALLURGICAL SOCIETY

INTRODUCTION

1. The ability of a nation to explore, exploit and develop its natural resources through viable industries is a strong basis for ensuring formidable and sustainable economic development. This could, in turn anchor power projection in the international systems through laying of foundations for viable partnership, indigenous sourcing and transformation of available raw materials to value-added useful products for self-sustenance. As such, this would become imperative in an increasing competition and quest for dominance in socio-economic growth among nations in world affairs. The transformation of natural resources of a nation into high value technological products especially in civil and military wares such as utensils, vehicles, tanks, aircraft, ships, guns, machines, munitions and communication equipment for human consumption cannot be overemphasized. Aside the global influence, it confers in a nation’s respect, control and economic prosperity.

2. Most of the technologically advanced countries have successfully and effectively utilized their resources potentials in all sectors of their economies. The focus of these countries is to enhance effective economic growth towards self-sufficiency using more of their material resources. Metallurgical industries are not exempted. They are those industries that deal with extraction of metals from their ores, purifying, alloying and creating useful objects from the extracted metals. These metals are said to be the core components used in producing the aforementioned wares for basic use as well as economic growth in various nations. On the other hand, Sustainable Development Goal is a blueprint used to address challenges like poverty, inequality, climate change and environmental degradation in a nation by achieving a better and more viable future for a society through available resources. Owing to the topic of discourse, these definitions will form the basis this paper would dwell upon. Sustainable Development Goals has been the driving force behind developmental breakthrough in various nations. Therefore, exploration, exploitation and development of these metals or resources into meaningful wares would help in achieving self-sufficiency, economic growth as well as improving the wellbeing of the citizenry.

3. The critical nature of metallurgical industries accentuates the desire of developed and some developing countries like US, Brazil and India to pursue sustainable development goals through well-articulated and focused policy to achieve some level of success in industrialization. In the United States of America (USA) for instance, technological advancement for sustainable development is accorded top priority by the government. The government works with a number of US firms whose primary focus is production to adequately manufacture consumer goods such that seeking same from foreign providers is reduced to the barest minimum. This is achieved through long term planning, adequate funding as well as gathering of resources. These efforts have enabled the US Government project power to any part of the globe almost unchallenged. Also, in an effort to attain self-reliance in production of goods and machines, the Government of India promulgated a Procurement Policy in 2016 which mandates 75 per cent of the total acquisition orders of the Indian organizations to be sourced from Indian firms. In our continent Africa, countries such as South Africa, Sudan, Egypt and Cote D’Ivoire have exploited their natural resources for sustainable development through effective metallurgical industries. This has enhanced industrialization, expanded their economies and provided employment opportunities for their citizens.

4. Nigeria is endowed with vast human and natural resources which include oil and gas and mineral deposits. The need to harness these endowments led to the promulgation of some laws and regulations as well as establishment of some strategic turn-key projects such as Kainji Hydroelectric Dam, Ajaokuta iron and steel complex amongst others. These efforts have changed the narrative as the
country had already achieved a significant backward integration in some sectors of the economy especially in the oil and gas sector. However, the same cannot be said of some sectors that are metallurgical industries dependent.

5. The purpose of this paper therefore is to examine how sustainable development goals could be achieved through metallurgical industries in Nigeria. The paper will begin by giving an overview of metallurgical industries in Nigeria from inception till date. Thereafter, technological development using metallurgical industries in other countries would be discussed. Furthermore, issues and challenges militating against the attainment of sustainable development goals through metallurgical industries would be highlighted. Lastly, the paper would proffer strategies to achieve sustainable development goals.

AIM

6. The aim of this paper is to discuss achievement of sustainable development goals in Nigeria through metallurgical industries with a view to proposing ways forward.

SUSTAINABLE DEVELOPMENT GOALS IN NIGERIA

On the 25th of September 2015, Member States of the United Nations adopted the 2030 Agenda for Sustainable Development at the 70th Session of the United Nations General Assembly with a set of 17 Sustainable Development Goals (SDGs) and 169 Targets. The SDGs seek to address the unfinished business of the Millennium Development Goals (MDGs), foster inclusive development whilst addressing the economic, environmental and social aspects of Sustainable Development.

For emphasis, the SDGs Framework provides the basis for a peaceful, just, equitable and inclusive world. The 2030 Agenda commits all signatory countries to work together to promote sustained and inclusive economic growth, social development and environmental protection, ensuring in the process that all women and men, including children, youth and future generations, fulfil their potential in dignity and equality in a healthy environment. In 2016, Nigeria adopted the SDGs Agenda. The 17 Sustainable Development Goals are shown on the screen. Distinguish ladies and gentlemen, how far has Nigeria gone in pursuance of these goals? There is therefore the need for us to consider the relevance of the metallurgical industries in this pursuit.

OVERVIEW OF METALLURGICAL INDUSTRIES IN NIGERIA FROM INCEPTION TILL DATE.

7. The idea of metallurgical industries was first mooted and conceptualized as Iron and Steel industries by Nigeria’s national development planners in 1958. At this period, widespread consultations took place both within and outside the country with western experts to ascertain its viability and economic advantages in large-scale steel production. The general opinion however, was that Nigeria was not yet ready for a project as demanding and sensitive as having metallurgical industries comprising iron and steel plants. The primary reason canvassed was the high cost of the technological and associated infrastructural development necessary for a full-scale steel industry in Nigeria. In addition, it was thought that Nigeria would be unable to provide the required manpower and skills to put a steel plant into a successful and continuous operation. According to the National Council on Science and Technology (NCST), the initial attempt was to build rolling mills and establish market potential for the steel products, before the efforts became directed towards the establishment of an integrated iron and steel plant. Some of the companies that submitted proposals included the consortium of Westinghouse and Koppers in 1961, Demag, Ferrostat-Wellman, Mckee and David Ash more all in 1963.

8. It was however, from 1967 that significant progress was made towards the establishment of an iron and steel plant in Nigeria following the involvement of the then Soviet Union. As such, in 1967, a team of Soviet experts arrived in Nigeria to conduct a feasibility study on the establishment of an iron and steel plant, as a follow-up on a technical/economic agreement between the governments of Nigeria and the Soviet Union. In 1968, the Soviet geological experts after a general geological investigation of Nigeria reported that there were high prospects for finding rich iron ore and coal deposits in the country. Consequently, Nigeria signed a contract in 1970 with Techno-export of the then Union of Soviet Socialist Republics (USSR) under which they agreed to provide specialists and equipment to carry out further geological surveys in order to determine the quantity of iron ore and coal deposits that could be used to set up the plant. The Federal Government of Nigeria in pursuance of its policy in the steel sector on 14 April 1971 promulgated Decree No.19 setting up the Nigerian Steel Development Authority (NSDA), which was charged with the responsibility for the planning,
construction and operation of steel plants in the country. While on 18th September 1979, it also promulgated the National Steel Council Decree No.60 dissolving the NSDA.

9. The new decree provided for the formation of the Ajaokuta Steel Plant as well as five other limited liability companies. These are the Delta Steel Company Ltd, Aladja; the Jos Steel Rolling Mill, the Oshogbo Steel Rolling Mill, the Katsina Steel Rolling Mill, and the then Associated Ores and Mining Company Ltd. These steel infrastructures are in addition to the Nigerian Metallurgical Development Centre in Jos, the National Steel Raw Materials Exploration Agency in Kaduna and Nigerian Metallurgical Training Institute at Onitsha. They were designed to produce bars and wire rods at a capacity of 2.1 x 105 tonnes/year. This implied that the rolling mills were to be fed with billets produced at the Delta Steel Company, Aladja. The Katsina Steel Rolling Mill for instance, was designed to also produce long products covering the product range from 6mm to 40mm (plain and ribbed). It was established primarily to produce reinforcing and general purpose steel from billets for construction and wire associated industries. However, the poor capacity utilization of Delta Steel Company and the very long gestation period of the Ajaokuta project meant that the rolling mills had problems of inadequate supply or lack of billets to operate optimally. This contributed significantly to the poor performance of the Nigerian Steel Sector. However, the government of Nigeria wishes to fully divest its equity holdings in the rolling mills in the overall production capacity of the country. If fully employed, Nigeria would be a place with bloomy and sustained technologically developed nation.

TECHNOLOGICAL AND SOCIO ECONOMIC DEVELOPMENT THROUGH METALLURGICAL INDUSTRIES IN OTHER COUNTRIES

10. There is a need to present classical practices of technological transfer and socio economic development through metallurgical industries. These include Indian and Brazilian metallurgical industries. This would assist in identifying factors that could enable the Nigerian government to sustain its technologies and socio-economic development with a view to enhancing her capabilities. This is also evident that the 2 countries developed their technologies through metallurgical industries. They would be discussed in the succeeding paragraphs.

METALLURGICAL INDUSTRY IN INDIA

11. The metallurgical industry has played a significant role in India’s economic growth. India produces about 95 minerals, comprising 4 fuel related minerals, 10 metallic minerals, 23 non-metallic minerals, 3 atomic minerals and 55 minor minerals including building and another type of minerals (FICCI, 2018). The mineral production in India has shown significant growth at Compound Annual Growth Rate (CAGR) of 5.72% between 2013-2014 and 2017 to date to reach an estimated amount of US $ 17.62 billion in 2017-18. The metallurgical industry in India can be segmented into various sub-industries such as aluminium, Copper, lead, iron, zinc, steel etc. Among the various industries, the steel and aluminium are the key industries that have displayed a substantial growth in the past few years. Steel Industry is acting as a key industry because all other industries depend on the iron and steel industry for machinery. Moreover, steel is required to manufacture a wide variety of engineering goods and defence equipment.

12. In terms of the growth of the steel industry, India has emerged as the second largest steel producer with a production of 101.4 million tons of crude steel. In addition to this, India is also the largest producer of steel mica in the world. Furthermore, the growth of iron ore production in the country increased from 129.32 million tons in 2015 to 210.47 million in 2017. Lastly, the steel industry in India also contributes about 2% of India’s GDP and employs about 600,000 people. Indian exports have grown from 3.46 million tons of finished steel during the year 2010-11 to 4.91 billion in 2011-12 and reached 10.91 billion in 2017. The exports mainly comprise plates, hot rolled coils, coated sheets, pig iron and iron ore. U.S and China are the main recipients of India steel exports. In terms of imports, as expected, India has shown a declining trend, the imports declined from 9.8 million tonnes in 2017 to 8.9 million tonnes in 2018.

13. In addition to the aforementioned feats the steel industries have brought to the economic development in India, the aluminium industry has generated high growth due to its high production capacity. The aluminium production has grown at 17% in 2017 to emerge as the fourth largest aluminium producer in the world. The demand for aluminium has arisen from automotive,
construction and packaging industries. The rail and power networks and the infrastructure development plans of the government have driven the aluminium demand in the construction industry. The aluminium exports have witnessed a sharp rise of 34% during the year 2017-18. In the overall, the growth in the metallurgical industries can be attributed to the rise in infrastructure development and automotive production.

14. Amongst all industries, the Indian iron and steel industry enjoys a fair advantage in terms of cost of production, availability of raw material and cheap labour. The strong demand for iron and steel is derived from various other industries like automobile, consumer durables and infrastructure. In addition to this, the growth in the production of iron mica is driven by large bauxite reserves that exist in India. The government has adopted a vast number of measures to boost the growth in the metallurgical sector, particularly in the iron and steel industry. The government has allowed 100% FDI through the automatic route. In addition to this, the government has reduced the duty payable on the finished steel products through a streamlined process. Furthermore, to encourage R & D activities, the ministry of steel had been making provisions through steel development fund and plan scheme. Under this scheme, the government has approved 8 projects with a total cost of Rs 123.27 crore ($20.38 million). If Nigerian government could embark on the steps Indian government has taken to gain the aforementioned benefits, it would enhance greater foreign exchange, dependency on own materials and socio economic development in the country amongst others.

BRAZILLIAN METALLURGICAL INDUSTRIES

15. As the world’s second largest exporter of iron ore and tenth largest exporter of steel, Brazil’s iron and steel industry has traditionally relied on overseas growth drivers. However, the industry is poised to get a big boost from domestic factors too. Brazil has been a platform of the global investment community for several reasons which include political stability, fiscal strength and rapidly expanding middle class. Others include rising incomes and consumption, success of its poverty alleviation, social welfare programs and the structural advantages of its economy among others. Arguably, the only sore point in this compelling investment theme has been its poor infrastructure. While struggling to stabilize the economy through the 90s, successive governments consistently cut long-term investment to be able to fund current expenditures.

16. Those years of neglect reflect in the country’s congested ports, crowded airports, and underdeveloped railroads. In fact, Brazil’s appallingly inadequate infrastructure spending also manifests in its per capita annual consumption of steel, a major raw material for the infrastructure sector. Until recently, the nation used on average only around 100 kilograms of steel per person per year while the comparable figures for China and South Korea were 300 kilograms and 1,200 kilograms, respectively. Having realized that its growth momentum might wither if the infrastructure deficit is not bridged, Brazil launched a sustained effort to build or improve ports, railroads, airports, and roads. Riding on this infrastructural boom, the demand for steel in Brazil is already on the rise and had increased pressure over the years. The growth is in the size of the middle class, which now makes up more than half of Brazil’s population, and the nearly 45% rise in wages over the past few years, have pushed up the demand for automobiles, appliances, furniture and everything else that requires steel as a raw material. In fact, driven by increased bank lending, tax breaks on cars, and historically low interest rate, the automobile sector, which is globally one of the biggest consumers of steel along with the infrastructure sector, saw sales increase more than 11% year-on-year in 2009 and is projected to see a revenue growth of 25% in 2020. Thus, Brazil’s metallurgical industry is in a sweet spot now. This implies that long-term overseas demand for the country’s iron ore exports will likely remain strong and steel consumption is projected to grow rapidly within the country if all factors likely to hinder its growth are tackled. Nigerian government can borrow a leaf from the measures put in place by the government of Brazil to boost socio-economic growth to meet its goal through metallurgical industrial activities.
Nigerian Metallurgical Society

ISSUES AND CHALLENGES MILITATING AGAINST THE ATTAINMENT OF SUSTAINABLE DEVELOPMENT GOALS THROUGH METALLURGICAL INDUSTRIES

17. The challenges militating against the attainment of sustainable development goals through metallurgical industries include non-inclusive policy framework, weak technological and industrial base and low level of private sector participation in achieving metallurgical industrial goals.

NON-INCLUSIVE POLICY FRAMEWORK

18. Non-inclusive Policy Framework is perceived to be hindering the achievement of metallurgical industries development goals. It must be noted that since her independence in 1960, production and acquisition of local products have been an exclusive reserve of the FGN and is included in the Exclusive List of the Constitution of the Federal Republic of Nigeria 1999. Also, the Nigerian Investment Promotion Commission (NIPC) Act of 1995 has a prohibitive clause restricting productions of some hardware like that of defence. Ironically, government’s effort to promote indigenous production through local content utilization such as own resources also fell short of an all-inclusive policy framework for all sectors by anchoring only on the oil and gas sector.

19. If Nigeria’s strategic end-state for rapid industrialization and promoting socio-economic development goals through metallurgical industries is to be realized in the context of an extant policy and legal frameworks, there would be the need for an amendment of the Local Content Act to capture other sectors of the economy such as industries with particular reference to metallurgical industries. For emphasis, Nigeria’s reliance on foreign metallurgical products may only be resolved through a comprehensive policy framework in production.

WEAK TECHNOLOGICAL AND INDUSTRIAL BASE

20. Technological and industrial base means a group of public or private persons and organizations that engage in, or are capable of engaging in, similar research, development, production, integration, services or information technology activities. All over the world, technology and industry are drivers of development upon which the society relies on. In Nigeria, the technological and industrial base is weak. Success in the enhancement of socio-economic and development goals in Nigeria is dependent on the development and harnessing of the metallurgical contents and transformation of raw materials using strong technological and industrial base of the country. It is therefore necessary that Nigerian government should employ measures to build and strengthen its technological and industrial base through creation of synergy amongst groups, organizations and countries if necessary.

LOW LEVEL OF PRIVATE SECTOR PARTICIPATION

21. Due to the general apathy towards own grown industries in local production and the restrictive clauses in the constitution concerning private sector involvement in manufacturing of some products like defence equipment, there is low level private sector participation. For instance in the defence sector, most of the few indigenous firms engaged in arms procurement are mainly acting as fronts or outlets for foreign companies. In the contrary, in South Africa for example, the armament industry presents one of the central point of interaction between the security establishments and the business society.

22. In Brazil, Messrs Empreses Brasileira de Aeronautica (EMBRAER) has acted as a model of successful private sector participation in defence and civil production for over forty years. Though in recent time, some private companies like Proforce have entered into collaboration with the military for the production of some equipment, private sector participation in defence production in Nigeria is still a far cry compared with what obtains in countries like India, China, Brazil and Pakistan. There is no country where their military have been able to produce all their defence and civil requirements without the involvement of the private sector. There is therefore the need for government to produce guidelines to integrate and coordinate those companies involved in defence production and encourage others to key into the initiative. The MOD and Ministry of Trade and Investment could play facilitating roles in this regard.
THE WAY FORWARD
23. Many factors influence sustainable development goals in all sectors of the economy. The prospects in achieving sustainable development through metallurgical industries in Nigeria could be bleak if there is no deliberate effort to raise the level of technological and industrial base of the Country as well as the provision of the urgently needed infrastructure. Accordingly, there is the need for the FGN to rejuvenate and boost industrial activities nation-wide as well as increase budget on technological development in order to attain sustainable development goals in Nigeria. Some other measures that could serve as a way forward are discussed in subsequent paragraphs.

AMENDMENT OF NIPC ACT 1995
24. A review or comprehensive amendment of the existing NIPC Act of 1995 would no doubt ameliorate the challenge of non-inclusiveness in the Act. This would ensure that all critical sectors are provided for in the amended Act to give vent to the Government objective of galvanizing the metallurgical industries for job creation, industrialization and control. To achieve this, the FGN could mandate a committee for the review of the Act, working with other stakeholders from MDAs of government, multinational corporations, Nigerian Metallurgical Society, private companies and individuals. The expanded committee would ensure that all available iron ore and steel resources are harnessed to lay a strong technological base as one of the driving force. The Committee could be mandated to propose amendments to the Act by expanding it beyond oil and gas with a wider responsibility to the regulatory body. It would also provide an opportunity for the fine tuning of the any observed anomalies in the current oil and gas development Act.

AMENDMENT OF PROHIBITIVE CLAUSES IN THE CONSTITUTION REGARDING PRIVATE SECTOR PARTICIPATION
25. There is the need to amend restrictive clauses in the Constitution that discourage private sector participation in various productions like iron and steel in Nigeria. This will encourage more private companies to venture into local production thereby stimulating rapid growth in the metallurgical Industries with attendant increase in local content production and acquisition. Similarly, the restrictive clauses in the Act could be expunged to allow private partnership in equipment production. As highlighted earlier in the Indian and Brazilian examples, this approach has led to monumental growth in the economies of these 2 nations. The Ministry of Science and Technology could sponsor a bill for the amendment of these legal instruments to encourage private sector participation in metallurgical industries in the Country.

IMPLEMENTATION OF THE NATIONAL INTEGRATED INFRASTRUCTURE MASTER PLAN
26. The National Integrated Infrastructure Master Plan was conceptualized in 2014. The plan provides a roadmap for building world class infrastructure that will guarantee sustainable economic growth and development. It would enable the nation take advantage of the vast opportunities in the domestic and global economies to enhance the nation’s competitiveness and improve the quality of life of the citizenry. According to the plan, the country must aggressively increase infrastructure spending to meet up its demand and with infrastructure deficit expected to cost $2.9 trillion, it is expected that spending would need to ramp up quickly, from the current 3-5 percent of GDP to an average of 9 percent over the next 30 year period. The implementation of the plan will improve the Ease of Doing Business in the Country and thus attract investors. With more investment inflow, sustainable technological goals will be enhanced in most areas, including technology and acquisition.

CONCLUSION
27. The transformation of natural resources in Nigeria into high value technological products such as utensils, vehicles, tanks, aircraft, ships, guns, machines, munitions and communication equipment for human consumption is very vital. Nigeria is also endowed with vast human and natural resources which include oil and gas and mineral deposits. The need to harness these endowments led to the promulgation of some laws and regulations as well as establishment of some strategic turn-key projects such as metallurgical plants. Furthermore, with increasing threats of non-state actors and economical breakdown manifesting in the country, there is the need to appraise the entire process of employing metallurgical industries in achieving sustainable development goals.
28. To this end, classical practices of technological transfer and socio economic development through metallurgical industries in India and Brazil were analyzed. This assisted in identifying factors that could enable the Nigerian government sustain its technological development goals. It was evident
that the 2 countries developed their technologies through metallurgical industries. India produces 95 minerals, 4 fuel related minerals, 10 metallic minerals, 23 nonmetallic minerals, 3 atomic minerals and 55 minor minerals including building and another type of minerals (FICCI, 2018).

29. The mineral production in India has shown significant growth at CAGR of 5.72% between 2013-14 and 2017 date to reach an estimated amount of US $ 17.62 billion in 2017 -18. If Nigerian government could embark on the steps Indian government have taken to achieve the aforementioned benefits, it would enhance greater foreign exchange, dependency on own materials and socio economic development in the country amongst others. Similarly, Brazil is the world’s second largest exporter of iron ore and fifteenth largest exporter of steel. Having realized that its growth momentum might wither if the infrastructure deficit is not bridged, Brazil launched a sustained effort to build or improve ports, railroads, airports, and roads. This had gone a long way in improving its technological base as well as sustained its development goal. Nigerian government can borrow a leaf from the measures put in place by the government of Brazil to boost socio-economic growth to meet its goal through metallurgical industrial activities.

30. The challenges militating against the attainment of sustainable development goals through metallurgical industries include non-inclusive policy framework, weak technological and industrial base and low level of private sector participation in achieving metallurgical industrial goals. To mitigate these challenges, there is the need for the FGN to rejuvenate and boost industrial activities nation-wide as well as increase budget on technological development. Furthermore, there is need to amend the existing NIPC Act of 1995 to ameliorate the challenge of non-inclusiveness in the Act. In addition, there is need to amend prohibitive clauses in the constitution regarding private sector participation. Lastly, implementation of the national integrated infrastructure master plan is required as well as building a strong technological base.

REFERENCES
13. Metal Industry in India, list of metal manufacturing companies @ https://business.mapsofindia.com › India-industry › basic-metals accessed 16 Aug 19.
Nigerian Metallurgical Society

20. Abdulhakeem Ogunbajo, Muritala Adigun (2016); Industrial Growth and Standards Compliance of Steel bars in the Nigeria Construction Industry.

NMS-LP 002
SYNERGY BETWEEN MATERIALS SCIENCE & ENGINEERING AND THE OPERATIVES OF THE PROGRAM

PROF. A. G. F. ALABI, FNSE, SPX
(PROVOST, COLLEGE OF ENGINEERING AND TECHNOLOGY, KWASU)

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INTRODUCTION: SCIENCE AND ENGINEERING

Engineering is the application of the basic sciences to ease life for humanities. (Mathematics, Physics, Chemistry and more, recently Biology and Agricultural Science). The base line for all scientific discipline is mathematics which is used to translate the facts in the sciences to reality. The focus in this discussion is on Metallurgy and Materials as relate to the sciences.

What are materials?

In professional palace, materials are defined as metals, polymers, ceramics and other engineered materials that are produced by combining the first three materials to satisfy a required property. These engineered materials are referred to as COMPOSITE. Examples are:

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<tr>
<th>Metals</th>
<th>Ceramics</th>
<th>Polymers</th>
<th>Composites</th>
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<tr>
<td>aluminum</td>
<td>clay</td>
<td>polyvinyl chloride (PVC)</td>
<td>wood</td>
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<tr>
<td>copper</td>
<td>silica glass</td>
<td>Teflon</td>
<td>carbon fiber resins</td>
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<tr>
<td>steel (iron alloy)</td>
<td>alumina</td>
<td>various plastics</td>
<td>concrete</td>
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<tr>
<td>nickel</td>
<td>quartz</td>
<td>glue (adhesives)</td>
<td></td>
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<tr>
<td>titanium</td>
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<td>Kevlar</td>
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</table>
Metallurgy is the study of the production, processing and application of metallic products to manufacture machines and facilities that make life easy for human being. This discussion identifies metals as a class of materials. Even though, metals form the largest tonnage of materials employed in manufacturing, the relevance of other classes of materials is gaining prominence either singly as you have in polymers or in combined format as you have in composites.

Hence, the methods employed in the study of metals for use in manufacturing (Metallurgical Engineering) is equally the same for other materials (Materials Engineering). However, each of them has emanated from the basic sciences: Mathematics, Physics, Chemistry and Biology. It is therefore practicable to advocate for metallurgical/Materials Engineering to be collapsed to Materials Engineering as being proposed in the recent BMAS of COREN3.

In the same vein, because the base for Engineering is from scientific principles, it is possible to identify the discipline as Materials Science and Engineering as being practiced by the Obafemi Awolowo University, Ile-Ife, Kwara State University, Malete and the world over.

Materials Science and Engineering studies the relationship of material properties to its composition, structure and applications. It is therefore pertinent that all stakeholders in science and engineering be fused to present a common front to address any deficit of materials development in Nigeria. We all need materials to develop and the country is blessed with loads of materials that can catapult Nigeria and Nigerians to prominence and National Economic buoyancy4.

Advanced Applications of Materials1,2,5

**Semiconductors** (ceramics): computer chips, memory storage devices, solar cells, image screens

**Nanomaterials (ceramics, metals, polymers)**: gold nanoshells, quantum dots, ferrofluids, medical devices

**Metals**

Hydrogen-absorbing metal alloys for energy transportation or batteries

Typical alloys consist of Mn-Ti-V, Mg-Ni, Zr-Mn/Ti/V, Mn-Ni, La-Ni.

BCC metals show higher storage and desorption properties

Shape memory alloys

Some metals can absorb a gas densities equivalent to liquid hydrogen densities

**AVAILABLE FRONTS FOR THE GROUPS AS @ PRESENT (2019)**

- **NMS (Nigerian Metallurgical Society)** which deals mostly with metals and also involved other materials.

- **MSN (Materials Science and Technology Society of Nigeria)** also deals with materials which include metals. All Scientists (Physicists, Chemists, Geologists,
Nigerian Metallurgical Society

Biologists, Agriculturist and Mathematicians) including Engineers are eligible to be members of this group.

- NIMMME (Nigeria Institution of Metallurgical, Mining and Materials Engineers) accept only qualified Engineers and this forms the bottle neck for joining this group. The group also advocates for the development of all materials as they affect National Economic Development.

PROBLEMS ASSOCIATED WITH DIFFERENT GROUPING

It is obvious from previous discussion that each of the groups (NMS, MSN, NIMMME) has the same focus, that of developing and processing of materials for Engineering applications.

However, the groups are always at loggerhead on the same issues they are trying to protect. Each of the group wants to be on top of each other. The problem emanating from this role ambiguity is non-performance. For instance, the steel production in Nigeria had been in comatose because of this in-fighting and steel is the bedrock of national development. In order to put a stop to this problem and get the nation’s Minerals, Metals and Materials industries moving truly in Nigeria, we must work as a team.

PREFERRED SOLUTION

I hereby suggest that a committee be formed from members of the 3 groups, NMS, MSN and NIMMME when specific issues need to be discoursed to create a unity of purpose. Such unity would enable: The steel company to be fully operational which can create meaningful development to the national economy. Such unity would enable the steel company to be in full operation to create downstream opportunities such as Rolling Mills, Engineering Workshops, Construction Companies, Medium Sections and Structural Mill, Automotive Industries, Foundry Shops and other Manufacturing concerns.

For example, the Ajaokuta Steel has its vision statement as: Production of quality steel products to Industrialize Nigeria. It is now obvious to us that Industrialization of Nigeria is a mirage without steel production. The Ajaokuta Steel is said to be 99.9% complete and consist of:

- The light section mill
- The wire rod mill
- The thermal power plant which can produce 110 MW using steam turbo generators which can operate on natural gas, coke oven gas, blast furnace gas, liquid fuel are all in place

Various investment opportunities at the Ajaokuta Steel company are enormous. The plant is designed to attract investors with a focused policy to encourage investment in order to take full advantage of the economic potential of the steel plant. The windows for possible investments are:

a) Conversion of billets to produce wire rods and steel bars
b) Engagement as Jobbing Agents
c) Oil reconditioning and reclaiming
d) Mass production of Jaw Crusher Machine
e) Legal transaction in our products both in country and for export

f) Estate development

g) Construction of rail track and transportation

Resuscitation of ALSCON in Ikot-Abasi (Akwa Ibom). This could also create many downstream opportunities and support aluminum product operations that are dotted all over Nigeria. The advantage of this to small scale industries in terms of availability and cost cannot be overemphasized.

CONCLUSION

• It is obvious that no country can develop without developing its materials for which Nigeria is luckily endowed with.

• Such developments need the support of the stakeholders who must speak with one voice for any administration to take them serious.

• I am therefore, advocating that NMS, MSN and NIMMME even though existing separately must work together to chart a course for materials development and hence, industrialization of Nigeria. This can be done by speaking with one voice when issues that are pertinent to materials development are taken.

• TEAMWORK IS THE ANSWER

References


4. KWASU 5th Inaugural Lecture by Prof. A. G. F. Alabi. March, 2019


6. Ajaokuta Steel, the bedrock of Nigeria’s Industrialization (Personal communication).
THINKING ALOUD

- Napoleon Bonaparte once looked at the large expanse area of China and said: “Here lies a sleeping giant, but leave him alone; for if he wakes up, he will shake the world.”

- China, the world’s most populous nation on earth has since woken up and she is shaking the world.

- Is Nigeria, the most populous black nation on earth, not the sleeping giant of Africa?

- Is it not true that is Boeing 747 cargo planes come to Nigeria daily offloading cargo, then fly back empty, sometimes, they have to use sandbag to stabilize the aircraft.

- Is it not true that five (5) out of every six (6) ship that berth in Nigeria return to their base empty?

- Is it not true that only one ship which leaves with cargo filled with charcoal, gypsum, salt, and sesame seed?

- What shall we say about the statement credited to the American President, Donald Trump: “… if you sit on gold, diamond, oil, manganese, uranium … and your people don’t have food, are you human?”

- When will Nigeria begin to export manufactured products from its abundant solid mineral resources such as iron and steel products, aluminum, tin, lead, gold, copper, gems & ornaments to other countries after meeting her domestic need?
Who will wake Nigeria from her intellectual amnesia, technological slumber, industrial comatose, economic underdeveloped and transactional leadership and when?

When will the United Nations sustainable development goals be reality in Nigeria and be catapulted from developing nation to a developed one?

POSTULATIONS

THEOREM 1: “The possession of abundant solid mineral resources in a nation does not necessarily increase the wealth of a nation.” Nigeria is an example.

“When fish decays; it always starts from the head.”- Indonesia proverb

THEOREM 2: “A nation can be technologically advanced and economically buoyant with little or no natural resources.”- Examples: Singapore, Japan.

“Only the resources of man can bring the resources of the earth to life.”- Paul Baily

1. INTRODUCTION

METALLURGICAL INDUSTRY

• Critical importance of Metals & Minerals
• Gauge for wellbeing and standard of living of nations
• Human Development characteristically named after Metals and/or Mineral Products

EXEMPLIFICATION OF THE CRITICAL IMPORTANCE OF METALS

• Non-ferrous: The GDP of most of the 15 Southern African nations (out of 17 nations with the exception of Angola and Botswana) are directly proportional to the quantum of Metals produced by those nations (particularly gold, silver, copper, nickel and PGM)
• Iron and Steel: All the G-8 countries- Canada, France, Germany, Great Britain, Italy, Japan, USA and Russia are ALL TOP iron and steel producing nations
• “A nation that controls iron controls the world.”- Pohang Steel Company Ltd.

1.1 United Nations Sustainable Development Goals (UNSDGs)

• The 17 United Nations Sustainable Development Goals (UNSDGs) are universal call to end poverty, protect the planet and ensure that all people enjoy pace and prosperity in the year 2030
• UNSDGs require partnership with governments, private sector, civil societies alike to “make sure we leave behind a better planet for future generation”. This define the word SUSTAINABILITY.
• Sustainable is a term that emerges on international planning cycles with the following realizations:
  • The need of the present must be met without compromising the future generations to meet their own need
  • That all borrowers of the earth our children and our children’s children and must hand it to them in reasonably usage shape.
  • Human beings, not economic indications, are at the centre of development.
1.2 National Economic Agenda

- **Vision 20:2020**: The economic agenda of the last administration in Nigeria was vision 20: 2020. The goal was to ensure that Nigeria is among the 20 advanced economies in the year 2020 (next year).
- **ERGP**: The present Administration’s economic agenda tagged: Economic Recovery Growth Plan (ERGP) is aimed at increasing national productivity and achieving sustainable diversification of production, to significantly grow the economy and achieve maximum welfare for its citizen beginning with food, energy, and security.
- **The ERGP focuses on six (6) core sectors to grow the economy, namely: agriculture, transportation, power, gas, manufacturing and solid mineral processing. Above notwithstanding, it is an opening secret that neither solid mineral development nor manufacturing has substantially contributed to the Nigeria’s economy growth.**
- **A functioning steel industry is essential to industrial take-off** Nigeria grandiose ambition spelt out in the Nigerian Industrial Revolution Plan. National Enterprises Development Programme and its automotive plan are non-starter without a viable industry.
- **Steel drives construction, railway, ship building, automotive, mining and other industries. Steel production will stimulate mining in iron ore, manganese silica, aluminum, coal, and associated minerals which are used as raw materials and in secondary industries.**
- **The Metallurgical Industries do not exist in a vacuum**
- **The economy development of any nation depends considerably on the level of its industrial development.**
- **Industrial development in turn depends invariably on the technological advancement and the level of manufacturing activity in the national economy.**
- **The need to revive industries and set factories working presents an exciting challenge to the Nigerians Metallurgical and Manufacturing Engineers.**
- **For this to happen in this country, we must appreciate the fact that solid mineral development is a relay race if it will be sustainable. Without that, the Nigerian Metallurgical Industry will continue to be in comatose status.**
- **Figure 1 depicts the whole picture of the processes involved from the location of mineral resources (mineral exploration) to the market (A case of 7MS).**

![Figure 1: Seeing the Big Picture from Mineral Exploration to the Market (The 7Ms)](image-url)
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- Figure 2 and 3 illustrate solid mineral resources development as a relay race and interrelationship among the discipline in the solid minerals industry respectively.

Figure 2: Solid Mineral Resources Development Relay Race

Figure 3: Interrelationship among the Disciplines in the Solid Minerals Industry

2.0. COMATOSE STATUS OF THE NIGERIAN METALLURGICAL INDUSTRY

2.1. The Concept of World Without Metals!

- Generally speaking, without minerals there will be no metal. Metals are indispensable materials in all areas of technology and in all ages. A perusal at The Period Table shows that about 2/3 of the 110+ elements in the Periodic Table are metals. Imagine that the following metals and their alloys do not exist!
### Nigerian Metallurgical Society

<table>
<thead>
<tr>
<th>Metal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe &amp; Steel</td>
<td>The most important industrial metal &amp; alloy</td>
</tr>
<tr>
<td>Al</td>
<td>The light metal</td>
</tr>
<tr>
<td>Cu</td>
<td>Conductor metal</td>
</tr>
<tr>
<td>Ph</td>
<td>Plumber metal</td>
</tr>
<tr>
<td>Sn</td>
<td>The metal that forms the can</td>
</tr>
<tr>
<td>Ni</td>
<td>The versatile metal</td>
</tr>
<tr>
<td>Mg, Be</td>
<td>Ultra light metal</td>
</tr>
<tr>
<td>Ti</td>
<td>The strong middle weight</td>
</tr>
<tr>
<td>Cr</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Tungsten</td>
<td>The filament metal</td>
</tr>
<tr>
<td>Au, Ag, Pt</td>
<td>The precious trio</td>
</tr>
<tr>
<td>Tr, Pd, Rh</td>
<td>Their valuable cousin</td>
</tr>
<tr>
<td>Ga</td>
<td>The transition metal</td>
</tr>
<tr>
<td>Ta</td>
<td>The condenser metal</td>
</tr>
<tr>
<td>Cd</td>
<td>Weather reporter</td>
</tr>
<tr>
<td>Os</td>
<td>The heaviest metal</td>
</tr>
<tr>
<td>Li</td>
<td>The light metal</td>
</tr>
<tr>
<td>Ca, K, Na</td>
<td>Reactive metals</td>
</tr>
<tr>
<td>Hg</td>
<td>The liquid metal</td>
</tr>
<tr>
<td>Nb, Zr, Se, Te</td>
<td>Some new arrivals</td>
</tr>
<tr>
<td>Pu, Ra, Th, U</td>
<td>Radioactive metals</td>
</tr>
</tbody>
</table>

#### Race earth metals

Is there any of these metals/metal group numbers (i–xxii) that are produced in Nigeria from the primary source on sustainable basis? The answer is NO! They are all imported when needed. A self-reliant and strong economy cannot be built on mass importation of goods, services and skills. Nigeria should be adding values to its natural resources especially solid mineral resources—metal product which are depletable assets and whose products include metal and metal products; and embark on massive manufacturing.

### 3.0. COMATOSE STATUS OF THE NIGERIAN METALLURGICAL INDUSTRY

- The Nigerian Metallurgical Industry has neither been able to produce iron & steel (ferrous) nor aluminum (non-ferrous) on sustainable basis. Ditto for any other metals. So the Nigerian Metallurgical Industry is in state of comatose and she has to import
virtually all her metals and metallic products into the country in spite of the abundant solid mineral resources within her border.

- For mineral resources development to be sustainable, the answer to these five (5) pertinent questions should be positive:
  - Is this operation technically feasible?
  - Is it economically viable?
  - Is it environmentally friendly?
  - Is it a safe operation?
  - Is there clear out mineral and/or metal value addition chain?

- For Nigeria, the answers to these five (5) questions as far as solid mineral development are negative.

![Figure 4: (a) Igun mines field overgrown with bushes and anthill, (b) Roughing jig overgrown with bushes at Igun mines field](image-url)
3.1. Comatose Nigerian Metallurgical Industry: Pertinent Questions

- In 2005, the Federal Government of Nigeria obtained USD 120 million credit from the International Development Agency (IDA) for the purpose of funding the Sustainable Management of Mineral Resources Project (SMMRP). Again, in March 2017, credit of USD 150 million was obtained from World Bank by the Nigerian Government via International Development for Mineral Sector Support for Economic Diversification Project (MIN DIVER). In spite of all these loans, the report of the United Nations on Nigeria is that the nation is rich but the people are poor!
Taking cognizance of the title of this paper—“United Nations Sustainable Development Goals vis a vis the Comatose Nigerian Metallurgical Industry: Quo Vadis Nigeria”, the following tributary questions are pertinent:

- Between 2005 when Nigeria obtained facilities for World Bank Sustainable Management of Solid Mineral Resources Project (SMMRP) and 2017 Mineral Sector Support for Economic Diversification Project (Min Diver) – A period of 12 years
  - How many world class mineral and metallurgical engineers have been produced and how many technical personnel had their proficiency enhanced for the Nigerian Mineral & Metal Industry?
  - Which of the metallurgical institutions and research institutes in Nigeria have attained world class status during this period?
  - What are the research and development breakthroughs and patents from the relevant institutions and research institutes in Nigeria in respect of the challenges facing the Nigerian mineral/metal industry?
  - What is the increase in the GDP contribution of the metal industry to the national economy?
  - To what extent is the human capacity building of the technical staff of the Federal Ministry of Mines & Steel Development being enhanced and motivated?
  - How many types of metallic products have been produced in Nigeria during this time from the available mineral deposits in Nigeria for local consumption and export?
  - How many thousands have secured employment in the solid minerals industry since we have been taken World Bank loans for solid mineral resources development?
  - What are the consequences (immediate & remote) of the prevarication tendencies in respect of sustainable production of steel in Nigeria?

Yesterday’s neglect is today’s regret.

“We have caused the dust and then we complain that we cannot see.” - George Berkeley

4.0.  QUO VADIS NIGERIA?

“We can chart our future clearly and wisely only when we know the path which has led to the present” - Adlai Stevenson

- There are three options before Nigeria in order to revert the comatose status of the Nigerian Metallurgical industry sub-sector of the economy. The three options are:
  - To do nothing, continue to prevaricate and misplace our priorities.
  - To continue to rely on external body for ‘help’ like the World Bank intervention and continue to borrow.
  - To avoid shut cut, take the bull by the horn and muster political will through transformational leadership to do the needful. That is, to insist on doing the right thing and doing things right.

- Let us not consider the three options one by one with a view to choosing the best option that serve the national interest on the long run.

- **Option one:** Nigeria has the option of continuing to give excuses on why things cannot work, why for instance Ajaokuta cannot be resuscitated in good time to produce liquid steel on a sustainable basis. The nation has the option of doing nothing about the Delta Steel Company and the three inland rolling mills at Jos, Katsina and Osogbo that are in comatose status. She also has the option doing nothing and give excuses about the most important non-ferrous metals industry- the Aluminum Smelting Company at Ikot Abasi.
The argument of some of our policy makers is that iron & steel, and aluminum plants are better privatized so that the money spent on them is better spent on other things. It has been reported that an estimated amount of USD 6 billion has been committed to the existing iron and steel prospects in Nigeria.

With continued importation of metal products especially iron and steel into Nigeria instead of producing our own on a sustainable basis and in good time. The following are bound to happen:

- More buildings will collapse
- More graduates especially engineering graduates will be unemployed
- More brain drain will take place
- The value of the national currency will continue to diminish
- The National Economic Growth Plan (ERGP) for 2017-2020 of this Administration will be an “Alice in wonderland”
- The endurance limit of restless, unemployed youths will be exceeded sooner than later.
- United Nations Sustainable Development Goals in Nigeria will forever be a mirage.

Should not the Federal Government that started these existing steel projects complete, rehabilitate and operate them and thereafter privatize them following due process?

Today’s neglect is tomorrow’s regret.

**Option 2:** To continue to rely on external body for ‘help’ like the World Bank for robust mineral/metal value addition chain for sustainable solid mineral resources development for the Nigerian manufacturing industry. When presented on paper, this option looks fine since no nation is an island and there is interdependence of nations in international relations/economics. No Chinese (let us learn from Zambia), no Indian (let us learn from Ajaokuta), no Australian, no American or European can bail Nigeria out of underdevelopment but Nigerians. No external body did it for the Japanese and the Singaporeans. Singapore succeeded as a nation in catapulting themselves from an underdeveloped nation like Nigeria to a developed nation like Japan.

No amount of loan from IMF or World Bank can do the magic. This point was made clear by Lord Luggard, one-time Director General of Nigeria in his Mandate to Africa, when he frankly said (Eppelle, 1977):

“Let it admitted from the onset that European brains, capitals and energy have not been and will never be expended in developing the resources of Africa from motive of sheer philanthropism.”

Options one and two are out of the options required to revive Nigerian Metallurgical industry. To continue along this line is to continue to postpone the evil day. Nigeria can no longer afford to be the sleeping giant of Africa. She must wake up.

“**Insanity: Doing the same thing over and over and expecting a different result.**” - Albert Einstein

**Option 3:** The only option left is the emergence of transformational leaders (rather than transactional) who will do the needful. What may happen is that if we wait for somebody else to find a solution to our problems, the solution may degenerate. We may have to apply most prudently the principle of the Newton’s first law of motion to the situation at hand. 1977 Nobel peace prize winner, Betty William in a BBC World Debate Program said: “**If you don’t do something about what you know to be wrong, then you are part of the problem.**”
5.0. THE WAY FORWARD

“The greatest thing in the world is not so much where we are but in what direction we are moving.” – Oliver, Wendel Holmes

- In charting a way forward, the Nigerian Metallurgical Society (NMS) will need to address some questions which are pertinent to the theme of this year’s conference: “The role of Metallurgical Industries in Sustainable Development Goals.” They include the following:
  - What efforts is Nigeria making towards research and development of sustainable process design for columbite, galena and azurite/malachite to extract their respective metals?
  - What about the precious metals particularly gold?
  - What steps are being taken by the NMS to ensure that the Ajaokuta Steel Complex produce liquid steel within the shortest possible time?
  - For how long will Nigeria import metallic products especially iron and steel from China for railway construction and airport modernization? Have we not put the cart before the horse?
  - What solutions have we for incessant building collapse in Nigeria?
  - When is Nigeria going to develop our own ferro-alloys and super-alloys in Nigeria?
  - When is Nigeria going to produce our first indigenous car instead of mass importation of ‘tokunbos’? and uncompetitive automotive assembly plants.
  - How are we getting prepared for electric cars?
  - What role are we playing in domesticating sustainable additive manufacturing?
  - How feasible is nuclear power generation from the Nigeria uranium deposits?
  - Who bothers about utilizing the ilmenite dumps on the Nigerian Mineralized Plateau to manufacture paint?
  - Why can’t our Universities, Polytechnics and research institutes embark on research development in these need-driven areas?

- At the turn of the last Century, the Chinese Legendary, the late Mao Tse Tung, made the following historic statement when his nation was at a crossroad like ours:

  “The land is ours
  The nation is ours
  The society is ours
  If we do not speak who will speak?
  If we do not act who will act?”

This pregnant statement is relevant to the comatose Nigerian Metallurgy industry. It is with this same spirit that the Nigerian Metallurgical Society is urged to do the needful for repositioning the Nigerian Metallurgy industry towards the fulfillment of the relevant United Nations Sustainable Development Goals. After all, making allusion to historic statement of Chairman Mao, we can also declare that:

  “Nigeria is ours
  Nigerian Metallurgy industry is ours
  Nigerian Metallurgy Society is ours.
  If we do not speak, who will speak?
  If we do not act, who will act?”

Having identified the problems and the causes of the problems plaguing the Nigerian Metallurgy industry, the following are recommended as the way forward:
Nigerian Metallurgical Society

- First, no nation develops through shortcut. There must be the political will to produce liquid steel in Nigeria on sustainable basis within the shortest possible times. There is no better time to start than now. In this case, the nation should carefully set up an independent and empowered regulator for the Iron and Steel Industry (in lieu of the defunct National Steel Development Authority) like Nigeria National Petroleum Corporation (NNPC), Nigerian Communications Commission (NCC) and the Central Bank of Nigeria (CBN). Nature abhors vacuum.

- Second, there is no much lawlessness in the Nigerian Metallurgical industry such as observed in incessant collapse of building reckless, importation of metallic materials and indiscriminate export of metallic wastes. Well-implemented and sound Nigerian Metallurgical Bill Act and Regulations will curb these sharp practices. The Nigerian Metallurgical Bill should be reviewed to meet international best practices and be followed up until it is passed into an Act.

- Third, important as iron and steel are, they cannot stand alone without their brothers in the non-ferrous metallurgy. In production of ferro-alloys, superalloys and different types of steels, non-ferrous metals are needed. Time has come to take the issue of mineral/metal value addition chain seriously with respect to those metals such as aluminum, gold, lead, zinc, tin and columbite whose ores are available in Nigeria. They can be sustainably produced locally by research, development, invention, innovation and entrepreneurship. To this end, a non-ferrous Metal Research Institute be established in line with global best practices.

- Fourth, Mineral Processing Technology and Extractive Metallurgical Engineering are becoming endangered species in Nigeria. There is dearth of competent and current professional engineers/researchers/scholars in this two fields which are the means through which values are added to solid minerals. Mineral/extractive metallurgical engineers in Nigeria can be counted by fingertips. There is nowhere in Nigeria where meaning doctoral research programme in these fields can be conducted as at today because of lack of requisite functional equipment and expertise. This concerting scenario has negatively affected solid minerals resources development relay race. There is the need, therefore, for urgent, wholistic and well-planned manpower development for the Nigerian Metal & Mineral Industry. Bright minds should be sourced and trained locally and abroad on scholarship.

- Fifth, engineering education in Nigeria especially Mining engineering, Mineral engineering and Extractive Metallurgical engineering are underperforming. The brilliant graduating students just want to go abroad to read “anything” rather than continue with need-driven research locally. This is because the Nigerian engineering education is generally underplanned, underfunded, understaffed, underequipped and underspaced. The dysfunctional engineering education in Nigeria need to be squarely addressed and that urgently.

- Sixth, the solid mineral industry in Nigeria should adapt best global practices if it will be relevant to national economic development mining and metallurgy always go together and they should not be put asunder. Otherwise, 21st century mineral processing technology which is sandwiched between the two disciplines will go into extinction in Nigeria with time .In United Kingdom, there is institution of Mining and Metallurgy (IMM). In Australia, there is Australian Institution of Mining and Metallurgy (AUSIMM). In Canada, there is the Canadian Institutes of Mining and Metallurgy (CIMM). In South Africa, there is South African Institution of Mining and Metallurgy (SAIMM). In the United States, there is Society for Mining, Metallurgy and Exploration (SME). I do associate with all of them and I am a professional member of SME. There is the need therefore for the emergence of Nigerian Institution
Nigerian Metallurgical Society

of Mining and Metallurgy (NIMM) and a Council (CNIMM) should be carefully constituted for this as it is done in other parts of the world.

- Seventh, 2005, the Federal Government of Nigeria obtained USD 120 million credit from the International Development Agency (IDA) for the purpose of funding the Sustainin able Management of Mineral Resources Project (SMMRP). Again, in March 2017, credit of USD 150 million was obtained from World Bank by the Nigerian Government via International Development for Mineral Sector Support for Economic Diversification Project (MIN DIVER). To what extent are the Nigerian experts and key stakeholders involved in the procurement, expenditure of these loans and what about the appraisal of the first loan? This second loan should be judiciously spent on need-driven projects that of national interest as proposed by the relevant experts in Government, academia and industry. In addition, the Solid Mineral Development Fund should be judiciously invested on the recognized needs of the nation as far as Nigerian metal & mineral industry is concerned. The fact is that we should stop further borrowing so as not to mortgage the future of the next generations.

- Eight, the Roadmap for the Growth & Development in the Nigerian Mining Industry is a commendable effort. However, it is inadequate for metal/mineral value addition chain and environmental friendliness. So it is neither sufficiently need-driven nor adequately comprehensive to ensure sustainable solid mineral resources development. The Federal Ministry of Mines and steel Development as it is now called is advised to embark on five-year strategic plan in order to revive the strategic Nigerian metal & mineral industry.

- Ninth, there is the need to revisit the nomenclature and restructure the Federal Ministry of Mines and Steel Development.

- Revisiting the nomenclature: The nomenclature is anomalous and needs to be revisited. The metalliferous ore mined from the earth are both ferrous and non ferrous. Which Federal Ministry in the Federal Republic of Nigeria supervises non-ferrous metals like gold, aluminum, copper, lead, zinc, and tin if not the Federal Ministry of Mines and Steel development? There is even a department for non-ferrous metals in the Ministry. Should not the title of a paper and its content tally? If it is the same ministry, the nomenclature should encapsulate the non-ferrous metals. By syllogism, the appropriate nomenclature should be “Federal Ministry of Mines, Steel and Non-ferrous Metals Development.

- Repositioning the Ministry. The supervisory Ministry needs repositioning for enhanced efficiency and effectiveness. In order to achieve this aim, the few relevant professionals left in the Ministry and the agencies under them should be motivated and have their human capacity enhanced.

- Thereafter, the core values of integrity, excellence and professionalism should be imbibed by the Ministry officials “The deepest craving of human heart is to be appreciated”-William James.

- Tenth, value-driven Government- Academia-Industry Synergy engendered by transform.

- National leadership (rather than transactional leadership) at the national level is the panacea for revived Nigerian Metals Industry as illustrated in Figures 6 (a), (b) and (c).
Figure 6(a): Government-Academia-Industry Synergy

Figure 6(b): Government-Academia-Industry Divide as Root Cause of Continuous Underdevelopment in Nigeria:
6.0. CONCLUSION

- It is a well known fact that the economies of nations of the world fall and rise with the quantum of metal production and/or consumption particularly iron and steel. It can be recalled that the 17 United Nations Sustainable Development Goals are universal call to end poverty, protect the planet and ensure that all people including Nigerians enjoy peace and prosperity in the 2030 (21 years from now). This out theme for this year: “Role of Metallurgical Industries in (UN) Sustainable Development Goals” could not have been more apt. It is in consonance with this them that this paper is titled: United Nations Sustainable Goals vis a vis the comatose Nigerian Metallurgical Industry: Quo Vadis Nigeria?” the paper x-rays united nations sustainable goals, national economic agenda and sustainable solid mineral development (since the metallurgical industries do not exist- “vacuum”

- It has been observed that the well being and standard of living of any nation can be accurately ganged by reference to the level of production and/or consumption of its metal and/or mineral products. Human civilizations- The Stone Age, The Bronze Age, The Iron Age, The Nuclear/Atomic Age, The Space Age, and The Information and Communication Technology (ICT) Age- are characteristically named after metals and/or mineral products.

- The nexus between economic development of a nation and iron and steel production is discernible by the fact the G-8 nations- France, Germany, Great Britain, Italy, Japan, USA and Russia are ALL TOP iron and steel producing nations of the world. Furthermore, it has been observed that the gross domestic products of most of the 17 Southern African nations- Angola, Botswana, Burundi, Republic of Congo, Democratic Republic of Malawi, Mozambique, Namibia, Rwanda, South Africa,
Swaziland, Tanzania, Zimbabwe, Zambia are directly related to the quantum of their metal production.

- Unfortunately, Nigeria which is the most populous Black nation on earth is not among the comity of steel producing nations of the world because she is not been able to produce liquid steel. Ajaokuta Steel Complex, Delta Steel Company and the three inland rolling mills at Jos, Katsina and Osogbo that are in comatose status. The same goes for the non-ferrous metals- Aluminum Smelting Company at Ikot Abasi.is also in comatose state. The only tin smelting company in West Africa- located in Jos Plateau state has gone to the dust of history. It is no wonder is why Nigerian economy is in recession- in spite of the economic diversification agenda of the Federal Government of Nigeria. The nation obtained USD120 million credit from the International Development Agency (IDA) for the purpose of funding the Sustainable Management of Mineral Resources Project (SMMRP). Again, in March 2017, credit of USD 150 million was obtained from World Bank by the Nigerian Government via International Development for Mineral Sector Support for Economic Diversification Project (MIN DIVER). As at this month (October, 2019), Nigeria’s debt is said to have risen to N27.7 trillion. In spite of all these loans, the report of the United Nations on Nigeria is that the nation is rich but the people are poor!

- It is no longer a secret that Nigeria is undergoing economic recession. Nigeria is now said to be the world capital of poverty. This is not acceptable when Nigeria is so blessed with abundant solid mineral resources and even human resources. For the Nigerian Metallurgical Society, failure is not an option. We cannot afford to fail our founding fathers, the next generation whose future is being mortgaged and most importantly our God to Whom we are going to give account of our stewardship one day.

- Are we hopeless? I say No. “The greatest thing in this world is not so much where we are but in what direction we are moving”- Oliver Wendel Holmes. In the circumstance, the following are recommended to chart a new direction for the revival of the comatose Nigerian Metallurgical Industry towards National economic prosperity.

- All hands should be on deck by the relevant professionals, key stakeholders, Government and organized private sector to ensure sustainable liquid steel production within the next four years so that Nigeria can join steel producing nations of the world.

- Carefully set up an independent and empowered regulator for the Iron and Steel Industry (in lieu of the defunct National Steel Development Authority). Like Nigerian Communications Commission (NCC) and the Central Bank of Nigeria (CBN).

- The Nigerian Metallurgical Bill which is presently in the National Assembly should be reviewed in line with the international best practices by experts and thereafter action should be expedited towards passing it into Act and this is to be followed by the Regulation thereof.

- A need-driven non-ferrous metals research and development institute should be established to enhance metal/mineral value addition chain of the highly mineralized nation.

- There is the urgent need for wholistic, well-planned and aggressive manpower development in mining engineering, mineral processing technology and extractive metallurgical engineering for the Nigerian Solid Minerals Industry.

- The dysfunctional and theoretical mining engineering, mineral processing engineering and metallurgical engineering education in Nigeria should be squarely addressed and that urgently.
In line with the best global practices, there is an urgent need for the emergence of the Nigerian institution of Mining and Metallurgy (NIMM) where Mineral processing is sandwiched and a careful constituted council for this (CNIMM).

In the interest of this nation, no further loans should be taken so as not to mortgage the future of the next generation. Transparent and judicious disbursement of annual budgetary allocation and mineral resources Development Fund to be done to meet the recognized needs of the nation as recommended in this paper as far as the Nigerian Metals/Minerals Industry is concerned, carrying along the key stakeholders/ experts.

In view of the observed anomalies in the Road map for the Growth of Economic Development in the Nigerian Mining industry, there is the need to carefully craft five (5) years strategic plan for Solid Mineral Development with the Metal industry taking a centre stage.

There is need to restructure and rechristened the Federal Ministry of Mines and Steel Development as Federal Ministry of Mines, Steel and Non-ferrous Metals Development which is close to the name of the relevant committee in the National Assembly.

In addition, the supervising Ministry needs repositioning for enhanced efficiency and effectiveness. The prelude to this in enhanced capacity building, motivation and inculcation of core values of integrity, professionalism and excellence in the relevant professionals.

Value-driven Government- Academic - Industry synergy engendered by transformational leadership (rather than transactional) at the national level is the possible panacea for sustainable Metal & Mineral Industries in Nigeria which can boost Nigeria economic and thereby fulfil UNSDGs for the nation.

REFERENCES

Nigerian Metallurgical Society

- en.m.wikipedia.org/wiki/stone-age accessed on March 21, 2019
- en.m.wikipedia.org/wiki/bronze.age accessed on March 21, 2019
- en.m.wikipedia.org/wiki/ironage accessed on March 21, 2019
- en.m.wikipedia.org/wiki/information_age accessed on March 21, 2019
- https://www.google.com.ng/amp/s/www.thecable.ng/mining-contributes-0-3-nigeria-gdp/amp accessed on September 27, 2018
- https://en.m.wikipedia.org/wiki/sustainable_development_goals on September 27, 2018
- www.yourdictionary.com/civilisation accessed on September 27, 2018

FIRST DAY / PARALLEL SESSION 1
THURSDAY: FIRST DAY: 31ST OCTOBER, 2019-

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<td>Environmental Benefits of Recycling &amp; Sustainable Development: Roles of Iron And Steel Industry</td>
<td>Oju, Olusegun &amp; Adeyemo,M.S</td>
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<td>2</td>
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<td>Utilisation of Indigenous Ceramic Raw Materials for the Production of Water Closet</td>
<td>U. Elakhame, Y.O. Obe, A.E Samuel, O.O Luji &amp; O.O. Akinsanya</td>
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<td>Transforming the Economic Growth of Nigeria Through Metallurgical Resources for Sustainable Development</td>
<td>Ibrahim Usman</td>
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<td>2.45pm- 3.00pm</td>
<td>NMS 2019-TP006</td>
<td>Effect of Surface Preparation on the Corrosion Behaviour of Zinc Coating Mild Steel</td>
<td>W.A. Ayoola, M. A. Bodude, J. C. Ojakoya &amp; C.O. Onoh</td>
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<td>Responsive Consumption of Stainless Steel Through Sustainable Production</td>
<td>Vandeyoon T. I., Enenche Y.M., Abdulrahman A. S. &amp; Balogun B. T.</td>
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<td>NMS 2019-TP008</td>
<td>Effect Of Thermal Aging on Corrosion Rate of Al-4%Cu-Millet Husk Ash Particulate Composite in 1m HCl Acid Environment</td>
<td>I. Aliyu, L. Shuaibu, R. Dahiru, I. Y. Suleiman &amp; M. Abdulkadir</td>
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<td>Effect Of Stirring Speed On The Mechanical Properties Of Cast Aluminium Alloys</td>
<td>Oluwole Adigun, Sunday Borisade, Olawale Ajibola, Adebayo Owa, Adebayo Abdullahi, &amp; Samuel Olusunle</td>
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<td>4.00pm- 4.15 pm</td>
<td>NMS 2019-TP010</td>
<td>Synthesis of Zinc Oxide Nanoparticles in Fermented Palm Wine for Various Applications</td>
<td>Owoyemi, Helen, Fatile Oluwagbenga &amp; Adewuyi Benjamin</td>
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<td>NMS 2019-TP013</td>
<td>Beneficiation of Barite Ore from Funekaye in Gombe State using Magnetic Separation and Froth Flotation</td>
<td>Henry E. Mgbemere, John Ugboaja &amp; Suleiman B. Hassan</td>
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<td>NMS 2019-TP014</td>
<td>Revitalization of Foundry SMES in Borno State: An Overview Towards Sustainable Development</td>
<td>Kolo, L. A. M. Abdulrahman, A. S. El-Jummah, A. M.; Mshelia, Z. A. Shettima, I. I.; Mamza, J. S.; Maiva, E. S.; Gujja, A.; Mohammed, A. G; &amp; James, E</td>
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<td>NMS 2019-TP015</td>
<td>A Study of Grey Iron Thick Wall Casting Modified With Iron Powder and Ferrosilicon Alloy</td>
<td>Saka S. O., Seidu S. O., Akinwemori A. D, Shittu S. A A &amp; Taiwo A. S</td>
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<td>Energy Efficiency Improvement &amp; Sustainable Development In Iron And Steel Industry</td>
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<td>Ficus Platiphylla Leaves Extract as Corrosion Inhibitor for Al-Si-Mg Alloy in Marine Environment</td>
<td>S.M. Adams; I.Y. Suleiman V.S. Aigbodion &amp; I.M. Momoh,</td>
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<td>Repositioning Nigerian Artisanal And Small-Scale Mining Sector For Economic Resurgence</td>
<td>Borisade Sunday Gbenga, Oyelaran, Olutunde Ajani, &amp; Dada Esther Opeyemi</td>
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<td>Oyelaran Olutunde Ajani, Suberu A &amp; Dada Esther Opeyemi</td>
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<td>A.M Saliu, U. Shehu, &amp; A.A Adebisi</td>
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<td>Strength Properties Of Concrete Using Waste Glass As Partial Replacement For Different Coarse Aggregates Grading</td>
<td>O.A. Adetayo, &amp; C.A. Opasina</td>
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### Nigerian Metallurgical Society

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**SECOND DAY / PARALLEL SESSION : 3**  
Friday Second Day, 1st November 2019

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<td>Modeling And Evaluation Of Optimum Composite Panel Flexural Strength Subjected to Various Parameters Using Response Surface Methodology</td>
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<td>Suleiman Balarabe Abdulrahman, Aminu O Yusuff &amp; Nazir N Yunusa</td>
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<td>Agboola, J.B., Anyoku, S.E., &amp; Oladoye, A.M.</td>
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<td>Spheroidal Graphite Iron (SGI) Production of Furnace Roof Hangers Using The Facility of</td>
<td>Ocheri C., Njoku R.E &amp; C.N. Mbah</td>
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<td>Effect of addition of Magnesium on the Mechanical Properties and Microstructure of Aluminum based Alloy</td>
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<td>The Effect of Silicon Carbide Additives on the Refractory Properties of Local Clay</td>
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<td>The Influence of Annealing temperatures on the Fatigue properties Of 0.17% C Low Alloy Steels</td>
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<td>Performance Evaluation Of The Effect Of Date Palm Seed Oil As Cutting Fluid For Turning Operation On Aluminium Alloy</td>
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<td>Exploring the curriculum gap in computational materials Science education in Nigeria</td>
<td>Paul S. Nnamchi, Camillus S. Obayi, J.U.Odo’ R. O.Njoku, P.O.Offor A.O. Agabi</td>
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<td>Effect of Austempering Temperature and Time on Microstructure and Mechanical Properties of Austempered Ductile Iron</td>
<td>ApataA.Oluwatoyin,Mukoro, Edward, Feyisayo V. Adams, &amp; Ogbodo, J. Nkeiruka</td>
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<td>Evaluation of Solidification Shrinkage Process in Aluminium-Silicon (Al2000) Alloy Castings</td>
<td>Olusanya Francis Dacosta, Samuel Babatope Adejuyigbe, Bayode Julius Olorunfemi, Adeyemi Ademibi Adekunle, &amp; Ajani Olatunde Oyelaran</td>
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<td>56 2.45-3.00pm</td>
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<td>Characterization and corrosion study of heat treated and unheat treated API5L steel welded region in sweet oil field environment</td>
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<td>Adetula Y. V., Ozah B. N., Alabi O. O., Ibitoye A.O.</td>
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Paper: NMS 2019-TP001
Environmental Benefits of Recycling & Sustainable Development: Roles of Iron and Steel Industry
Oju, Olusegun and Adeyemo, M.S
Technical Education Department,
Kogi State College of Education (Technical), Kabba
olusegungbenga2yk@yahoo.co.uk, 08054081625

Abstract
The iron and steel manufacture involves a large number of processing which lead to complex problems of environmental pollution and this accounts for 6.7% of the global anthropogenic carbon dioxide emissions. It is well suited to sustainable development goals since it has virtually an unlimited lifespan and the potential for unlimited recyclability. This paper focuses on efficient energy utilization and environmental pollution control and also examines causes of energy inefficiency and environmental pollution. Some of the causes which include: use of outdated production technology, aged industrial infrastructures, lack of management skills and coal dominated energy structures. Recommendations were given at the end of the paper which includes: that there is a need for an integrated approach like green manufacturing technology towards energy and environment management of the industry so that better energy efficiency and environmental friendliness can be achieved.

Keywords: Recycling, Sustainable Development, Iron and Steel Industry

Paper: NMS 2019-TP002
UTILISATION OF INDIGENOUS CERAMIC RAW MATERIALS FOR THE PRODUCTION OF WATER CLOSET
Z.U. Elakhame1, Y.O. Obe1, A.E Samuel1, O.O. Luji1, O.O. Akinsanya1
1. Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria.
a. Email: ezeberu@yahoo.com, +2348038831703

Abstract:
The fact that Nigeria ceramics raw materials are underutilized as a result of inadequate information on the materials which limits the local production of water closet. The emphasis of this research was on the suitability of the physio-chemical properties of the abundant locally sourced ceramic raw materials from South-west Nigeria, while existing slip cast production method was adopted. The selected locally sourced raw materials included: kaolin, feldspar, silica and ball clay. Physical properties of the materials were tested which include Shrinkage, Porosity, Bulk density, Plasticity, and Modulus of Rupture. The results showed that the clay sample belong to Alumina-silicate group with 59.20% silica and 21.25% alumina. The samples' properties met the required standards; hence, the materials were found suitable for production of water closet of acceptable standards. Though, the porosity of the sample tiles increased as the percentage weight of the clay material in the mixed decreased and proportion of kaolin, silica, feldspar and ball clay increased. Sample containing 55% kaolin, 30% feldspar, 5% silica & 10% ball clay had better formulation properties than others.

Keywords: Ceramics materials, properties characterization, slip-cast, water-closet.
Paper: NMS 2019-TP003
Transforming the Economic Growth of Nigeria through Metallurgical Resources For Sustainable Development
Ibrahim Usman
danhalima0@gmail.com 08036447910
Integrated Science Department, Federal College Of Education, Katsina.

Abstract
Metallurgical resources of any nation are perhaps the most important mineral resources capable of ensuring speedy economic growth and development any nation can be proud of. It is a domain of natural science that involves the exploration, engineering, extraction as well as the use of chemical and physical properties of metallic elements, their intermetallic compounds and their mixtures such as alloys for the advancement of economic prosperity of any nation. This paper attempts to give a discourse of how metallic resources of Nigeria could be harnessed for its economic prosperity.

Key Words: Metallurgy, Economic growth, Sustainable Development.

Paper: NMS 2019-TP004
Whither: Quality of Steel Reinforcement Consumption in Nigeria. A Case Study of Building Collapses
Balogun B. T., Ayandokun W. A & Abdulrahman A. S.
Department of Materials and Metallurgical Engineering, School of Infrastructures, Process Engineering and Engineering Technology, Federal University of Technology, Minna.

Abstract
The quality of steel rods used for building construction in Nigeria has been thoroughly and extensively investigated using strength of material approach. The three most densely populated cities in Nigeria: Lagos, Abuja and Kano were chosen as areas of studies. A total number of 18 samples of steel rod of various diameter 8mm, 10mm, 12mm, 16mm, 20mm and 25mm were purchased from different vendors across the cities of Lagos, Abuja and Kano at different locations A, B and C in each cities. Each of the 18 samples of different diameters at three (3) different locations were cut into pieces of gauge length of 300mm, making a total number of 54 samples obtained in each city. A total number of 162 samples were finally prepared for the laboratory test at 300mm tensile machine gauge length of each samples so as to have the replicate of the test in three (3) times for various diameter samples. The results reveals that 67% of steel used for building construction in Lagos and Kano are below the standard, while 88% of the steel rods used for building construction in Abuja are below the standard. Consequently, the building collapses could be attributed to sub – standard reinforcement.

Keywords, Reinforcement; Tensile strength; Yield strength; Collapse buildings; Steel rod.

Paper: NMS 2019 - TP005
Sustainable Aluminium Matrix Composites: Prospects of Agro-wastes Utilization as Reinforcing Material
K. S. Ajao1, A. S. Abdulrahman2, A. G. Kareem3, A. Ibrahim1
1Department of Materials & Metallurgical Engineering, University of Ilorin, Ilorin
2Department of Materials & Metallurgical Engineering, Federal University of Technology, Minna
3National Agency for Science and Engineering Infrastructure, Abuja
*Corresponding author: ajao.ks@unilorin.edu.ng

Abstract
Aluminium matrix composites had been adjudged suitable for varieties of industrial applications. Lower density, abundance availability and good compatibility of agro-wastes particles with aluminium matrix has been experiencing the attention of researchers. Adoption of agro-wastes as reinforcing material in aluminium matrix composites fabrication could be a
good replacement for the expensive and scarce synthetic ceramic reinforcements, and serve as a means of achieving sustainable production of aluminium matrix composites. This paper reviewed previous works on aluminium matrix composites reinforced with agro-wastes derivatives.

Keywords: Agro-wastes, Aluminium, Composites, Matrix, Reinforcement, Sustainability

Paper NMS 2019- TP 006

Effect of surface preparation on the corrosion behaviour of zinc coating mild steel

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Abstract

Surface modification of engineering materials is necessary for preventing corrosion and subsequence failure of materials in service. There are different methods of surface preparations which can affect engineering materials in different ways. This study investigated the effect of surface modifications on the corrosion behavior of zinc coated and uncoated mild steel. Quantitative analysis and Potentodynamic Polarisation Technique (PPT) were used to evaluate the immersed samples of different surface preparations. The results indicate that the least weight loss was observed for uncoated sample prepared with P1200 grit paper (0.1066 g) and successive samples in the order of P220 grit paper (0.1158 g) < P60 grit paper (0.1252 g) < filing (0.1378 g) and grinding (0.1590 g) after 35-day of continual immersion. Prepared sample surfaces further coated with zinc spray demonstrated similar trend as the uncoated at lower weight losses. PPT results further suggested the same behavior observed in the quantitative analysis.

Paper NMS 2019-TP 007

Responsive Consumption Of Stainless Steel Through Sustainable Production

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Abstract

Stainless steels are indispensable in economic growth and development of our society. Stainless steel has so many usage, from automobile parts to household utensils, hospital equipments and other finished or semi-finished products. The concern of any nation should not be on how to import and consume, but the desire to design the system to start and maintain the productivity level of products. Nigeria however, is faced with several challenges of stainless steel consumption. It imports from other countries without putting in place appropriate standards, and the imported stainless steels qualities cannot be ascertained. This paper looks at the responsive consumption of stainless steel in Nigeria and problems of steel production in general. It also proffers solution to some of these problems

Keywords: Consumption, Production, Stainless Steel, Sustainable development,
Effect of Thermal Aging on Corrosion Rate of Al-4%Cu-Millet Husk Ash Particulate Composite in 1M HCl Acid Environment

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Abstract

The use of agricultural wastes which is cost-effective and environmental-friendly materials as reinforcements in metal matrix composites is growing fast in various engineering fields. With this, the research investigates the effect of thermal aging on corrosion rate of Al-4% Cu reinforced with millet husk ash (MHA) particulate composite in 1M HCl acid environment. The millet husk ash (MHA) particle size of 75 μm was prepared for the studies. Different weight percentages of 2, 4, 6, 8, and 10 wt. % MHA were used to develop matrix composites for the investigations. The millet husk ash was characterized by X-ray fluorescent (XRF). Weight measurements were used to study the corrosion behaviour of as-cast, thermally aged hardened and normalized coupons. The time was varied in the range of 24 to 120 hours at 24 hours interval at 30°C respectively. The XRF analysis showed that MHA contains mostly silica (SiO₂). The corrosion rates both in alloy and the composites increase as the weight percentage of reinforcement increased. The silica hard surface reacted with the copper to form strong surface that aided corrosion. The trends are as follows: As-cast corrosion rate is greater than that of normalized and greater than that of aged hardened of the Al-4%Cu alloy and the composites.

Key Words: Thermal Ageing, Millet Husk Ash, Corrosion Rate, Acid Environment

Effect of Stirring Speed on the Mechanical Properties Of Cast Aluminium Alloys

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Abstract

In the present study, effect of stirring speed on cast aluminium alloy and the resulting improvement in mechanical properties have been characterized. Al-Cu alloys with percentage copper compositions between 0-15% Cu were prepared via stir casting method at different stirring speed using a mechanical stir caster. Each sample was produced with varied stirring speed of 0 rev/min, 10 rev/min, 50 rev/min and 90 rev/min during the casting process and materials produced were tested for hardness and tensile strength. The results show that hardness of the materials produced increased progressively with stirring speed while improvement recorded in strength was not progressive with the stirring speed. This study shows that controlled variation of stirring speed during metallurgical casting process could be used to produce improved material property for useful engineering applications.

Keywords: Stirring speed, casting, aluminium alloy, hardness,
SYNTHESIS OF ZINC OXIDE NANOPARTICLES IN FERMENTED PALM WINE FOR VARIOUS APPLICATIONS

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Abstract

In this research, an investigation was carried out on synthesis of zinc oxide for various applications. Zinc oxide nanoparticles were nanostructured by co-precipitation method using fermented palm wine. Synthesis of zinc oxide nanoparticles were carried out by making use of fermented palm wine, zinc acetate, sodium hydroxide and Triethanolamine (TEA) as starting materials. These chemicals reagents were prepared and the resulting mixture was heated under the action of magnetic stirrer for different reaction time of 1 hour, 2 hours and 3 hours. The particle size and morphology of the synthesized nanoparticles was investigated by Transmission Electron Microscope (TEM) and the elemental composition was obtained from Energy Dispersive Spectroscopy (EDS) attached to TEM and X-ray fluorescence (XRF). The crystal structures of synthesized nanoparticles were also observed using X-ray Diffraction (XRD). Results obtained from characterization of the nanoparticles show that pure ZnO nanoparticles with average particle sizes of 66.17nm, 117.10nm and 204nm were obtained for samples heated for one hour, two hours and three hours reaction time respectively. It was observed that the particle sizes of the nanoparticles increased as the reaction time increased. It was concluded that chemically pure zinc oxide nanoparticles can be synthesized using fermented palm wine in combination with other chemical reagents.

Keywords: Co-precipitation, Palm wine, Zinc oxide nanoparticles, Synthesis.

The Impact and Effect of Risk Management Planning on Titanium Alloy Manufacture with EOSINT M 270 Laser Machine

Witheosint M 270 Laser Machine

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&

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Abstract

This paper provides an overview on the impact and effect of risk management planning on EOSINT M 270 Laser machine while manufacturing Titanium Alloy and how to Minimize the Risk Management planning on the machine; the Importance of Risk Management Planning on the machine for future use; including the Background of EOSINT M 270 Laser Machine; and the Process of operating EOSINT M 270 Laser Machine; plus, the advantages of EOSINT- M270 Laser Machine.

Keywords: EOSINT M270 Laser Machine, Fabrication, Molding, Planning, Risk Management.
Mathematics as Tool for Scientific and Engineering Practices for National Development

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Abstract
Mathematics and computational tools are central to science, engineering and technology which permeate nearly every facet of modern life and hold the key to solving many of humanity's most pressing current and future challenges. Understanding how science and mathematics has achieved this success, and the techniques that it uses is an essential part of any science education. Teaching of mathematics should deal with the process and not just confine to transferring the knowledge from the mind of the teachers to notebooks of students, a right ambiance is required and it is definitely the mathematics Laboratory. The paper explicitly discusses the concept of mathematics and education, mathematics laboratory and its numerous advantages, and proposes a new approach to science-mathematics education that will capture students' interest and provide them with the necessary foundational knowledge in any field for sustainable national development. It advocates teachings and learning of Mathematics through Laboratory experiences, which invariably provide opportunities for students to interact directly with the material world.

Keywords: Teaching, Mathematics laboratory, Students’ interest, National development

Beneficiation of Barite ore from Funkeaye in Gombe State using Magnetic separation and Froth Flotation

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Abstract
Barite ore from Funkeaye local government area in Gombe state has been beneficiated using a combination of magnetic separation and froth flotation techniques. The initial characterisation using X-ray diffraction (XRD), X-ray Fluorescence (XRF) and specific gravity measurements on the ore showed that it is barite with a specific gravity of 4.03 with Fe₂O₃ and SiO₂ as the major impurities. The specific gravity value of the barite increased to 4.31 after magnetic separation of the samples. Due to the high concentration already obtained, 0.1M of the Frother (pine oil) and the collector (oleic acid) were used separately to carry out froth flotation on the sample. The results show that with frother alone, an S.G value of 4.44 was obtained while with collector alone, an S.G value of 4.41 was obtained. The results show that the beneficiated sample is suitable for use as a mud in the drilling of crude oil.

Keywords: Barite, Froth Flotation, Magnetic Separation, Beneficiation, Specific Gravity
Paper: NMS 2019 –TP 014

Revitalization of Foundry SMEs in Borno State: An Overview towards Sustainable Development

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Abstract

Borno State needs to revitalize foundry in order to achieve meaningful economic development. The UN SDG Goal one is to end poverty in all its form everywhere before the year 2030. Foundries are in the forefront of output expansion, employment generation, income redistribution, promotion of indigenous entrepreneurship and production of primary goods to strengthen industrial linkages. Presently, foundry SMEs contribution to the economic development is still far below expectation. Foundry in Maiduguri are faced with many challenges; which include but not limited to lack skilled labour, lack of proper quality control procedure resulting in casting defects in the cast component. Therefore, this study focused on the revitalization of foundry SMEs in Borno State towards Sustainable Development Goals, with the intent to know the problem associated and the way forward towards achieving success of SDG. The contribution of SMEs to economic development is such that a country can only ignore to its own peril. For the purpose of this research work descriptive method under the qualitative research method was adopted. 21 respondents were interviewed and their observations were captured to form the basis of this research. The research revealed that foundry SMEs in Borno State are at the lower ebb as a result of insecurity and lack of Government support.

Keywords: Foundry-management, SMEs, SDGs

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Paper: NMS2019-TP015

A Study of Grey Iron Thick Wall Casting Modified with Iron Powder and Ferrosilicon Alloy

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Abstract

This study investigates the chilling tendency of iron powder on thick wall grey cast iron. A series of grey cast irons (chill wedges of type W, specified in the ASTM A367 of different cooling moduli CM = 0.45-0.54cm) were poured in sand mould at varied iron powder (Fe – Powder) addition with constant ferrosilicon (FeSi) alloy by ladle inoculation. The treated irons solidified within strongly hypereutectic range (carbon equivalent CE = 4.60 - 4.89). The chill evaluation parameters were measured and evaluated. The double treated irons (0.2wt% Fe - powder + 0.3wt% FeSi alloy and 0.4wt% Fe - powder + 0.3wt% FeSi alloy) were observed to have given the optimum iron powder addition with best intermediate chilling result for W3½ and W4 while the single treated iron (0.3wt% FeSi alloy) gave the best inoculating effect. The comparison between single treated and double treated irons increases from clear chill, through mottle chill up to total chill evaluation, particularly for W4. The hardness of the treated irons increased as iron powder addition rate increased with 0.6 wt% Fe - powder + 0.3wt% FeSi alloy having recorded highest hardness value (37.1HRC) at chill zone and thus corroborated with the chilling parameters evaluated while 0.2wt% Fe powder + 0.3wt% FeSi alloy recorded the lowest hardness value (20.6HRC) at the slowest cooling rate. High chilling was also recorded as a result of high Sulphur, phosphorus and nearly proper Mn and S.

Keywords: grey iron, thick wall casting, iron powder, ferrosilicon
Paper: NMS 2019-TP016

**Energy Efficiency Improvement & Sustainable Development In Iron And Steel Industry**

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**Abstract**

Iron and steel manufacture involve a large number of processing which lead to complex problems of environmental pollution and these accounts for 6.7% of the global anthropogenic carbon dioxide emissions. Waste generation adversely affects productivity and contributes to the high cost of production. It has been shown that improving the efficiency of operation and fuel saving measures help in reducing pollution in steel plants. Iron/steel manufacture is well suited to sustainable development goals since it has virtually an unlimited lifespan and the potential for unlimited recyclability. This paper focuses on efficient energy utilization, causes of energy inefficiency and environmental pollution. Some of the causes which includes: use of outdated production technology, aged industrial infrastructures, lack of management skills and coal dominated energy structures. Recommendations were given at the end of the paper which includes: that there is a need for an integrated approach like green manufacturing technology towards energy and environment management of the industry so that better energy efficiency and environmental friendliness can be achieved.

**Keyword:** Green manufacturing, environmental pollution, CO₂ emission, energy saving technologies, recycling, Sustainable development.

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Paper: NMS 2019-TP 017

**Evaluating Gravity Behaviour of Gyel Columbite in Varying Concentration Parameters Towards Niobium Pentoxide Recovery**

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**Abstract**

The gravity behaviour of Gyel columbite at varying concentration parameters was studied towards niobium pentoxide recovery. Crude samples of the ore were sourced from different pits at Gyel mining site and Thirty (30) kg of the collected sample was weighed from which 10 grms. was randomly sampled for chemical characterization. The weighed ore was crushed, ground, homogenized and separated into size fractions from -500 + 355 µm to -125 + 90 µm. 5 kg of each fractions was subjected to gravity separation using a Denver Mineral Jig at varying stroke speed of 500 – 2500 rpm; feed rate of 50 – 250 Kg/hr. and jig deck slope of 0 – 30° respectively. The resulting products were analyzed chemically. ED-XRF analysis of the crude reveals that it contains 6.71% Nb₂O₅, 4.20% Al₂O₃, 27.0% SiO₂, 22.2% TiO₂, 23.1% Fe₂O₃ and other compounds in trace amount; the major associative gangue being silica and zirconia. Recovery of niobium pentoxide at varying stroke speeds was maximized at -500 +355 µm and stroke speed of 1500 rpm averaging 70.99 % at assay of 12.34 %Nb₂O₅. Also, optimized recovery at varying feed rates was obtained at size of -355+ 250 µm and feed rate of 250 Kg/hr averaging 71.88 % at grade of 8.12 %Nb₂O₅. More so, at varying deck slopes, optimum recovery of niobium pentoxide was obtained at size of -355+ 250 µm and deck slope of 60° averaging 68.84 % at grade of 7.91 %Nb₂O₅.

**Keywords:** Gravity Behaviour, Gyel Columbite, Concentration Parameters, Niobium Pentoxide, Recovery
Quality Steel Production For Automobile Industry For Sustainable Development

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Abstract
The sustainable development goal can be met through the production of quality steel. Steel is essential in the automotive industries and has found renowned global usefulness by the ease of formability, energy impact absorption, resistance to corrosion upon coating, weldability and possibility of recycling. However, weight could stand as a disadvantage when compared to order viable substitute. A newly developed grades of advanced high-strength steel (AHSS) significantly outperform competing materials for current and future automotive applications as a result of steel’s performance flexibility, as well as its low cost, superior recyclability, weight reduction capabilities, safety attributes and reduced greenhouse gas emissions. Dual phase and martensitic steels show a good combination of strength, formability and weldability, which together with the cost-effectiveness of cold forming results in making body-in-white structural parts, as well as safety parts such as door impact beams, bumper systems and seat structures. This paper explored steel and its quality production for the automotive industry in Nigeria for sustainable development. It was also discussed that the industrialization of Nigeria depends heavily on its steel production.

Keyword: Advanced high strength steel; Automobile industry; Steel industry; Development

Ficus Platyphylla Leaves extract as Corrosion Inhibitor for Al-Si-Mg Alloy in Marine Environment

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Abstract
A study of the effects of Ficus Platyphylla (FP) leaves extract as corrosion inhibitor for Al-Si-Mg alloy in 3.5wt% NaCl solution was conducted using gravimetric mass-based and electrochemical techniques at 30°C, 50°C and 70°C, from 1, 2, 3, 4, 5 hours of exposure time with varying concentrations of the extract 0.2, 0.4, 0.6, 0.8 and 1.0 v/v respectively. The alloy was produced by sand casting technique and the extract was characterized using Fourier transform infrared spectroscopy (FT-IR) and Gas chromatography mass spectroscopy (GC-MS) respectively. From the result, the plant extract was found to contain tannins, saponins, flavonoids and alkaloids. The rate of corrosion decreased with addition of the plant extract in all the concentrations studied. The inhibition efficiency of the extract increased with an increase in concentration of the FP and decreased with increase in temperature. The adsorption of the inhibitor onto Al-Si-Mg surface is exothermic, spontaneous and is best described by Langmuir adsorption models. The calculated values of activation energy, enthalpy and entropy of activation, free energy of the process can be said to be physisorption. The Tafel polarization data indicate that the studied plant extract is a mixed type inhibitor.

Keywords: Inhibitor, adsorption, polarization, ficus platyphylla, gravimetric.
Study on the Effects of Different Weld Joints on the Tensile Property and Microstructural Features of Mild Steel Using Shielded Metal Arc Welding Processes.

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Abstract

The effects of different butt-joint welds on the tensile property of mild steel using shielded metal arc welding process was investigated. The mild steel plates were prepared in different weld joint geometries and welded using shielded metal arc welding (SMAW) techniques. The different butt-joints considered in this study includes: single V-joint, double V-joint, and square butt-joint and single J-joint. The welding parameters used such as current, voltage and welding speed were kept constant throughout the experiment. The tensile test reveals that the double V-joint gives the highest tensile property with the ultimate tensile strength of 475.49N/mm² while the square joint gave the least tensile strength of 278.17N/mm². The microstructural examinations also reveal the structural changes and grain size that occur at the fusion zone, heat affected zone and the base metal. It is therefore, concluded that the double V-joint which gave the highest ultimate tensile strength when compared with other joints should be used for application that requires high strength.

Keywords: Arc welding, Tensile strength, Microstructure, Butt Joint, SMAW

Repositioning Nigerian Artisanal and Small-scale Mining Sector for Economic Resurgence

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Abstract

Millions of people in the developing world depend on artisanal and small-scale mining (ASM) for their livelihoods. This wealth, however, can come at a price. Artisanal and small-scale mining has many associated environmental and occupational health issues, particularly when practiced informally or with limited technical and material resources. The health and well-being of miners, their family members as well as nearby communities is often adversely affected. Nigeria is richly endowed with vast but largely untapped natural resources including solid minerals and arable land. Mining industries is a key driver of economic growth and development process, which could lead to better social and economic wellbeing. There is vast consensus that the current rising cost of mineral investment and ecosystem pressures require new economic and social contract paths which should protect the interests of the Artisanal and Small-scale Miners. These path should address alternatives exploration, mining, processing methods and marketing of vital minerals in an eco-friendly way while improving the economic status of the miners. The opportunity exists to make better use of the ASM personnel towards the exploitation of natural resources and using modification and adaptation actions as a tool towards a more inclusive development path for the developing Nigeria. It is in this respect that the contributions of engineering and Technological Institutions are germane in terms of training, design and fabrication of appropriate mining and processing equipment which should be affordable and adaptable to Nigerian condition. Although intensive effort is being made particularly by some organs of the government, the paper examines how such actions can be further boosted and accomplished using the expertise and knowledge available in Engineering and Technological Institutions of Nigeria.

Keywords: Artisanal, Mining, Economic Development, Resurgence
Nigerian Metallurgical Society

Paper: NMS 2019-TP 022
Sustaining Developmental Goals Through Fabrications Of Durable, User-Friendly Mathematics Trainer Kits For Metallurgical Industry
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Abstract
The importance of metallurgical industry, for any nation, is obvious and overwhelming. In this context, paraphrasing a known dictum, we can strongly say that in the industrial environment and in life generally ‘if there is no metallurgy, nothing is!’ Metals are well suited to sustainable development goals. They are not biodegradable and have virtually an unlimited lifespan and the potential for unlimited recyclability. Thus metals can be considered as renewable materials. The paper examined the nature of national goals and the importance and significance of Metallurgy in National Economy. It specifically delved into the need of fabricating high-quality, cost-effective and user-friendly Mathematics Trainer Kits purposefully designed to educate students about the problems and trouble-shooting techniques that are supposed to be adopted when exposed to advanced working systems in the industries. With the fabrication and manufacturing of these kits mathematics laboratory kits, couple with its numerous advantages, will capture students’ interest in mathematics and engineering, and consequently provide them with the necessary foundational knowledge in any field for sustainable national development.

Keywords: Metallurgy; Fabrication; Trainer-kits; National economy and Sustainable development

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Paper: NMS 2019-TP 023
Technopreneurship: Issues and challenges
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Abstract
Entrepreneurship is acknowledged to be a significant driver of national wealth. The best solution to solve a problem of unemployment, in a country like Nigeria, is to have as many Job Creators as possible, so we need Entrepreneurs. Various Government and Non-Government agencies are doing lot of work to promote Entrepreneurship. Even it has established National Agency for Science and Engineering Infrastructures (NASENI), National Centre for Technology Management (NACETEM), and National Technology Business Incubation Board (NBTI) with centres spread across the country. This paper discusses various issues and challenges related to the commercialization of technology-innovations and patents. The main issues discussed here are: to go for patent or not, techno-innovations or techno-entrepreneurship, supports for commercialization of technology innovations/ patents, technology business incubation, technology transfer, enterprising tendency and characteristics and several other factors that influence the success of entrepreneurship development were identified.

Keywords: Techno-innovation, Techno-entrepreneurship, Patent, commercialization, Incubation
Effect Of Soaking Time on the Mechanical Properties of Mild Steel

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ABSTRACT

This paper presents the results of the investigation on the effect of soaking time on mechanical properties (hardness, tensile strength and yield strength) of mild steel. The mild steel samples were subjected to annealing at 910°C at different soaking time of 20mins, 40mins, 60mins and 90mins respectively. Hardness test, tensile test and yield test were conducted to determine properties of annealed mild steel with increasing soaking time. The hardness showed almost the same value and a sudden drop in value at 40 minutes soaking time but later increased in value from 60 to 90 minutes. While the tensile strength and yield strength showed a continuous increase in value with increasing soaking time. There was a linear relationship between tensile strength and yield strength of the material for different soaking time.

Keywords: Heat treatment, mechanical test, soaking time, tensile test, annealing.

The Mineralogical, and XRD Analyses Characterized Clay and Clay Minerals of Bida

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The detail physical, chemical and surface properties of clays mainly depend on their mineralogical compositions. The main objective of this research was to study the mineralogical and chemical composition of clay obtained from a clay deposit in Bida Niger State. The clay sample was collected from a deposit in Minna, Nigeria. It was cleaned, soaked, dried, crushed and sieved then moulded to some definite shapes depending on the type of test carried out on the various clay samples. The qualitative mineralogical phase identification was performed by X-ray diffraction (XRD) in powder samples using an Analytical Empyrean, diffraction DY674. In determining the chemical constituents of the clay samples in terms of the individual oxides; the analysis of the samples was carried out. The mineralogical composition of clay, 20.854° of intensity 18.7% and 26.634° of intensity 100.0% was observed to be quartz minerals, while the mineralogical composition of clay, 12.318° of intensity 100.0% and 19.801° of intensity 80.0% was observed to be kaolinite minerals. It was observed that the high abundance of quartz minerals in the clay deposits sample shows that the clay have high silica content, and are bound to be strongly acidic as the silica provides several sites for the hydroxyl groups or water molecules to bind. These results reveal that the dominant clay mineral in the clay deposits at Bida is kaolinite. It is not surprising that clays from these areas have been used for pottery, ceramic, bricks and tiles.

Key words: Kaolinite, Mineralogy, Chemical Composition, X-Ray Diffraction

The Role of Metals Industry in the Diversification of National Economy

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Abstract

It is important to remember that, Nigeria’s Tax Regime does not exist in isolation rather in industrialization. Tax policy is a crucial part of the overall institutional framework of a nation. In order to implement the Nation’s Metals Industry Projects, a preliminary time scale schedule attached
Nigerian Metallurgical Society

to the implementation plan of completing and reviving our metals industry is necessary. Those with primary responsibility for implementing the plan must be technically coordinated, managed and supervised to ensure uniform progress across the metals industry projects. In order to attract investment and get metals project off the ground, Nigeria has to put in proactive effort compared to what is needed to do in the past, this will help to develop the metals sector to provide a solid Backbone in manufacturing and contributing to Gross Domestic Products (GDP). Nigeria needs to establish a right policy framework ahead of the next upward investment cycle. Otherwise, she will miss out on the next surge in metals investment. Nigeria’s Industry is for now only wishful thinking without sustainable domestic production. Hence, Nigeria has to stand-out among other countries which are more familiar to techno-economic development.

Keywords: Metals Industry, Tax policy, GDP, Framework policy, Metals investment.

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Paper: NMS 2019-TP027

Microstructural analysis and dry sliding wear and friction behaviour of ZA-27 alloy reinforced with boron carbide particulate composite

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Abstract

The effect of Boron Carbide (B₄C) on the dry sliding wear and friction behaviour of ZA-27 alloy composites was investigated. The base alloy was reinforced with B₄C particles of 30µm and the composite was produced by stir casting method. The as-cast samples consisting of varied weight percentage amount of B₄C of 0, and 5 are tested for tribological properties and the results were compared with the unreinforced sample under the same conditions. The wear and frictional performance of the metal matrix composites was studied by performing dry sliding wear test using a specimen on disc approach. The composite demonstrated increased wear and frictional resistance compared to the unreinforced alloy. Finally, confirmation tests were carried out to verify the experimental results and Scanning Electron Microscopic studies were done on the wear surfaces.

Index Terms- Metal Matrix Composites, Stir casting, Wear and friction

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Paper NMS 2019-TP 028

Strength Properties of Concrete Using Waste Glass As Partial Replacement for Different Coarse Aggregates Grading

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Abstract

This study examined the variation in the strength properties of concrete using waste glass aggregate (WGA) as partial replacement for different coarse aggregates grading. Three quarter inch and one inch (25mm) coarse aggregates were partially replaced with WGA of respective sizes in different percentages of 0%, 10%, 20% and 30%. Physical properties such as specific gravity, bulk density, slump, and workability of fresh concrete and strength properties such as compressive strength and tensile strength of hardened concrete of grade M25, mix ratio 1:1:2 were tested after 7, 14, 28, 56 and 90 days. The results of the physical properties revealed that the WGA exhibited lower specific gravity value of 2.70, bulk density of 1364kg/m³, moisture content of 0% as compared to granite of specific gravity value of 2.74, bulk density 1660kg/m³, and moisture content of 0.01%. The compressive
strength results of partially replaced WGA increases as the curing age of the concrete increases. At 7 and 90 days the compressive strength results of 20mm aggregate of the control mix concrete were 30.05N/mm$^2$ and 42.60N/mm$^2$ respectively while that of 20mm 30% WGA partial replacement were 32.14N/mm$^2$ and 45.70N/mm$^2$ respectively, and for 25mm aggregate control mix concrete were 29.74N/mm$^2$ and 49.80N/mm$^2$ respectively, while that of 25mm, 30% WGA partial replacement were 28.71N/mm$^2$ and 45.50 N/mm$^2$ respectively. The tensile strength for all the ages reached optimum value at 10% partial replacement WGA for both 20mm and 25mm. At 28days, the tensile strength result of 20mm aggregate of the control mix concrete was 2.86N/mm$^2$, while 20mm 10% WGA replacement was 2.90N/mm$^2$, and for 25mm aggregate control mix concrete, tensile strength result was 3.11N/mm$^2$ while that of 25mm WGA 2.55N/mm$^2$. The results of the strength properties showed that the concrete grade M25 adopted was suitable for the WGA partial replacement as the compressive strength results for all ages did not fall below 25N/mm$^2$.

**Keywords:** waste glass aggregate, partial replacement, workability, compressive strength, tensile strength

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**Paper: NMS 2019-TP029**

**Effect of Weld Polarity on the Mechanical Properties of Arc Welded Medium Carbon Steel Using Locally Formulated Low Hydrogen Electrode**


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**Abstract**

The study investigated the effect of polarity on the microstructure and mechanical properties of welded joints made from shield metal arc welding (SMAW) on medium carbon steel using locally formulated low hydrogen electrode flux coatings. The electrode was produced using mild steel core wire and the flux was formulated using commercial low hydrogen flux (E7018) as base material and partially replaced with potash extracted from locust bean seed pod, Titanium dioxide (TiO$_2$), Potassium Fluoride (KF), and Sodium Silicate (Na$_2$SiO$_3$) as additives to enhance the mechanical properties of the welded joints. The partial replacement was done at varying compositions and the electrodes were coded as X$_3$, X$_5$, and X$_7$. The welding was carried out at 75A rooting and 115A capping current using Direct Current Electrode Positive (DCEP) and Direct Current Electrode Negative (DCEN) polarities. Welded sections were prepared for mechanical properties and microstructure examination. The universal testing machine was used to determine the tensile properties while microstructure examination was carried out at 400X magnification. Brinell hardness was used to determine the hardness and Charpy impact test was conducted to determine impact strength. The results from tensile properties using electrode coded X$_3$ and X$_5$ using DCEN had yield strength of 510.33N/mm$^2$ and 471.67N/mm$^2$ respectively which compares favourably with yield strength of E7018 low hydrogen electrode which is 479.6N/mm$^2$ while ultimate tensile strength (UTS) for the electrodes coded X$_3$ and X$_5$ using DCEN were 548.67N/mm$^2$ and 501.33N/mm$^2$. These values compares closely with UTS of E7018 electrode welded joints which has a value of 569N/mm$^2$. Results from impact and hardness tests showed that welded joints employing DCEN had better hardness and impact strengths than welded joints using DCEP polarity. Based on this study, DCEN is the suitable polarity for the formulated electrode.

**Keywords:** low hydrogen flux, welded joints, rooting current, polarity, microstructure
Characterization and Corrosion Behaviours of Austenitic Stainless-Steel in Hydrochloric at Different Concentrations

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Abstract
Characterization and corrosion behavior of austenitic stainless steel (ASS)316 types in various concentrations of hydrochloric acid solutions were investigated in relation to its pitting corrosion resistance. The austenitic stainless steel 316 was characterized by Spectro Ametek analysis. Experimental test was carried out using potentiodynamic polarization (PDP) at room temperature (30°C) to evaluate the change of corrosion mechanism based on its polarization resistance. Hydrochloric acid solutions were prepared with various concentration of 0.5-2 M at 0.5 M interval. The Tafel and characterization results showed that the austenitic stainless steel was influenced by the concentrations and the chemical compositions respectively. The corrosion resistance of the ASS 316 at various HCl concentrations from the highest to the lowest were 0.5 M, 1 M, 1.5 M, and 2 M respectively and therefore, the lowest corrosion resistance of ASS was at 2 M. The degree of pits, cracks, and dissolution of ASS in the hydrochloric acid increases with increase in acid concentrations. The results obtained from the Tafel and characterizations were also in good agreement.

Keywords: Austenitic SS 316, Characterization, Corrosion Behavior, Pitting, Resistance, HCl solution, Tafels.

Characterization of Nrobo- Uzo-Uwani Nigerian Clay for Possible Ceramic Tiles Manufacturing

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Abstract
A combination of X-ray diffraction and X-ray fluorescence techniques have been employed to characterize the Nrobo, Uzo-uwani clay deposit in Enugu state, Nigeria. The clay sample was also subjected to some physico- mechanical tests which included linear shrinkage, bulk density, water absorption and flexural strength tests. The results obtained from XRF analysis showed that the Nrobo clay contains high amount of silica (SiO₂), 59.12%, followed by alumina (Al₂O₃) which is 30.01%. The clay sample was also found to contain fluxing minerals such as Na₂O, K₂O, MgO, Fe₂O₃, and CaO which helped to melt silicate and bound particles of the clay during firing. X-ray diffraction studies showed that the clay sample consists predominantly of quartz (SiO₂) and magnesium aluminium iron oxide (MgAl₂Fe₄O₁₄). Results from the physical and mechanical tests revealed that flexural strength varies between 37.68 and 60.45 Kgf/cm², fired linear shrinkage varies from 11.90 to 15.70%, water absorption varies from 12.61 to 20.22% and bulk density varies from 2.29 to 2.51 g/cm³ for clay samples fired between 900°C and 1200°C.

Keywords: Characterization, Nrobo- Uzo-uwani, Nigerian Clay, Ceramic Tiles and Manufacturing
Fracture Toughness and Microstructure of Heat-Treated 0.22% Carbon Steel

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Abstract
Effect of heat treatment on fracture toughness and microstructure of 0.22% carbon steel has been investigated. Samples of 0.22% C steel were subjected to annealing and normalising heat treatments at a temperature of 900 °C. Tensile tests were then conducted on standard tensile and circumferential notched tensile specimens of both as-received and heat treated steels. Microstructural investigations were also performed on the specimens. Heat treatment resulted in changes in the microstructure and fracture toughness. It was observed that the as-received sample had a higher value of fracture toughness than the heat-treated samples due to finer morphology of ferrite and inter-lamellar spacing of pearlite than the annealed and normalized samples. The fracture toughness results obtained using the CNT test samples were found to be valid (in plain strain condition) and in close agreement with data available in literature.

Keywords: CNT, fracture toughness, carbon steels, heat treatment.

Development of Fireproof panels for Rural Building Applications in Nigeria

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Abstract
Development of low cost non-structural building materials for affordable housing has attracted a lot of researches in Nigeria. Currently, wall, ceiling and door panels are some essential building materials that could be developed using natural fibre composites (NFC). Natural fibres are becoming very attractive because of their abundant availability, lightweight, renewability within a short period of time as well as the ease of their processing into finished products. However, NFC responds rapidly to flame when exposed to heat atmosphere and sometimes can be very destructive during a fire scenario; this has raised serious concerns to manufacturers and end users. Therefore, there is need for these panels to meet existing fire safety standards if their use must be sustained for various building applications. In this paper, fireproof (FP) panels were developed with oil palm fibre polyester (OPFP) and wood sawdust polyester(WSP). Flame retardants (FR); aluminum tri-hydroxide (ATH) and ammonium polyphosphate (APP) were modified with Gum Arabic powder (GAP) at 18% loading ratio as follows; OPFP18%ATH/APP-GAP and WSP18%ATH/APP-GAP. The FR were added to the OPFP and WSP panels during fabrication using hand lay-up compression moulding and cured at room temperature. The OPFP and WSP fireproof panels were tested for tensile strength (TS) and Flexural strength (FS); ignitability properties such as Time to ignition (Tig), peak heat release rate (p-HRR), total smoke production(TSR) and residual mass (Rm) using cone calorimeter apparatus as well as for flame regression using radiant panel flame spread apparatus. From the mechanical results obtained, improvement of TS and FS were not noticeable for OPFP18%ATH/APP-GAP FP panel where as WSP18%ATH/APP-GAP FP panel stood at 16.45MPa and 50.49MPa representing respectively 70.1% and 19.8% more than those without FR addition. The fire performance of the FP panels showed that theOPFP18%ATH/APP-GAP and WSP18%ATH/APP-GAP FP panels improved the ignitability properties better compared to those without FR, confirming GAP to be a good FR additive. In terms of flame
regression, the WSP 18%ATH/APP-GAP FP panels exhibited the highest flame energy which led to early flame cessation. It can be concluded that the addition of GAP to existing FR could meet established fire safety standards for rural building applications.

**Keywords**: Fireproof panels, flame retardant, ignitability properties, natural fibre composites

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**Paper: NMS2019–TP034**

**Modeling and Evaluation of Optimum Composite Panel Flexural Strength Subjected to Various Parameters Using Response Surface Methodology**

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**Abstract**

The influence of operating parameters on panel flexural strength was investigated in this work. Response surface methodology (RSM) was used to develop cubic model and investigate the effect changes in the level of feather mass, particle size, sand and cement on flexural strength of panel using Box Behnken design. The contribution of square of significant to the model developed feather mass, square of particle size, sand and cement, interaction between feather mass and particle size and interaction between sand and cement (A, B, A^2, B^2, AC, AD, BC, CD, A^2B, AC^2) are important. Based on R^2, it was observed that the experimental data fitted better because of the "R-Squared" of 0.9526 is in reasonable agreement with the "Adj R-Squared" of 0.8375. The agreement between the predicted and actual values describe the accuracy of the model developed and can be used to navigate within the design space. The maximum value of flexural strength of 17.14 kN/mm^2 was obtained with increase in feather particle size from 0.01 mm to 3 mm at low level weight of cement of 60 g. The three chicken feathers used would make good composite panel; however, composite panel made from indigenous black chicken feather has higher flexural strength than that of chicken feathers from exotic white and black.

**Keywords** – Feather mass, flexural strength, RSM, Sand, Particle size

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**Paper: NMS 2019–TP035**

**Between Castor Seed Oil and Castor Seed Biolubricant in the Machining of Al–Mg Alloy**


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**Abstract**

This work was carried out to evaluate the effects of castor oil and its biolubricant derivative on chip thickness ratio (CTR), surface finish (SF) and temperature during cylindrical turning of Aluminum Magnesium alloy. The machine parameters studied are spindle speed, feed rate and depth of cut. The performance of the oil and biolubricant were compared with that of kerosene used as a standard lubricant. Also, Fourier Transform Infrared Spectroscopy (FTIR) Analysis was carried out on the biolubricant and crude castor oil respectively; the test result shows a difference in a peak at 1738.89 cm^-1 observed in biolubricant which represent the ester linkage formed from esterification of castor oil during biolubricant synthesis. The experimental results obtained from the turning operation showed that castor oil with CTR of 7.14 and SF of 0.016mm and its biolubricant derivative with CTR of 14.2 and SF of 0.018 mm performed better when compared with kerosene that has CTR of 6.67 and SF of 0.020 mm at a spindle speed of 355 rpm. Kerosene gave the best cooling effect with a maximum temperature of only 34.3 °C, followed by castor oil which with 37.8°C and castor biolubricant 35.1°C. However from the overall results show castor oil can serve as a substitute to kerosene because it gave the surface finish, continuous chip formation, and least temperature variation during the turning operation.

**Keywords**: aluminium, biolubricant, castor oil, kerosene, surface finish.
Nigerian Metallurgical Society

Paper NMS 2019-TP036
Hardness and Corrosion property of mild steel coated with Al-Zn and Al-Zn-Mg binary-ternary alloys
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Abstract
In the present study, two coatings: Al-Zn binary and Al-Zn-Mg ternary alloys were deposited by hot dipping method on mild steel substrates. The corrosion behaviour and microhardness of the coatings were characterized by electrochemical analysis and Vickers micro-hardness test respectively. Additionally, weight loss technique was used in the event of the corrosion evaluation of the coatings. The environment used in the corrosion analysis is simulated seawater with 3.65 % sodium chloride (NaCl). The results revealed that mild steel samples coated in Al-Zn-Mg slurry demonstrated superior corrosion resistance and higher hardness than the ones coated in Al-Zn binary bath. Thus, the work further established that Al-Zn-Mg ternary alloy could be viewed as a good coating agent for mild steel substrates.

Keywords: Al-Zn binary alloy, Al-Zn-Mg ternary alloy, coating, hot dipping, mild steel, corrosion behaviour, micro hardness

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Paper: NMS 2019-TP037
Control Of Environmental Pollution Caused By Internal Combustion Engine
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Abstract
It is shown that air pollution is of two major origin; radioactive and non-radioactive pollution. Pollution as an economic setback factor is looked at in its generating prospect, its effects on human being and action to be undertaken to reduce its magnitude. The automobile has become the most reliable and economical means of transportation worldwide, since the inversion of internal combustion Engine, based on four strokes Otto circle designed by a German Scientist (Dr. N A Otto) in 1866A.D. The problem associated with this type of Engine is emission of volatile organic compounds (CVOCs) and other species as a result of combustion of fossil fuels. This paper discusses the environmental hazards caused by these gases. It also suggests means of poisonous gas emission reduction, to enhance human health in the society.

Keywords: Pollution, Radioactive, Magnitude, Internal Combustion and Emission.

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Paper: NMS2019-TP038
Correlation of Hot-Rolled Mild Steel Mechanical Properties With Carbon Equivalent Value
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Abstract
Due to the preponderance of steel production via heterogeneous steel scraps as the main input, most of the trace elements in the scraps are often present in amounts higher than required. The resultant effect on mild steel soundness and weldability is usually evaluated using carbon equivalent value (CEV) tool. Thus, a carbon equivalent value in excess of the required specification is indicative of endangered steel that is not safe for use. In this study, the influence of carbon equivalent values on
microstructure evolution and the corresponding mechanical properties of hot-rolled mild steel used in concrete reinforcement were investigated. The methodology entails close tracking of several cycles of hot rolling of mild steel and samples obtained thereof. The samples were subjected to composition analysis from which the carbon equivalent values (CEVs) were computed. Furthermore, the samples were taken through microstructural analysis and mechanical characterisations in terms of tensile, impact and hardness. Results show strong influences of CEVs on the rolled steel mechanical properties of which outrageous CEVs, ranging from 0.51-0.61 confer abysmally low mechanical characteristics. This is attributed to the undesirable interference with appropriate microstructural evolution by certain elements presence above specifications resulting in coarse pearlite. It is concluded that the best hot rolling practice of desirable quality reinforcing steel would entail billet sorting using as a guide the results of carbon equivalent analysis performed on the roll-stocks prior to the commencement of rolling.

**Keywords:** Hot-rolled mild steel, carbon equivalent value, weldability, concrete reinforcement, mechanical properties

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**Paper: NMS2019-TP039**

**Effects of Cooling Rate During Casting on the Corrosion Resistance of 6xxx Aluminium Alloy**

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**Abstract**

6xxx aluminium alloy, despite its good mechanical properties do undergo corrosion attack thereby reducing the lifespan of the alloy and increasing liability in its application. This study investigates the effects of cooling rate during casting process on microstructure, mechanical properties and corrosion behaviour of 6xxx aluminium alloy. Aluminium ingot was melted in a muffle furnace and cast into rods. The cooling rate was controlled by holding the moulds at different temperatures. Microstructural characteristics were examined by optical microscopy. Mechanical properties such as impact strength, hardness, and tensile strength were analysed using standard methods. Corrosion behaviour was evaluated by potentiodynamic polarization. It was found that increasing cooling rate resulted in a significant improvement in mechanical properties and corrosion resistance of the 6xxx alloy. The findings were explained in terms of microstructural refinement and chemical homogeneity of the alloy.

**Keywords:** 6xxx-series Aluminium alloy, microstructure, mechanical properties, corrosion.

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**Paper: NMS2019-TP040**

**Spheroidal Graphite Iron (SGI) Production of Furnace Roof Hangers Using the Facility of Foundry Shop-Ajaokuta Steel Company Limited (ASCL)**

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**Abstract**

This paper is centred on the importance of spheroidal graphite iron (SGI) for the production of furnace roof hangers for the use in the wire rod mill of the Ajaokuta Steel Company Limited. The production process was discussed; the characteristics of the spheroidal graphite over gray cast iron,
and steel and malleable cast iron were mentioned. The usefulness of spheroidal graphite iron in engineering applications were also highlighted.

**Key Words:** Spheroidal, Graphite, Iron, Production and Furnace Roof Hangers

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**Paper: NMS2019-TP041**

**Effect of addition of Magnesium on the Mechanical Properties and Microstructure of Aluminum based Alloy**

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**Abstract**

Al-Zn-Cu alloys are widely used in various manufacturing industries. The need for reduction in weight while increasing strength of Al-Zn-Cu alloy continues as key interest for the various manufacturing industries. Therefore, the present study investigates the influence of magnesium (Mg) addition on mechanical properties and microstructure of Al-Zn-Cu alloy. Al-Zn-Cu was modified by adding Mg in the range of 0.5 to 1.5 wt.% and prepared by sand casting. The cast Al-Zn-Cu-Mg alloy samples were heat-treated at 460°C for 2 h, quenched in water and then age-hardened at 160°C for 5 h. Tensile, impact and hardness tests were carried out on the as-cast and heat-treated Al-Zn-Cu-Mg alloy samples. The surface morphology of the as-cast and precipitation hardened samples were observed using optical and scanning electron microscopy. The highest tensile strength (178.038 N/mm²) and hardness value (42.49 HB) was obtained from the addition of 0.33 wt.% Mg to Al-Zn-Cu alloy and 0.001 wt.% Mg to Al-18Zn-2Cu alloy, respectively. The presence of coarse reinforcing intermetallic phases was observed in the as-cast samples compared to the well-distributed fine grain size microstructure of intermetallic phases in the precipitation hardened samples. Each element imparted different characteristics to the alloy and their composition had a varying effect on the mechanical properties of the alloy. It can be concluded that addition of magnesium has a positive impact on the tensile strength of Al-Zn-Cu-Mg alloy while precipitation hardening eliminates micro segregations, thus improving the mechanical properties of Al-Zn-Cu-Mg alloy.

**Keywords:** Mechanical properties; microstructure; Al-Zn-Cu-Mg alloy; precipitation hardening.

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**Paper: NMS 2019-TP042**

**The Effect of Silicon Carbide Additives on the Refractory Properties of Local Clay**

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**Abstract**

The use of silicon carbide for upgrading some refractory properties of Panada clay, found in Ilorin East Local Government Area of Kwara State, Nigeria for the production of refractory bricks for furnace lining was being investigated; 5-25% silicon carbide was used as blending agent. Refractory properties measured included linear shrinkage, apparent porosity, bulk density, thermal shock resistance and cold crushing strength. Linear shrinkage and apparent porosity of the bricks made from the blending decreased with the percentage of silicon carbide added. These properties decreased from 6.66 to 3.50% and 11.10 to 2.57% silicon carbide level respectively. The cold crushing strength and thermal shock resistance of the bricks increased from 15,000 to 36,000 KN/m² and 7 to 15 revolutions respectively as the percentage of silicon carbide added increases.

**Key words:** Refractory, furnace, silicon carbide, blending agent, bulk density, shrinkage, porosity.
Nigerian Metallurgical Society

Paper: NMS 2019-TP043

Welding and Fabrication for National Growth

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Abstract

This discussion will be approached through the backward integration view. This means that, Fabrication and Welding becomes the modified view of the presentation. To continue this view therefore, some questions need to be asked. What exactly is Fabrication in a production process? What is Welding? What are the roles played and are still playing in the strategy of Metallurgical Industry in sustainable development goals? Attempts to answer these questions, will lead not only to traditional method of production but also Modern method of production that is sustainable in the development goals that has become the driver of the role of Fabrication and Welding in the production Industry today. The purpose of this paper therefore, is to define Fabrication and Welding from my own perception that may narrow their meaning in a presentation like this. However, these will give direction to understanding of these views that will be advanced in the course of this presentation. The paper will consider this presentation in design fundamentals, development cut out of pattern pieces, assembly, five resource needs and welding of the assembly pattern parts with finishing of the fabrication and welded parts that provide jobs that are needs of SDG4 goals in SOA methodology.

Keywords: Welding, Fabrication, Development and National Growth

Paper: NMS 2019-TP044

Optimization of Epoxidized Mahogany Seed Oil Using the Taguchi Approach For Quenching Applications

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Abstract

This study aimed at optimizing epoxidation process parameters for mahogany seed oil (MSO) via Taguchi technique. The epoxidation process was carried out with peroxycacid generated in situ by using hydrogen peroxide and acetic acid. The epoxidation method was conducted by varying the process parameters namely temperature, mole ratios of hydrogen peroxide to double bond concentration (DBC), acetic acid to DBC and amount of catalyst. The optimum per cent relative conversion to oxirane (RPCO) of 53.100 % was achieved at the optimal condition of 50°C reaction temperature, mole ratio of hydrogen peroxide to DBC of 1:5:1, mole ratio of acetic acid to DBC of 1:1 and 3 wt% of catalyst. The epoxidized mahogany seed oil (EM) was characterized by Fourier transforms infrared (FTIR) and 1H NMR spectra. Similarly TGA/DTA and cooling curve analyses on EM was employed to checkmate the improved oxidative stability and cooling characteristics respectively. The result of FTIR and 1H NMR analyses confirmed the formation of an epoxide in the EM. Furthermore, EM found to have splendid heat transfer rate compared to raw mahogany seed oil (FM).

Keywords: Epoxides, heat transfer coefficient, optimization, Taguchi, acetic acid, hydrogen peroxide, temperature, mahogany seed oil
International Exchange and Free Trade: The Pros and Con for Developing Countries
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Abstract
In pursuit of development, governments of developing countries have adopted different strategies over the years. One of such approaches to boost international exchange is export–oriented manufacturing and the common policy instrument adopted to stimulate commercial export has been the establishment of free trade agreement. This paper uses Nigeria as a case and examines the possible benefits and disadvantages associated with international exchange and the practice of free trade in developing nations. It tries to explain what constitutes free trade and international exchange while identifying the benefits and shortcomings of free trade as a development strategy. The final part makes up the conclusion and recommendations.
Keywords: import, export, free trade, international exchange, development

Identification and Processing of Nigerian Gemstones: A Case Study of Nigerian Institute of Mining and Geosciences
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Abstract
Nigeria is blessed with over 44 deposits of different solid minerals including gemstones in large quantity, and the sector contributes less than 0.3% to the Gross Domestic Product (GDP) of the nation. The scope of the work is study the role plays by the Nigerian Institute of Mining and Geosciences (NIMG) in identification and processing of the nation gemstone in order to increase the market value of Nigeria gemstone. From the study it was observed that NIMG have some state-of-the-earth equipment used in processing of gemstone. The institute can serve as a centre for skill acquisition in gemstone processing into finish product and also serve as centre in Nigeria for making jewelleries and beads using gemstone in the country. The SMEs are encouraged to visit the institute for the development of small and medium scale enterprises in jewelleries and beads making.
Key words: Nigeria, mining, gemstone and small-scale, jewellery.

The Influence of Annealing Temperatures on the Fatigue Properties of 0.17% C Low Alloy Steels.
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Abstract
The fatigue properties of 0.17% C low alloy steel after being annealed were investigated in the work reported here. The steel samples used for the present work were subjected to annealing (heat treatment) at 750, 780, 810, 840, 870, 900, 930, 960 and 990°C they were soaked for 30, 60, 90 and 120
minutes at each temperature. The fatigue properties were determined. The results showed that for the steel under study, higher annealing temperature and longer holding time improved the fatigue properties significantly.

**Key words:** Annealing, Fatigue Properties, Temperature and Soaking Time

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**Paper: NMS 2019-TP048**

**Design and Fabrication of Wire Drawing Machines: G.M.O Steel Industries Experience**

C. S. Obayi¹, P.S. Nnamchi¹, A.D. Omah¹, C.C. Daniel-Mkpume¹, S.I. Neife², P.O. Offor¹, B.A. Okorie¹

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**Abstract**

Wire drawing is a fundamental step in the manufacture of metal products that are dependent on drawn wires as major production inputs. G.M.O. Steel Industries Limited is engaged in mass production of drawn steel wire dependent products such as wire nails, welding electrodes, binding wires, bed-mesh and springs. As a result of inadequate supply of enough drawn wires from available wire drawing machines to run the production lines as a result of expansion and increased production coupled with high cost of importation of wire drawing machines, G.M.O. Steel industries embarked on the project of designing and fabricating wire-drawing machines locally. The aim of the project was to design and construct functional wire drawing machines in our factory, taking into consideration the available materials, cost of manufacture, available tools, machines and processes. The design started with the decision on the load required to achieve 27% reduction in diameter of low carbon steel wire in a single draw which was about 4.18 KN, followed by a systematic design procedure to realize machine that would overcome this drawing load. The next step was the fabrication of the designed wire-drawing machine. The project was a successful one and more than thirty-two functional machines were produced. Our record showed that out of wire-drawing machines used in G.M.O Steel Industries Ltd, 66.7% were designed and fabricated in the company. This project sustained production, improved production output, lowered production costs and attracted external patronage from allied steel companies.

**Key words:** Design, fabrication, wire drawing machine, wire nail manufacture, G.M.O. steel industries

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**Paper: NMS 2019-TP049**

**Performance Evaluation of the Effect of Date Palm Seed Oil as Cutting Fluid for Turning Operation On Aluminium Alloy**

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**Abstract**

The effect of date palm seed oil as coolant in the turning operation of aluminium alloy was studied. The oil was extracted using Soxhlet extractor. The physiochemical properties of the oil were evaluated. The parameters investigated during the operation were surface temperature, surface roughness and chip thickness at varying spindle speed. The physiochemical properties test reveal the oil parameters such as density at 31°C, viscosity at 31°C, flash point, iodine value, specific gravity, Ph. Level, free fatty acid and saponification value of 0.87g/cm³, 36cp, 111°C, 88.12/100g of oil, 0.82, 6.98ph, 1.26% and 125.4 mg/KOH/gram of oil respectively. It was observed that, although date seed oil gave a higher surface temperature than the soluble, it has a better surface finish than soluble oil. Therefore, where the surface finish is considered important, date seed oil should be used in the machining of aluminium alloy instead of soluble oil. This result shows that it has the characteristic of lubricants that could be used in machining operation.
Nigerian Metallurgical Society

Keywords: Date seed oil; Aluminium alloy; turning operation; chip thickness

Paper : NMS 2019-TP050
Exploring the curriculum gap in computational materials Science education in Nigeria

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Abstract

With the emphasis that is currently placed on the development of graduate skills and easing the transition of students from academic study into the workplace, there has never been a greater need to explore undergraduate curricula in terms of fitness for purpose. This paper examines the case of computational materials science education and identifies a clear void in the current metallurgical and materials science curricula, and lack of awareness, unpreparedness and perceived unwillingness to assess this line of research. Evidently, because the application of Computational Materials Science education have never had a good romance either with the public or with the higher education policymakers in Nigeria (ditto NUC, NMMS, COREN, NSE), for so long students and teachers considers it stodgy; awkward and probably the realm of the dreamers. The article proposes how a change in curriculum design can create the missing awareness among teachers and policy makers on the need to adapt this less complexity, lower cost, and less energy consumption, and very highly customization way of research. In effect, recommend we take advantage of the development and deployment of very fast computers to speed up and enhance our knowledge base and increase the countries productivity.

Key words: Computational materials science; Curriculum gap; engineering; experimental research; Nigerian; Universities; virtual laboratory.

Paper : NMS 2019-TP051
Effect of Austempering Temperature and Time On Microstructure and Mechanical Properties of Austempered Ductile Iron

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Abstract

In this study, the effect of austempering temperatures on microstructure and mechanical properties of Austempered Ductile Iron (ADI) was investigated. The specimens were austenitized at 850 °C for 1hr and they were quenched into a salt bath held at two different austempering temperatures (250°C and 350°C) and austempered for various times (30 min, 60 min, 90 and 120 min). Microstructural constituents were characterized by using scanning electron microscope. Impact toughness and hardness tests were conducted to determine the mechanical properties of the samples. Experimental results showed that, enhancement of the impact toughness of ADI depend on the microstructure. The
selection of austempering temperature constitutes a key parameter to obtain superior impact toughness hardness combination in ADI.

**Keyword:** Austempered Ductile Iron (ADI), Austempering Temperature, Nodular Iron, Toughness

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**Paper: NMS 2019-TP052**

**Evaluation of Solidification Shrinkage Process in Aluminium-Silicon (A1200) Alloy Castings**

Olusanya Francis Dacosta¹, Samuel Babatope Adejuyigbe², Bayode Julius Olorunfemi³, Adeyemi Adefemi Adekunle⁴, Ajani Olatunde Oyelaran⁵

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**Abstract**

Solidification plays a critical role in the production of sound castings. Hence, an understanding of the casting solidification mechanism and how it can be controlled are important considerations in foundry work. The objective of this work was to evaluate solidification shrinkage process of Aluminium-Silicon alloy castings. It was also revealed that alloy composition affects the threshold Niyama values. The Niyama value obtained for alloy A1200 was 0.103 (°C-s)^1/2 /mm) because of lower silicon content. The shapes of the castings did not have significant effect on the Niyama values. However, the sizes of the castings affected their Niyama values since the smaller sized castings had higher values than the bigger /mm while that with cast dimension 150mm x 50mm ones. For alloy A1200 with cast dimension 200mm x 50mm, the Niyama value was 0.103(°C-s)^1/2 has a value of 0.129(°C-s)^1/2 /mm. The results would assist users to predict internal soundness in Al-Si castings and determine optimal casting parameters.

**Keywords:** Aluminium, Alloy, Solidification, Shrinkage, Al-Si (A1200), Castings

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**Paper: NMS 2019-TP053**

**Capacity Building in Safety and Hazards Management in Nigeria Metal Industries**

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**Abstract**

This paper discusses the need for capacity building in safety and hazards management in Nigeria metal industries. Specific examples of Metal industries in Nigeria were enumerated to include Rolling Mill, Extrusion industry, Foundry industry, Machining and Fabrication shops, Forging shops, Wire or Cable drawing, Metal Smelting and Metal Stamping industries. Health and safety hazards, Sources of hazards and types of hazards such as slips and trips, electricity, noise, chemical substances, dust, aggression, violence and bullying in metal industries were discussed. Hazards management, assessment, evaluation and control were also discussed. The paper concludes that healthy and safe working place are extremely relevant, by failing to adhere to its principles, it affect moral, social, psychological and economics of the society. Therefore, capacity building in form of training, workshops and seminars create awareness on safety rules and regulations for metal industrial workers. This not only leads to accident reduction, loss of lives and property but creates conducive working environment for workers in metal industries which will enhance workers willingness for substantial growth of metal industries in Nigeria.
Technological Determinism: A Viable Solution towards Achieving Sustainable Development Goals on Poverty Alleviation

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Abstract
Technology has a major role to play in poverty alleviation. Technological determinism is a set used to describe set of claims made about the relationship between what we generally call technology, and society. This paper is to determine the communication technological gadgets as a means of achieving SDGs’ goals on poverty alleviation. The study shows that about 736 million people still lived on less than US$1.90 a day; and this emphasize that there are more women living with high rate of poverty than men because they are denied of jobs and adequate education. The paper discussed the goal of the SDGs’ to bring an end to poverty in our societies and gave standards that can be used by government and individuals to control poverty in the nation. In conclusion, the researchers found out that the technological determinism has an idea that technology now controls our society and culture. It inferred that there is need for effective use of communication gadget for adequate alleviation of poverty.

Keywords: Technological, Determinism, Viable Solution, SDGs, Poverty Alleviation.

TECHNOLOGICAL ACQUISITION AND INTELLECTUAL PROPERTY POLICY: AN OVERVIEW TOWARDS SDG

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Abstract
Acquisition of technology involves the purchase of external knowledge and technology without active cooperation with the source. This external knowledge can be embodied in machinery or equipment that incorporates this knowledge. It can also include the hiring of employees who possess the new knowledge or the use of contract research and consulting services. Disembodied technology or knowledge also includes other know-how, patents, licences, trademarks and software. This study also discuss Intellectual property as a policy exists to create an enabling environment for – and to stimulate investment in – innovation; to create a framework in which new technologies can be traded around the world and shared. The economic imperative at the heart of innovation is fundamental to the process of societal transformation that the Sustainable Development Goals aim to achieve. The UN Sustainable Development Goals (SDGs) provide a universal frame work to tackle the biggest problems facing our planet. From ending world hunger to improving global healthcare. The SDGs seek to shape development policies and investment to deliver the best impact.

Keywords: Technological, Acquisition, Intellectual property (IP) Policy, SDGs
Characterization and corrosion study of heat treated and unheat treated API5L steel welded region in sweet oil field environment.

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Abstract.

Corrosion is a cankerworm in engineering materials with a slow but destructive capacity. Resources, techniques and mechanisms have been employed to stop corrosion, however, the best that has been achieved is prevention and control via applications such as coating, cathodic protection, inhibition, material selection amongst others. The effect of heat treatment on the corrosion behavior of welded API5L steel in 0.5M NaCl with CO₂ in a flowing system at 25°C, 40°C and 60°C. The heat treatment was carried out on welded API5L steel. The steel was heated to its austenitic temperature (873°C) and then normalized. The morphology of the steel were studied using a Scanning electron microscope with energy dispersive spectroscopy. and X-ray Diffraction analysis was used for phase analysis. The corrosion rate reduced with heat treatment. The SEM result showed dense oxide formation on the surface of the steel which agreed with the XRD result.

Corrosion Behaviour of Antimony Modified Carbidic Austempered Ductile iron (CADI) in Neutral Environment.


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Federal University of Technology, Akure. Ondo State Nigeria

Correspondence Author; aabarnabas@futa.edu.ng, GSM: +234 (0) 7036616565

Abstract

In this work, effects of antimony content and different austempering temperatures on the corrosion behaviour of antimony modified carbidic austempered ductile iron (CADI) were studied. Six rod-like samples containing different amount of antimony (0.096 – 0.48 wt. %) were produced by sand casting using sandwich method. The alloys had equivalent-carbon content of 4.44 which is consistent with typical hypereutectic composition. The alloys were first heated to austenitic temperature of 910°C before austempering at 300°C or 325°C for a period of 3 hours. Optical and scanning electron microscopy were carried out on both as-cast and austempered samples to study the microstructural features in the alloys. The corrosion behavior of the alloys in neutral solution was examined using potentiodynamic polarization technique following ASTM G59-97 standard. The results showed that the microstructures of the as-cast samples contained few nodular graphites, pearlitic and carbides, while the austempered samples contain significant amount of graphite nodules, carbides of varying sizes, ausferrite and retained austenite. The amount of nodular graphite decreased, while pearlite and carbides phases increased with increasing antimony content. Additionally,
increasing antimony content led to an increase in corrosion resistance of the carbidic austempered ductile iron until critical antimony content was attained. From the corrosion results obtained, it was observed that the electrochemical behaviour of these CADIs in neutral environment was influenced by antimony content, austempering temperature, and austempering time.

**Keywords:** Carbidic austempered ductile iron; Microstructure; Carbides; Antimony; corrosion, Austempering temperatures; Neutral environment.

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**Paper:** NMS 2019-TP058

**BUILDING RESILIENT INFRASTRUCTURE TO PROMOTE INCLUSIVE AND SUSTAINABLE INDUSTRIALIZATION; AN EXCLUSIVE ROLE OF METALLURGICAL INDUSTRIES**

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**Federal University of Technology, Akure (FUTA), Ondo State, Nigeria.**

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**Abstract**

The world has become a global village and metallurgical industries could become one of the major forces in the global economy, occupying a vital position in the supply chain of raw material on sustainable basis on needs of the present generations while preserving the natural environment in its undisturbed state. Economic development must not compromise environment integrity. These goals, called United Nations Sustainable Development Goals (UNSDGs) build on the successes of the United Nations Millennium Development Goals (UNMDGs). They include new area such as economic inequality, innovation, sustainable consumption, peace and justice. The sustainable development goals encompass development and economic growth; industry, innovation and infrastructure; responsible consumption. The role of metallurgical industries becomes imperative to achieve sustainable development goal with the aim to building resilient infrastructure in order to promote inclusive and sustainable industrialization.

**Keyword:** Industrialization, Iron and steel, Sustainable development goal, Infrastructure.
PRODUCTION OF ABRASIVE SANDPAPER USING PERIWINKLE SHELLS AND CRAB SHELLS


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5Department of Mechanical Engineering, Kwara State Polytechnic, Ilorin

ABSTRACT

In this study, the abrasive properties of periwinkle shell and crab shell grains with the binding effect of polyester resin at high concentration were evaluated. The abrasive properties considered were the hardness, compressive strength and wear resistance. The shells were processed into grit standards by crushing, grinding and then sieving using ASTM E11 set of sieves into grain sizes of P40. Further on, the grits were developed into polymer matrix composite with particles varying from 96 wt.% to 92 wt.% and resin 3 wt.% to 7 wt.% with 1 wt.% each of cobalt naphthalene and methyl ethyl ketone peroxide hardener respectively by mixing and mold compression using a hydraulic press. It was found that hardness and compressive strength increased, wear rate decreased with an increase in polyester resin content. The composition with most improved abrasive properties was 92 wt. % periwinkle shell grains to 7 wt.% polyester resin.

Keywords: Abrasive properties, Periwinkle shell, Crab shell, Wear Rate
National Steel Raw Materials Exploration Agency (NSRMEA)

Ministry of Mines and Steel Development
No. 18 Rabah Road, P.M.B. 2140, Malali Village, Kaduna, Nigeria
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