Conference Proceeding Book

International Conference on Frontiers of Chemicals and Materials Engineering (ICoFCheM 2023)

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Advances in the field of materials research have significantly impacted today's technological revolution. The success of discovering functional materials that meet current technical specifications and design has accelerated the technical process. It is essential to align all materials science and technological development activities. Accordingly, common goals in this technological development could be tackled hand-in-hand by cooperation between industry-research institutions.

Therefore, the conference "International Conference on Frontiers of Chemical and Materials Engineering (ICoFCheM 2023)" is organized to create a platform for meeting researchers, academicians, technocrats and key players to share knowledge and findings in the related field. This conference will become an annual event to celebrate the success of scientific research by experts in various collaborations between industry and research institutions across the country and worldwide.

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Message from Conference Chairman

Greetings and a warm welcome to all esteemed delegates who have gathered here for the International Conference on Frontiers of Chemical and Materials Engineering (ICoFCheM 2023). It is with great pleasure that I extend my heartfelt greetings as we embark on this enlightening journey together.

Our world is undergoing a remarkable transformation, largely driven by the remarkable advancements in materials research. The quest for cutting-edge functional materials that seamlessly align with contemporary technical demands and innovative design principles has propelled the wheels of technological advancement forward. In this pursuit, the fusion of materials science with technological progress emerges as a pivotal force. The convergence of these disciplines presents us with unprecedented opportunities to reshape industries, enhance products, and foster sustainable development.

The essence of this conference rests not only in the exchange of knowledge but also in the formation of collaborative alliances that extend beyond the confines of the event. As we convene here, we are poised at the threshold of a new era—a chapter where collective endeavors will define the trajectory of technological evolution. Looking ahead, our aspirations for ICoFCheM 2023 are ambitious. We envision this conference as a cornerstone of an annual tradition—a celebration of the remarkable achievements that arise from the synergy between rigorous scientific exploration and the practical insights drawn from industrial applications. Together, we shall pave the way for a future where collaboration and innovation intertwine seamlessly. Welcome to a realm where the boundaries of possibility are stretched, and the frontiers of chemical and materials engineering are explored with vigor and enthusiasm.

I would like to express my deepest gratitude to the organising committees, sponsors, and partners who have worked tirelessly to make this conference a reality. Your dedication and commitment deserve utmost praise and recognition. Together, we can create a world where technology is not only a means of progress but also a driving force for social harmony and sustainable development.

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Professor Ts. Dr. Norinsan Kamil Bin Othman
Department of Applied Physics, Faculty of Science and Technology
Universiti Kebangsaan Malaysia

THE INFLUENCED OF SULFATE AND IRON REDUCING BACTERIA ON CARBON STEEL IN MARINE ENVIRONMENTS

BIOGRAPHY

Dr Norinsan Kamil Othman, PhD, is a Professor in the Department of Applied Physics, Faculty of Science and Technology, The National University of Malaysia (UKM), and has expertise in corrosion science. His study mainly focuses on corrosion, high-temperature high-pressure (HTHP), soldering alloys, welds, and carbon steels. He received the certificate of Professional Technologist from the Malaysia Board of Technologists in 2019.

He has received several awards in research and innovation competitions since 2010. He has published six books and seven book chapters. He also published more than 148 papers indexed by Scopus and WOS. He is also a project leader for 18 research projects and co-researcher for 27 projects, including industry grants. Eight inventions from his project were filed for patents. He is now Head of the Joint Lab of DNV-GL@UKM. His research expertise includes Pure and Applied Sciences - Materials Science (Corrosion), (Corrosion Science) & (High Temperature Corrosion)

Keynote Speakers

Assistant Professor Dr. Zeinab Abbas Jawad
Department of Chemical Engineering,
Qatar University, Doha, Qatar

MIXED MATRIX MEMBRANE ON GAS SEPARATION

BIOGRAPHY

Dr Zeinab Jawad has been an assistant professor in the Department of Chemical Engineering at Qatar University since January 2021. Before that, she worked as a lecturer (May 2015) and was promoted to senior lecturer (December 2017) in the Department of Chemical Engineering at Curtin University Malaysia. Dr Jawad received her PhD Degree in Chemical Engineering from Universiti Sains Malaysia in 2014. She also obtained her Bachelor's and Master's Degrees in Chemical Engineering from the University of Technology, Baghdad-Iraq, in 2003 and 2007, respectively.

Her research focuses on developing a mixed matrix membrane for CO_2 separation. She is particularly interested in understanding the fundamental transport phenomena across the membrane and utilising this membrane-based separation technique to control environmental pollution issues. As-to-date, she was awarded her Chartered Engineer under Engineering Council (United Kingdom) on 29th March 2018. Furthermore, she is an associate member of IChemE, a member of the Institution of Engineering and Technology (MIET), and an Iraqi Engineers Union assistant member. Recently, she was awarded as a fellow in the advanced higher education academy (United Kingdom) in January 2021.

Conference Programme

TIME	PROGRAMME	VENUE (PHYSICAL)	VENUE (VIRTUAL)
8.00 am – 9.00 am	REGISTRATION	Registration counter	
9.00 am – 10.00 am	**Keynote Speaker 1:** ***The Influenced of Sulfate and Iron Reducing Bacteria on Carbon Steel in Marine Environments*** *by* **PROFESSOR Ts DR. NORINSAN KAMIL BIN OTHMAN** Chairperson: **PM Dr. Mohd Nazree Derman**	Selangor Room (Level 3)	
10.00 am – 10.30 am	Morning Coffee Break	Hallway	Oral Presentation Session  Chairperson: Ts. Dr. Hoo Peng Yong
10:30 am – 1.00 pm	**Opening ceremony** **Launching Ceremony of the Global Trends in Engineering & Science Technology Congress**	Tun Dr Ismail Hall	
1.00 pm – 2.00 pm	Session Break / Lunch		
2.00 pm – 3.00 pm	**Keynote ELSEVIER**		
3.00 pm – 4.00 pm	**Keynote Speaker 2:** *Mixed Matrix Membrane on Gas Separation* *by* **DR. ZEINAB ABBAS JAWAD** Chairperson: **Dr. Mohd Sharizan Md Sarip**		
4.00 pm – 6.30 pm	Oral Presentation Session	Selangor Room (Level 3)	
6.30 pm – 7.00 pm	**CLOSING CEREMONY**	Selangor Room (Level 3)	

Oral Session Schedule

SESSION 1

Time	Presentation Title	Field
10.00 - 1015	Effect of Silicone Rubber on The Properties of Epoxy/ Recovered Carbon Black (RCB) Conductive Materials	Materials Engineering
1015 – 10.30	Physical and Electrical Properties of PLA-Carbon Composites	Materials Engineering
10.30 – 10.45	Science Mapping for Catalyst Support	Materials Engineering
10.45 – 11.00	Microstructural And Corrosion Behavior of D3 And SS 440C For Blade Application	Metallurgical & Minerals Engineering
11.00 – 11.15	Dielectric Properties of PLA-Recovered Carbon Black Composite	Chemical Engineering
11.15 – 11.30	Effect of Coagulant Bath Medium on Methylene Blue Dye Removal Performance Using Polylactic Acid Membranes	Chemical Engineering
11.30 – 11.45	Structural And Electrical Characterizations of Sn/Zr Co-Doped Barium Titanate Perovskite Ceramic.	Materials Engineering
11.45 – 12.00	Investigation on Phase Evaluation of Ilmenite Ore by Carbothermal Reduction and Carboiodination Reaction	Metallurgical & Minerals Engineering

Oral Session Schedule

SESSION 2

Time	Presentation Title	Field
1500 - 1515	AC and DC Anodization on The Electrochemical Properties of SS304L: A Comparison	Materials Engineering
1515 - 1530	Brief Review: The Potential of Lithium Titanate as An Anode Material in Lithium-Ion Batteries	Materials Engineering
1530 - 1545	Carbon Nanotubes Formation on Clay and Fly Ash from Catalytic Thermal Decomposition of Recycled Polypropylene	Materials Engineering
1545 - 1600	Comparison Study Between Recovered Carbon Black and Commercial Carbon Black Filled Epoxy Conductive Materials	Materials Engineering
1600 - 1615	Formation of Epoxide from Palm Kernel Oil by In Situ Epoxidation	Materials Engineering
1615 - 1630	The Review of $Li_4Ti_5O_{12}$ (LTO) Anode: Phenomenon and Compatibility to It Electrolyte and Cathode in Lithium-Ion Batteries	Materials Engineering
1715 - 1730	Corrosion Resistance Improvement of 6061 Aluminum Alloy Using Anodizing Process	Metallurgical & Minerals Engineering
1730 - 1745	Effect Of Physicochemical Properties and Feed Mix Ratios on The Carbothermic Reductions of Iron Ore with Coke	Metallurgical & Minerals Engineering
1800 - 1815	Quantitative Analysis Method for Zingiber Officinale Water Extract Using High Performance Liquid Chromatography	Chemical Engineering

THE INFLUENCED OF SULFATE AND IRON REDUCING BACTERIA ON CARBON STEEL IN MARINE ENVIRONMENTS

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ABSTRACT. Petroleum pipelines transporting crude oil from production wells are exposed to corrosive environments, namely, CO_2 gas and microorganisms. These ubiquitous microorganisms naturally inhabit the marine ecosystem. The microbial group often given attention in the study of microbiologically influenced corrosion (MIC) is sulfate-reducing bacteria (SRB); at the same time, another group, the iron-reducing bacteria (IRB), that live in a consortium with SRB is less highlighted. In an environment that contains both factors of CO_2 gas and microorganisms, the dominant type of corrosion occurrence is pitting corrosion. However, the mechanisms and electrochemical activities that foster such corrosion to happen have yet to be fully understood. The characteristics of film formation and morphology in systems containing CO_2 and microorganisms are also known to influence uniform and pitting corrosion behaviours. Therefore, this study focuses on the corrosion effects of API 5L X65 carbon steel in the presence of SRB, IRB, and a mixture of both in a marine-like medium with CO_2 environments. Bacterial samples were obtained from Loji Petronas Penapisan Melaka Sdn. Bhd., Sungai Udang Melaka, Malaysia. Weight loss, electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization methods were implemented to determine the corrosion behaviour. Biofilms and corrosion products were respectively characterised by field emission scanning electron microscopy (FESEM), X-ray photoelectron spectroscopy (XPS) and infinite focus microscope (IFM). Findings from the weight loss method confirmed that uniform corrosion dominated the bacteria-free medium with a higher uniform corrosion rate value of 1.05 mm/year compared to the pit penetration rate of 0.12 mm/year. The synergistic effects of the SRB+IRB consortium provide the highest rate of pit penetration due to SRB in-activities, giving a higher pit penetration rate value of 1.20 mm/year compared to the uniform corrosion rate of 0.27 mm/year. Surface analysis proved the presence of sulfur on carbon steel specimens exposed to the SRB+IRB consortium in CO_2 environments and XPS enhanced the findings by detecting the formation of the iron sulfide (FeS) layer. The presence of FeS contributes to the formation of pit corrosion due to the SRB metabolite activities. These metabolite activities easily dissolve in the medium and change the chemical interface properties of the metal and biofilm. For samples exposed to SRB only, the results obtained were almost identical to exposure to the SRB+IRB consortium. However, the corrosion rate value measured for the SRB+IRB consortium was higher due to the synergistic effect of the two bacteria. In contrast, the effect of IRB recorded low values of corrosion and pit penetration rates. This may be due to the formation of hematite (Fe_2O_3) and cementite (Fe_3C) which were

believed to form a passive layer to protect the steel surface from corrosion attacks. In conclusion, the presence of SRB alone and the consortium of SRB+IRB in a CO_2 environment induces the formation of pit corrosion, the IRB shows protective characteristics against corrosion, a medium without bacteria promotes the production of uniform corrosion. The findings of this study are presumed to contribute a deep understanding of the MIC mechanism in CO_2 environments troubling the oil and gas industry. With a better understanding of MIC, new and improved corrosion prevention strategies can be put into action.

EFFECT OF SILICONE RUBBER ON THE PROPERTIES OF EPOXY/RECOVERED CARBON BLACK (RCB) CONDUCTIVE MATERIALS

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Abstract. The primary focus of this study is to investigate the effect of silicone rubber (SR) content on the mechanical, thermal, electrical conductivity, and morphology properties of epoxy/recovered carbon black (rCB) conductive material. The conductive material is to produce the electrostatic discharge (ESD) tray for the electronic packaging industry. This study investigated the effect of silicone rubber content (0, 5, 10, 15, and 20 vol.%) on the properties of epoxy/SR/rCB composites, with the rCB content fixed at 15 vol.% for its optimum electrical conductivity. The silicone rubber acts as a toughening agent for epoxy. Through the fracture toughness result, it can identify the role of silicone rubber in improving the toughness properties of the epoxy/SR/rCB composite. The optimum results for mechanical properties were recorded at 5 vol.% SR. The addition of SR to the epoxy matrix enhances the electrical properties of the epoxy/SR/rCB composite. The effect of thermal aging on epoxy/SR/rCB composites was also studied to determine the properties of the composite materials at high temperatures for a long period of time. After thermal aging, the mechanical, thermal, electrical conductivity, and morphology properties of the epoxy/SR/rCB composite were slightly reduced.

Keywords: *conductive materials, epoxy, recovered carbon black, silicone rubber, toughness*

ELECTRICAL AND PHYSICAL PROPERTIES OF PLA-CARBON COMPOSITES

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Abstract. Polylactic acid or polylactide (PLA) is a biodegradable thermoplastic that can be produced from renewable material to create various components for industrial purposes. In 3D printing technology, PLA is used due to its good mechanical, electrical, printing properties, environmentally friendly and non-toxic properties. However, the physical properties and excellent electrical insulation properties of PLA have limited its application. In this study, with the carbon black (CB) as filler added into PLA, the lattice spacing and morphology were investigated by using X-ray diffraction (XRD) and scanning electron microscope (SEM), respectively. The physical properties of PLA-carbon composite were evaluated by using tensile test, shore D hardness test and density and voids measurement. Impedance test was conducted to investigate the electrical properties of PLA-Carbon composites. The results demonstrate that the inclusion of carbon black as filler enhances the physical properties of the PLA-carbon composites, including tensile properties, hardness, and density. The addition of carbon black also leads to improved electrical conductivity of the composites. Better enhancement toward the electrical properties of PLA-carbon composites is observed with 1wt% of carbon black in N774 grade. The N550 grade with 2wt% of carbon black shows better improvement in the physical properties of PLA-carbon composites, achieving 10.686 MPa in tensile testing, 43.330 in shore D hardness test, and a density of 1.200 g/cm3 in density measurement. The findings suggest that PLA-carbon composites have the potential for enhanced performance in various industrial applications, particularly in sectors requiring improved physical and electrical properties.

Keywords: *3D-printing, PLA, Carbon black, Physical properties, Electrical properties.*

SCIENCE MAPPING FOR CATALYST SUPPORT

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Abstract. Science mapping are visual representations of the structure and dynamics of scholarly knowledge. In chemistry, a catalyst support is the material, usually a solid with a high surface area, to which a catalyst is affixed. The incredible potential of heterogeneous catalysts is derived from their porous nature, which can be optimized to meet reaction conditions including high temperature, high pressure, and corrosive environments. Consequently, the share of solid catalysts in the chemical industry will continue to rise because of the growth in world population and the escalation of global energy demand, which was forecast to double from 2000 to 2035. The porous catalyst support such as clay-fly ash composite has the potential to be used in many fields, such as catalyst support and gas adsorbents.

MICROSTRUCTURAL AND CORROSION BEHAVIOUR OF D3 AND SS 440C FOR BLADE APPLICATION

Nur Maizatul Shima Adzali[1,2*], Nurul Abidah Mohamad Khapeli[1], Alina Rahayu Mohamed[1,3]

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Abstract. Tool steel, such as D3 is a specific type of metal that is used for the purpose of cutting, sculpting, or otherwise forming a material into a component or part that can be adapted to a particular application [1]. While stainless steels (SS) 440C is the martensitic stainless steels that possess the highest mechanical strength, hardness, and wear resistance due to its composition [2]. D3 tool steel and SS 440C are normally being employed for application such as knife blade and cutting tools. These steels are iron alloys which have high carbon and high chromium content. In this study, lab work focused on the microstructural and corrosion behavior of D3 and SS 440C after went through heat treatment processes. Heat treatments for both steels were started with normalizing at 1020˚C, continue with hardening at 1000˚C followed by oil quenching. Cryogenic treatment was carried out in liquid nitrogen for 24 hours. The addition of cryogenic heat treatment is believed to increase the hardness and corrosion resistance for steels. Both samples were then tempered at two different tempering temperatures, 150˚C and 426˚C. Figure 1 shows the heat treatment profile of heat treatment process for D3 and SS 440C samples. For corrosion test, the samples were immersed in NaCl solution for 30 days to study the corrosion behavior of D3 and SS 440C after heat treatment. The mechanical properties of these steels have been investigated using Rockwell hardness machine before heat treatment, after heat treatment (before corrosion) and after corrosion test. Microstructure observation of samples were carried out by scanning electron microscopy. Corrosion rate of these steels were calculated after corrosion test completed. From the results, the highest hardness is observed for D3 steel which tempered at 160˚C (54.1 HRC). In terms of microstructural analysis, primary carbide and pearlite in the as-received samples transform to tempered martensite and cementite after heat treatment process. From this research, for corrosion test, heat treated SS 440C sample tempered with 426˚C possessed the excellent corrosion resistance with corrosion rate 0.2808 mm/year.

Keywords: *blade, corrosion, cryogenic, D3 tool steel, hardness, microstructure, stainless steel 440C*

DIELECTRIC PROPERTIES OF PLA-CARBON COMPOSITE

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Abstract. The use of dielectric materials made from PLA has become increasingly important for generating, transforming, and storing clean energy. Recovered carbon black (rCB), which is derived from old tires or rubber goods, can be used for various industrial and commercial purposes. The aim of this experiment is to explore the potential application of rCB with 3D printing and to assess the particle size of carbon black using different mesh sizes. PLA is unsuitable for electrical power applications due to its poor dielectric properties. To improve its dielectric characteristics, PLA can be reinforced with carbon fibers or carbon particles. This study focuses on the effect of different mesh sizes of sieved rCB additions on the dielectric properties of PLA-carbon composites, with varying ratios of 0%, 1%, and 3%.

Keywords: *Dielectric, Recovered Carbon Black, PLA, Impedance, 3D Printing, Composite*

EFFECT OF COAGULANT BATH MEDIUM ON METHYLENE BLUE DYE REMOVAL PERFORMANCE USING POLYLACTIC ACID MEMBRANES

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Abstract. The asymmetric Polylactic acid (PLA) membrane was prepared via phase inversion method using non-solvent induced separation (NIPS) technique. This study aims to synthesize as well as to characterize the PLA membrane, evaluating the membrane performance on water flux and permeability. In addition, this research also studied the removal performance of methylene blue dye. The polymer solution has been prepared using 12 wt% of PLA and dissolved in 88 wt.% of Dimethylacetamide (DMAc) as a solvent. Then, the cast film was immersed in different ratio of coagulant bath medium (distilled water: methanol: ethanol) ranging from 100:0:0, 75:25:0, 75:0:25 and 75:12.5:12.5, respectively). Several characterizations were performed which include, membrane contact angle and membrane porosity. Performance PLA membranes were determined in terms of water flux and permeability at 1 bar transmembrane pressure using dead-end permeation cell. Finally, methylene blue (MB) removal efficiency was tested at the same transmembrane pressure. The findings revealed that the increase of alcohol concentration in coagulant bath resulted in higher porosity and lower contact angle. In short, MB dye rejection efficiency is also closely related to the amount of alcohol ratio used in coagulant baths. Increases in concentration of methanol and ethanol in coagulant bath medium increases the membrane porosity thus increased in efficiency of methylene blue rejection.

Keywords: *Polylactic Acid Membrane; Dye Removal; Coagulant Bath Medium; Non-Induced Phase Separation*

INVESTIGATION ON PHASE EVALUATION OF ILMENITE ORE BY CARBOTHERMAL REDUCTION AND CARBOIODINATION REACTION

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Abstract. This article presented the experimental investigation on phase evaluation of ilmenite ore via carbothermal reduction and carboiodination reaction for titanium production by using graphite as a reductant. The carbothermal reduction and carboiodination reactions were performed as sequential processes. The carbothermal reduction was evaluated at a temperature of 1000℃ using a horizontal tube furnace with inert argon gas. Then, the carbothermal reduction product was further reduced using carboiodination reactions in temperatures ranging from 900℃, 950℃, and 1000℃ using a vertical tube furnace with mixed gas with argon gas. The phase evolutions and chemical compositions of raw ilmenite and reduced samples were investigated using XRD and XRF, respectively. The results found that the Perak ilmenite ore contained mainly higher of 71.27 wt% of TiO_2 and 18.85 wt% of Fe_2O_3. After carbothermal reduction, the ilmenite phase was transformed into rutile, iron, and titanium oxide via XRD analysis. The ilmenite and rutile phases still remained at 900°C, and 950°C however, at a temperature of 1000°C, the Ti_3O_5 phase is found together with iron, Fe and TiO_2.

Keywords*: Carbothermal reduction; Iodination reduction; Graphite, Ilmenite ore; Phase evaluation.*

AC AND DC ANODIZATION ON THE ELECTROCHEMICAL PROPERTIES OF SS304L: A COMPARISON

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Abstract. This study investigates the application of alternating current (AC) and direct current (DC) anodization techniques on stainless steel 304L (SS304L) in an ethylene glycol and ammonium fluoride (NH_4F) electrolyte solution to produce a nano-porous oxide layer. With limited research on AC anodizing of stainless steel, this study focuses on comparing AC and DC anodization in terms of current density versus time response, phase analysis using X-ray diffraction (XRD), and corrosion rate determined by linear polarization. Both AC and DC anodization were performed for 60 minutes at 50 V in an electrolyte solution containing 0.5% NH_4F and 3% H_2O in ethylene glycol. The results show that AC anodization exhibited higher current density compared to DC anodization. XRD analysis revealed the presence of ferrite (α-Fe) and austenite (γ-Fe) phases in the as-received specimen, while both AC and DC anodized specimens exhibited only the γ-Fe phase. The corrosion rate of the AC-anodized specimen was measured at 0.00083 mm/year, lower than the corrosion rate of the DC-anodized specimen at 0.00197 mm/year. These findings indicate that AC anodization on stainless steel offers advantages in terms of higher current density, phase transformation, and lower corrosion rate compared to DC anodization. These results highlight the need for further investigation and exploration of AC anodization as a promising technique for enhancing the electrochemical properties of stainless steel.

***Keywords**: AC Anodizing; Corrosion Rate; DC Anodizing; Linear Polarization, Stainless Steel 304L*

BRIEF REVIEW: THE POTENTIAL OF LITHIUM TITANATE AS AN ANODE MATERIAL IN LITHIUM-ION BATTERIES

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Abstract. Lithium ion batteries have attracted much attention in recent decades as one of the advanced rechargeable batteries in energy storage applications. Li-ion batteries are currently the primary source of electronic devices, such as cameras, calculators, mobile phones, and laptops, up to electric vehicles. Lithium titanate ($Li_4Ti_5O_{12}$) or LTO, has been intensively investigated as an important anode material for lithium-ion batteries. It is due to its high working potential of about 1.55 V (vs. Li/Li^+) during charge and discharge, zero strain, and excellent cycle stability. This paper reviews the potential of lithium titanate as an anode material with its properties and factors, as well as the various approaches used to improve the rate capability and cycle performance of LTO itself. Furthermore,methods of the process ranging from nanostructures, lattice doping, and surface modifications to composites are known to provide a large surface area and shorten the distance of the Li^+ transport pathway, which involves the reason why these methods can improve the rate capability and performance of the LTO cycle. Ultimately, the capability of LTO as a battery storage application has many factors. Thus, it can lead the way for further development of LTO.

***Keywords**: Lithium ion batteries; Energy storage; Lithium titanate; Improvement.*

CARBON NANOTUBES FORMATION ON CLAY AND FLY ASH FROM CATALYTIC THERMAL DECOMPOSITION OF RECYCLED POLYPROPYLENE

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Abstract. This research is aimed to investigate the growth of Carbon Nanotubes (CNTs) on two different substrates: Fly ash and clay. Recycled polypropylene was thermally decomposed at 900°C in an inert environment for 90 minutes. Carbon atoms liberated from this process were deposited on fly ash and clay substrates. These substrates were initially immersed in ferrocene solution to provide a metal catalyst for carbon nanotubes growth. Deposited products were weighted and characterized using Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD). Morphological analysis observed that both fly ash and clay were coated with fiber-like structures that were further proven to be CNTs based on a diffraction peak around 26° from XRD pattern [1] as depicted in Figure 1. In conclusion, clay and fly ash could be utilized as potential substrates for CNTs formation.

Keywords: *CNTs; Catalytic Thermal Decomposition; clay; fly ash; recycled polypropylene*

COMPARISON STUDY BETWEEN RECOVERED CARBON BLACK AND COMMERCIAL CARBON BLACK FILLED EPOXY CONDUCTIVE MATERIALS

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Abstract. Waste tyres management and recycling has grown to be a significant issue because it brings up a global environmental concern. Thus, turning the recycled waste tyres into useful products may help to tackle the environmental issue. The aim of this research is to study and compare the effect of rCB and commercial CB at certain 15 vol. % of filler loading on the mechanical, thermal, morphology and electrical properties of epoxy/CB composites. For this project, epoxy resin, diethyltoluenediamine (DETDA), recovered carbon black (rCB) and commercial carbon black (CB) graded N330, N550, N660 and N774 were compared mixed accordingly to the formulation determined. The CB content was dispersed in the epoxy matrix using mechanical mixing technique. The distribution and dispersion of CB in the epoxy matrix affects the characteristics of the conductive composites. rCB content at 15 vol% was selected at fixed content for comparison purpose due the optimum value in electrical conductivity results. The flexural strength results followed the sequence of rCB > N774 > N660 > N550 > N330. As for electrical conductivity results, epoxy/N330 exhibited the highest conductivity value, while the others achieved at magnitude of X10-3 due to the highest external surface area of N330. In terms of thermal stability, epoxy/N330 and epoxy/N774 were slightly more stable than epoxy/rCB.

Keywords: *carbon black; conductive materials; epoxy.*

THE REVIEW OF $Li_4Ti_5O_{12}$ (LTO) ANODE: PHENOMENON AND COMPATIBILITY TO IT ELECTROLYTE AND CATHODE IN LITHIUM-ION BATTERIES

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Abstract. The performance of lithium-ion batteries (LIBs) relies heavily on the properties and compatibility of their individual components, including the anode, electrolyte, and cathode. Among various anode materials, $Li_4Ti_5O_{12}$ (LTO) has gained significant attention due to its exceptional stability and safety features. This research aims to provide a comprehensive review of LTO anodes, focusing on the phenomenon and compatibility of their electrolyte and cathode with respect to LIB performance. The review begins by discussing the fundamental electrochemical properties of LTO as an anode material, emphasizing its high Li+ ion diffusion coefficient, low volume change, and excellent cyclability. Next, the compatibility of LTO anodes with different electrolytes is examined, considering both liquid and solid-state electrolytes. Various electrolyte additives and their impact on the electrochemical performance of LTO anodes are also explored. Furthermore, the review accumulates the influence of LTO anodes on it electrolyte and cathode in lithium-ion batteries. It evaluates the interfacial stability between LTO, electrolyte and cathodes. The importance of maintaining a stable solid electrolyte interphase (SEI) and preventing side reactions was highlighted where it could compromise battery performance. The review addresses the challenges associated with the compatibility of LTO anodes with high-capacity cathode materials including $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ (NCA) and $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$ (NMC). The strategies to mitigate the detrimental effects together with the garnet-type Li-ion electrolytes were discussed. Overall, this research provides valuable insights into the phenomenon and compatibility of LTO anodes with electrolytes and cathodes in LIBs. It sheds light on the critical factors influencing the performance of LTO-based batteries and offers recommendations for optimizing their overall electrochemical performance. The findings of this review contribute to the development of advanced LIB systems with enhanced stability, safety, and energy storage capabilities.

CORROSION RESISTANCE IMPROVEMENT OF 6061 ALUMINUM ALLOY USING ANODIZING PROCESS

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Abstract. Aluminum alloy is a material that is frequently used in the aerospace and transportation industries due to its high mechanical and corrosion resistance qualities. Unfortunately, aluminum alloys are prone to corrosion, limiting their application in some harsh situations such as when submerged in aqueous environments. The purpose of this study is to investigate how anodizing can increase the corrosion resistance of 6061 Aluminum alloy. The anodizing process was carried out using two different parameters which are voltage (5V, 10V, 15V) and electrolyte sulfuric acid (H_2SO_4) concentration (0.3M, 0.5M) for 1 hour. The anodized samples were performed using several analyses such as mass change per surface area, X-Ray Diffraction (XRD) analysis, microstructure analysis, and corrosion test. From this study, it is found that the difference in anodizing parameters affects the corrosion resistance of the samples. Sample anodized at 15V, 0.5M gives the best corrosion resistance.

Keywords: *6061 Aluminum Alloy, Anodizing, Corrosion Resistance*

EFFECT OF PHYSICOCHEMICAL PROPERTIES AND FEED MIX RATIOS ON THE CARBOTHERMIC REDUCTIONS OF IRON ORE WITH COKE

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Abstract. This study aimed to investigate the effect of physicochemical properties and mix ratios of iron ore (oxide feed): coke (reductant) on the carbothermic reductions of iron ore. Coke size was fixed at ≤63 μm while iron ore size varied between 150 μm - 63 μm and ≤63 μm respectively. Mix ratios were changed from 100:0 (reference) to 80:20 and 60:40 while the temperature, heating rate and soaking duration in muffle furnace were fixed at 1100°C, 10°C/min and 1 hour. Malvern Mastersizer, XRF, CHON and XRD analyses are used for determination of raw feed characteristics. Occurrence of any phase transformations from $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow FeO \rightarrow Fe$ during the carbothermal reductions were identified through XRD profiles and supported with weight loss (%). XRF analysis proved that iron ore is of high grade with 93.4% of Fe_2O_3 content. Other oxides present in minor amounts are 2% Al_2O_3 and 1.8% SiO_2 with negligible amounts of other compounds such as MnO, K_2O and CuO. Composite pallet with finer size iron particles (≤63 μm) and higher carbon content of 60:40 exhibited 45.14% weight lost compared to 32.30% and 3.88% respectively for 80:20 and 100:0 ratios. It is evident that reduction reactions can only occur with the presence of coke, the carbon supply. The small weight loss of 3.88% at 100:0 ratio occurs due to the removal of moisture and volatiles and oxidations of iron ore. Higher carbon supply at 60:40 leads into better heat and mass transfer and diffusivity during carbothermic reductions. Overall, finer particle size and higher carbon supply improves reactivity and gas-solid interactions resulting in increased reductions and phase transformations.

Keywords: *carbothermic reductions; diffusivity; physicochemical properties; reactivity; reductant.*

QUANTITATIVE ANALYSIS METHOD FOR ZINGIBER OFFICINALE WATER EXTRACT USING HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

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Quantitative analysis for zingiber officinale sample using subcritical water extraction (SWE) was developed using High Performance Liquid Chromatography (HPLC) to support the development of this new green extraction process. Three main ginger bioactive compounds focus on this research that is 6-gingerol, 6-shagoal and 10-gingerol. Several phases of the work had been done to establish the quantitative analysis method such as the optimization of HPLC operating condition, development of the standard calibration curve and generated of the compound equation. The good correlation of the calibration curve was generated with the value of r2 ≥ 0.9814 and percentage RSD < 5.00 %. Simultaneous, fast, and reliable method with 20 minutes injection time and 8-minute injections delay was establish compare with the 45 minutes injection time for previous HPLC analysis for all component detection and quantification without post-treatment process after the SWE process. In future, online measurement of zingiber officinale bioactive compound extracted using subcritical water extraction are possible using this technology.

Keywords: *Zingiber officinale, HPLC, 6-Gingerol, 6-Shagoal, 10-Gingerol, RSD, r2.*