



MINISTRY OF HIGHER EDUCATION

SINGLE DISCIPLINARY PROJECT

APPLICATION FORM
FUNDAMENTAL RESEARCH GRANT SCHEME (FRGS)
Skim Geran Penyelidikan Fundamental
(Pindaan 1/2012)

JABATAN PENDIDIKAN TINGGI
KEMENTERIAN PENGAJIAN TINGGI

A. Application Details

Application ID	403077
A(i). Selected Grant Scheme	FRGS 2021-1
A(ii). Title of Proposed Research Project	Electric field-driven catalytic activity of cotton textile-reduced graphene oxide: A new phase-boundary catalyst system for hydrogenation of alkene
A(iii). Keywords	electric field-driven catalytic activity, phase-boundary catalyst, hydrogenation of alkene

B. Details of Project Leader

B(i). Name	Hadi Nur
B(ii). Academic Qualification	Postdoc (1999 -2002) - Hokkaido University, Japan PhD (1998) - Chemistry, Universiti Teknologi Malaysia MEng (1995) - Materials Science and Engineering, Institut Teknologi Bandung (ITB) BSc (1992) - Chemistry, Institut Teknologi Bandung (ITB)
B(iii). Nationality	Indonesia
B(iv). IC/Passport No.	B7201146
B(v). Position	Professor
B(vi). Institution	Universiti Teknologi Malaysia (UTM)
B(vii). Faculty/Centre	FAKULTI SAINS
B(viii). Unit/Department	INSTITUT IBNU SINA
B(ix). Office Phone No.	075536162
B(x). Handphone No.	0127564647
B(xi). E-mail Address	hadi@kimia.fs.utm.my
B(xii). Date of First Appointment with this Institution	02/06/2003
B(xiii). Type of Service (Permanent/Contract)	Contract Type: Academic Expected Retirement Date: 31/05/2021

C. Research Information

C(i). Research Domain

Research Domain	Sub Research Domain
Pure and Applied Science	Chemistry

C(ii). Research Cluster

C(iii). 10-10 Malaysia Science, Technology, Innovation and Economy (MySTIE) - based on 10 Socio-Economic Drivers

MySTIE: Energy

C(iv). Shared Prosperity Vision 2030 (SPV 2030)

SPV: KEGA 12 – Green Economy

C(v). Sustainable Development Goals (SDGs)

SDG: SDG 9 – Industry, Innovation and Infrastructure

C(vi). Location of Research

Location
Centre for Sustainable Nanomaterials, Universiti Teknologi Malaysia

C(vii). Duration of this research

From	July/2021
To	June/2023
Duration	2 years

C(viii). Other Researchers

Researcher Id	Name	IC / Passport Number	Faculty/ School/ Centre/ Unit/ Department	Position	Area of Expertise	Invitation Status	Next Appointed Leader	Role
46725	Nursyafreena binti Attan	870803015724	Universiti Teknologi Malaysia	Senior Lecturer (Lecturer)	Application of Magnetic Field, Catalyst	Accepted	☐	On the synthesis and characterize of catalyst.
61393	Juan Bin Matmin	860903235303	Universiti Teknologi Malaysia	Senior Lecturer (Dr)	Nanochemistry, Supramolecular Chemistry	Accepted	☐	On the synthesis and characterize of catalyst.
68298	Sheela A/P Chandren	831009015346	Universiti Teknologi Malaysia	Senior Lecturer (Universiti Teknologi Malaysia)	Photocatalysis and Catalysis	Accepted	☒	On the application of catalyst in the photodegradation of oil spill.

C(ix). Research projects that have been completed or are on-going by project leader in the last three years

Title	Grant Name	Role	Progress (%)	Status	Duration	Start Date	End Date
Prompt Gamma Neutron Activation on ⁴⁴ NatRu and ¹⁰⁰ Ru for nuclear structure parameters evaluation.	FRGS 2019-1	Member	13	In Progress	2 years 9 months	01/09/2019	31/05/2022
The use of tilapia derived gelatin as a substitute to mammal gelatin in tissue engineering for halal biomedical application.	FRGS 2017-1	Member	100	Incomplete - Final Report	2 years 6 months	15/08/2017	14/02/2020
Fundamental study on the mechanism of hybrid integration of a multiple stacking strategy in the microchip electrophoresis platform	FRGS 2017-1	Member	100	Complete - KPI Achieved	2 years	15/08/2017	14/08/2019
Synthesis of titania inverse opal containing single gold nanoparticle per void as active	FRGS 2017-	Member	100	Complete - KPI	2 years	15/08/2017	14/08/2019

photocatalyst under visible light irradiation for the degradation of organic pollutant	1	member	100	KPI Achieved	2 years	15/08/2017	14/08/2019
Synthesis and Characterization of Aminoglycoside Antibiotic Loaded Organo-Silver-Kaolinite as Biocompatible Antimicrobial Agent	FRGS 2017-1	Member	78.75	Incomplete - Final Report	2 years	15/08/2017	14/08/2019
Environmental Feasibility Investigation of Solidified Peat Through Groundwater and Chemical Reaction Assessments for Transportation Infrastructure Development in Southern West Coast of Malaysia.	FRGS 2016-1	Member	100	Incomplete - Final Report	3 years	01/08/2016	30/07/2019
Elucidation of Mechanism and Catalytic Properties of Porous TiO ₂ Microrod Synthesized under Magnetic Field for Low-Temperature Catalytic Combustion of Dimethyl Ether	FRGS 2016-1	Member	100	Complete - KPI Achieved	2 years 6 months	01/08/2016	30/01/2019
INVESTIGATION OF REUTEALIS TRISPERMA (KEMIRI SUNAN) AS POTENTIAL FEEDSTOCK FOR BIODIESEL USING ASTM D6751 AND DIN 14214	FRGS 2015-1	Member	100	Complete - KPI Achieved	3 years	02/11/2015	31/10/2018
Utilization of Laser Ablation for the Preparation of Titania Nanoparticles from Titanium Metal	Industry-International Incentive Grant	Member	N/A	In Progress	1 year	01/11/2020	31/10/2021
The use of tilapia derived gelatin as a substitute to mammal gelatin in tissue engineering for halabiomedical application	FRGS	Member	N/A	Complete - KPI Achieved	2 years	15/08/2017	14/08/2019
Micro-electromembrane extraction with electrokinetic supercharging as a new powerful online preconcentration tool for capillary electrophoresis	GUP Tier 1	Member	N/A	Complete - KPI Achieved	2 years	01/07/2016	30/06/2018
Synthesis and application of carbon-metals based nanocatalyst from electronic waste in oxidation reactions	GUP Tier 1	Project Leader	N/A	In Progress	2 years	01/02/2016	31/01/2018

C(x). Academic publications that have been published by the project leader in the last five years

Title	Name of Journal	Year
Photocatalytic remediation of organic waste over Keggin-based polyoxometalate materials: A review	Chemosphere	2021
Incorporation of Acalypha Indica Extract in Polyvinyl Alcohol Hydrogels: Physico-chemical, Antibacterial and Cell Compatibility Analyses	Jurnal Teknologi	2021
Annealing temperature induced improved crystallinity of YSZ thin film	Materials Research Express	2020
Carbon-containing-titania coated stainless steel prepared by high voltage powder spray coating and its adhesion phenomena	Progress in Organic Coatings	2020
A review on synthesis of kaolin-based zeolite and the effect of impurities	Journal of the Chinese Chemical Society	2020
Electrospun Nano-Fibers for Biomedical and Tissue Engineering Applications: A Comprehensive Review	Materials	2020
SEM, XRD and FTIR analyses of both ultrasonic and heat generated activated carbon black microstructures	Heliyon	2020
A novel porous magnesium production through powder metallurgy technique using wire-pieces of titanium space holder for bone scaffold materials	Journal of Engineering and Scientific Research	2020
The improvement of Triboelectric effect of ZnO Nanorods/PAN in flexible Nanogenerator by adding TiO ₂ nanoparticle	Journal of Polymer Research	2020
A critical review of metal-doped TiO ₂ and its structure–physical properties–photocatalytic activity relationship in hydrogen production	International Journal of Hydrogen Energy	2020
Review of CIGS-based solar cells manufacturing by structural engineering	Solar Energy	2020
Augmented Reality for Introducing Fuel Cell as Electrochemical Energy Conversion	International Journal of Interactive	2020

on Vocational School	Mobile Technologies,	2020
Magnetic field-induced alignment of polybenzimidazole microstructures to enhance proton conduction	Journal of the Chinese Chemical Society,	2020
Physical and electrochemical appraisal of cotton textile modified with polypyrrole and graphene/reduced graphene oxide for flexible electrode	The Journal of The Textile Institute	2020
Vinyl-functionalized mesoporous carbon for dispersive micro-solid phase extraction of azole antifungal agents from aqueous matrices	Separation Science and Technology	2020
Antioxidant, antimicrobial and antiviral properties of herbal materials	Antioxidants	2020
Adsorption Study of Rhodamine B and Methylene Blue Dyes with ZSM-5 Directly Synthesized from Bangka Kaolin without Organic Template	Indonesian Journal of Chemistry	2020
A critical review of metal-doped TiO ₂ and its structure–physical properties–photocatalytic activity relationship in hydrogen production	International Journal of Hydrogen Energy	2020
One-pot non-template synthesis of hierarchical ZSM-5 from kaolin source	Solid State Sciences	2019
A proposed mechanism of action of textile/Al ₂ O ₃ –TiO ₂ bimetal oxide nanocomposite as an antimicrobial agent	The Journal of The Textile Institute	2019
Highly Crystalline Zinc Oxide/Mesoporous Hollow Silica Composites Synthesized at Low Temperature for the Photocatalytic Degradation of Sodium Dodecylbenzenesulfonate	Australian Journal of Chemistry	2019
Hexamethyldisiloxane-modified ZnO–SiO ₂ -coated superhydrophobic textiles for antibacterial application	Journal of the Chinese Chemical Society	2019
A new green method for the synthesis of silver nanoparticles and their antibacterial activities against gram-positive and gram-negative bacteria	Journal of the Chinese Chemical Society	2019
Effect of calcination temperature on the photocatalytic activity of carbon-doped titanium dioxide revealed by photoluminescence study	Journal of the Chinese Chemical Society	2019
Bias voltage dependent structure and morphology evolution of magnetron sputtered YSZ thin film: a basic insight	Materials Research Express	2019
Investigating the catalytic activity of a novel phase boundary catalyst in oxidation of styrene	Asia-Pacific Journal of Chemical Engineering	2019
Carbon-containing Hydroxyapatite Obtained from Fish Bone as Low-cost Mesoporous Material for Methylene Blue Adsorption	Bulletin of Chemical Reaction Engineering & Catalysis	2019
A perspective on catalysis in the immiscible liquid-liquid system	10.9767/bcrec.14.3.5365.660-671	2019
Negative Effect of Calcination to Catalytic Performance of Coal Char-loaded TiO ₂ Catalyst in Styrene Oxidation with Hydrogen Peroxide as Oxidant	Bulletin of Chemical Reaction Engineering & Catalysis	2018
Structure, degradation, drug release and mechanical properties relationships of iron-based drug eluting scaffolds: The effects of PLGA	Materials & Design	2018
One-Dimensional-Like Titania/4'-Pentyl-4-Biphenylcarbonitrile Composite Synthesized Under Magnetic Field and its Structure–Photocatalytic Activity Relationship	Frontiers in Chemistry	2018
Preliminary Study of Potential Herbal Tea, <i>Acalypha indica</i> and Comparison with Domestic Tea in Malaysia Market	Food Science and Technology	2018
Release of curcumin incorporated in albumin loaded silica	Malaysian Journal of Fundamental and Applied Sciences	2018
Modification of Electrical Properties of Silver Nanoparticle	IntechOpen	2018
Utilization of fish bone as adsorbent of Fe ³⁺ ion by controllable removal of its carbonaceous component	Journal of Physics: Conference Series	2018
Effect of ZnO and Annealing on the Hydrophobic Performance of x (ZnO)-CA-PLA	Journal of Physics: Conference Series	2018
Room Temperature Amine Surface Modification of Synthesized Microporous Carbon Spheres	Journal of Mathematics	2018
Synthesis and characterization of zeolite NaX from Bangka Belitung Kaolin as alternative precursor	Malaysian Journal of Fundamental and Applied Sciences	2018
A review of <i>Acalypha indica</i> L. (Euphorbiaceae) as traditional medicinal plant and its therapeutic potential	Journal of Ethnopharmacology	2017
A Review of Silver Nanoparticles: Research Trends, Global Consumption,	Journal of the Chinese Chemical Society	2017

Synthesis, Properties, and Future Challenges	Journal of the Chinese Chemical Society	2017
Titania-Loaded Coal Char as Catalyst in Oxidation of Styrene with Aqueous Hydrogen Peroxide	International Journal of Chemical Reactor Engineering	2017
High voltage powder spray coating as a new method for the preparation of carbon-titania coated stainless steel	Malaysian Journal of Fundamental and Applied Sciences	2017
Hydroxyapatite Coating on Titanium Alloy Ti-6Al-4V with Electrophoretic Deposition (EPD) for Dental Root Application	International Journal on Advanced Science, Engineering and Information Technology	2017
Enhancement of Antibacterial Capability of Cotton Textiles Coated with TiO ₂ -SiO ₂ /Chitosan Using Hydrophobization	Journal of the Chinese Chemical Society	2017
In Situ Synthesis of Silver Nanoparticles for Ag-NP/Cotton Nanocomposite and Its Bactericidal Effect	Journal of the Chinese Chemical Society	2017
Effect of magnetic field on the synthesis of well-aligned TiO ₂ -5CB by sol-gel method	Malaysian Journal of Fundamental and Applied Sciences	2017
Effect of Fe ₃ O ₄ on the Electro-Optic and Magneto-Electric Characteristics of (PANI/Fe ₃ O ₄)-Ag Film	Materials Science and Engineering	2017
Titania-based photocatalysts functionalized on stainless steel and its photocatalytic antibacterial activity	Malaysian Journal of Fundamental and Applied Sciences	2017
A review of <i>Acalypha indica</i> L. (Euphorbiaceae) as traditional medicinal plant and its therapeutic potential	Journal of Ethnopharmacology	2017
Preparation of Titania on Stainless Steel by the Spray-ILGAR Technique as Active Photocatalyst under UV Light Irradiation for the Decomposition of Acetaldehyde	Applied Sciences	2017
Effect of magnetic field on the synthesis of well-aligned TiO ₂ -5CB by sol-gel method	Malaysian Journal of Fundamental and Applied Sciences	2017
High voltage powder spray coating as a new method for the preparation of carbon-titania coated stainless steel	Malaysian Journal of Fundamental and Applied Sciences	2017
Mesostructured TUD-C Supported Molybdena Doped Titania as High Selective Oxidative Catalyst for Olefins Epoxidation at Ambient Condition	Microporous and Mesoporous Materials	2016
Zinc Oxide Nanoparticles-Immobilized Mesoporous Hollow Silica Spheres for Photodegradation of Sodium Dodecylbenzenesulfonate	Australian Journal of Chemistry	2016
Mesostructured TUD-C Supported Molybdena Doped Titania as High Selective Oxidative Catalyst for Olefins Epoxidation at Ambient Condition	Microporous and Mesoporous Materials	2016
Highly Homogeneous Nitrogen Doped Titania Nanomaterials: Synthesis and Characterization	Jurnal Teknologi	2016
Textile/Al ₂ O ₃ -TiO ₂ nanocomposite as an antimicrobial and radical scavenger wound dressingRSC Advances	RSC Advances	2016
New method to synthesize mesoporous titania by photodegradation of surfactant template	Solid State Sciences	2016
Self-cleaning TiO ₂ -SiO ₂ clusters on cotton textile prepared by dip-spin coating process	Jurnal Teknologi	2016
Antimicrobial Treatment of Different Metal Oxide Nanoparticles: A Critical Review	Journal of the Chinese Chemical Society	2016
Dynamic degradation of porous magnesium under a simulated environment of human cancellous bone	Corrosion Science	2016
On the drastic reduction of organic structure directing agent in the steam-assisted crystallization of zeolite with hierarchical porosity	Microporous and Mesoporous Materials	2016
Photocatalytic activity and reusability of ZnO layer synthesised by electrolysis, hydrogen peroxide and heat treatment	Journal Environmental Technology	2016
Can kaolin function as source of alumina in the synthesis of ZSM-5 without an organic template using a seeding technique?	Malaysian Journal of Fundamental and Applied Sciences	2016
Second generation bioethanol production: A critical review	Renewable and Sustainable Energy Reviews	2016
Second generation bioethanol potential from selected Malaysia's biodiversity biomasses: A review	Waste Management	2016

Radio frequency magnetron sputtered ZnO/SiO ₂ /glass thin film: Role of ZnO thickness on structural and optical properties	Journal of Alloys and Compounds	2016
THE USE OF THE COMBINATION OF FTIR, PYRIDINE ADSORPTION, ²⁷ Al AND ²⁹ Si MAS NMR TO DETERMINE THE BRÖNSTED AND LEWIS ACIDIC SITES	Jurnal Teknologi	2016
A rapid MCM-41 dispersive micro-solid phase extraction coupled with LC/MS/MS for quantification of ketoconazole and voriconazole in biological fluids	Biomedical Chromatography	2016
SELF-CLEANING TiO ₂ -SiO ₂ CLUSTERS ON COTTON TEXTILE PREPARED BY DIP-SPIN COATING PROCESS	Jurnal Teknologi	2016
Imazalil sulphate pesticide degradation using silver loaded hollow anatase TiO ₂ under UV light irradiation	Malaysian Journal of Fundamental and Applied Sciences	2016
Zinc Oxide Nanoparticles-Immobilized Mesoporous Hollow Silica Spheres for Photodegradation of Sodium Dodecylbenzenesulfonate	Australian Journal of Chemistry	2016

C(xi). Executive Summary of Research Proposal

(Please include the problem statement, objectives, research methodology, expected output/outcomes/implication, and significance of output from the research project)

Controlling chemical reactions using electric fields could be revolutionary in chemistry. Chemists understood that electric fields could control heterogeneous catalytic reactions. Here, the electric field-driven hydrogenation of alkene using cotton textile-reduced graphene oxide as a layered catalyst will be used to demonstrate the effect of the electric field in catalytic reactions. Many particulate catalysts, such as nickel, palladium, and platinum, were used for the hydrogenation of alkenes. Their disadvantages are low effectiveness, long time of the process, and high costs of the catalysts. The efficient hydrogenation of alkene seems to be a challenging field, scientifically. The major problem encountered in using solid particulate catalysts is the difficulty of effective interaction between the gas and catalyst particles due to their location in the liquid phase that reduces the contact of gas and liquid phases with the catalyst in the hydrogenation reaction. Previously, we proposed the possibility of applying a phase-boundary catalytic system to an immiscible liquid-liquid reaction by using a layered textile catalyst. Based on these facts and findings, our research interest is focused on developing a system to demonstrate the electric field's effect in the liquid-gas heterogeneous catalytic reaction. To study electric field effects on the catalyst system, we will design a reaction vessel that enables a solution-exposed cotton textile-reduced graphene oxide electrostatic environment controlled with a voltage source. Here, the catalytic activity of reduced graphene oxide for hydrogenation of alkene, as a model reaction, will be studied under electrical current. This research will answer the question is whether the electric field can control the catalytic hydrogenation of alkene or not. We regard this as an open question that, once answered, may elucidate fundamental structure–property relationships governing dissociation of hydrogen gas on reduced graphene oxide active sites in the presence of local electric fields for the hydrogenation of alkenes.

C(xii). Detail Planning

(a) Research background

1. Problem Statement

Although only a few publications on the successful experimental demonstrated the electric field's effects in catalytic reactions, it is theoretically possible to control the catalytic reaction using an external electric field. Electric fields can change the thermodynamics of chemical reactions in the same way as to temperature and pressure. Several computational methods have been used to explain the effect of external electric fields on catalytic reactions and also the application of such methods, i.e., selective methane activation. Here, we will demonstrate the breadth of possibilities in electric field-assisted catalysis using cotton textile-reduced graphene oxide in the hydrogenation of alkene as a model reaction. Our research group has demonstrated that catalytic reactions at the gas-liquid system can be carried out using a layered phase boundary catalyst. This study focused on proving the hypothesis that the hydrogenation of alkene can be controlled by applying the external electric field using a layered phase-boundary catalyst. For this reason, cotton textile-reduced graphene oxide will be prepared as a layered phase-boundary catalyst. The structure-properties-function relationship of electric field-assisted catalysis of cotton textile-reduced graphene oxide in the hydrogenation of alkenes needs to be comprehensively studied using a reaction vessel that enables a solution-exposed cotton textile-reduced graphene oxide electrostatic environment controlled with a voltage source and a variety of available spectroscopic techniques.

2. Hypothesis

The external electric field effect on heterogeneous catalytic reaction can be demonstrated using catalysis of cotton textile-reduced graphene oxide in the hydrogenation of alkene. One expects that this catalyst system can prove the concept system to demonstrate controlling chemical reactions using electric fields. As a guide for future actions, this work will open new perspectives for using the electric field to control the catalytic chemical reactions.

3. Research Questions

- Can the external electric field control the catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkene?
- What is the structure-properties-function relationship of electric field-driven catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkene?

4. Literature Reviews

In chemistry, controlling chemical reactions is an important and always-exciting job. Thermodynamically, chemical reactions can be

controlled by playing with pressure and temperature. Recently, controlling chemical reactions using electric fields has received attention from scientists, although not entirely successful [1]. Chemists are beginning to explore whether electric fields can be used to control reactions. At first glance, the use of electric fields in chemical reactions is difficult to demonstrate and prove. Can an electric field affect the formation and breaking of individual bonds? It is a very challenging question to answer.

The elucidation of the role of the electric field for heterogeneous catalysis has been studied theoretically [1]. These studies cover the role of internal and external electric fields in influencing catalytic activity and selectivity. Computational methods such as the vacuum-metal interface model have been used to demonstrate the electric field's effect on heterogeneous catalysis [2]. Experimental studies using capacitor reactors have also been reported in the literature [3]. Based on this evidence, it is clear that electric fields can change the thermodynamics of chemical reactions in the same way we are used to temperature and pressure. Consequently, electric field-assisted catalysis has become an exciting area of research to be explored.

Even though great effort has been attempted to demonstrate electric fields' effect on heterogeneous catalysis, these works only apply to specific reactions using particular reactors. The reactions involving methane transformation have been studied previously [4]. Among others are methane's oxidative coupling, methane steam reforming, the direct dehydrogenative coupling of methane, methane cracking, and methane's partial oxidation. Therefore, there are still many opportunities to conduct experiments using other types of reactions. One of them is the hydrogenation of alkenes.

Hydrogenation is a chemical reaction between hydrogen molecules (H_2) and a compound using nickel, palladium or platinum as a catalyst. This process is usually used to reduce or saturate organic compounds. Hydrogenation is usually the addition of a hydrogen atom pair to a molecule, often an alkene. The catalyst is needed for the reaction to be used; Non-catalytic hydrogenation only occurs at very high temperatures. Hydrogenation reduces the triple and double bonds in hydrocarbons. However this reaction is carried out at a relatively high temperature, i.e., around $150\text{ }^{\circ}\text{C}$ [5].

Density Functional Theory (DFT) calculation have shown that the electric field acts as a catalyst to decrease the energy barrier for the dissociative adsorption of hydrogen gas molecules on graphene [6]. Therefore, there is an opportunity for graphene to be used as a catalyst for the hydrogenation of alkenes with the help of electric fields.

Recently, our group proposed a new type of catalytic system named phase-boundary catalysis (PBC) [7-21]. PBC is a new type of heterogeneous catalytic system which facilitates the chemical reaction of a particular chemical component in an immiscible phase to react on an active catalytic site located at a phase boundary. We have found a convenient method for assembling the oxide particles at the oil-water interface by partial modification of the outer surface of the particles with an alkylsilane agent. One of the most striking features of this amphiphilic material is that the assembled particles loaded with small amounts of titanium (IV) oxide act as an efficient catalyst for the oxidation of hydrophobic alkenes and alcohols with dilute hydrogen peroxide without mechanical agitation. The reaction system is thus called phase-boundary catalysis. We have also proposed the possibility of the application of a phase-boundary catalytic system to liquid-gas reactions [20]. Based on these findings and facts, our research interest is focused on demonstrating and elucidate the external electric field effect on heterogeneous catalytic reaction using cotton textile-reduced graphene oxide in the hydrogenation of alkenes. To support this proposal, just recently, we reported the physical and electrochemical appraisal of cotton textile modified with polypyrrole and graphene/reduced graphene oxide for flexible electrode [21].

In conclusion, this study is to prove the concept system to demonstrate controlling chemical reactions using electric fields. We expect this work to open new perspectives for using the electric field to control the catalytic chemical reactions, especially for the hydrogenation of alkenes (see Fig. 1).

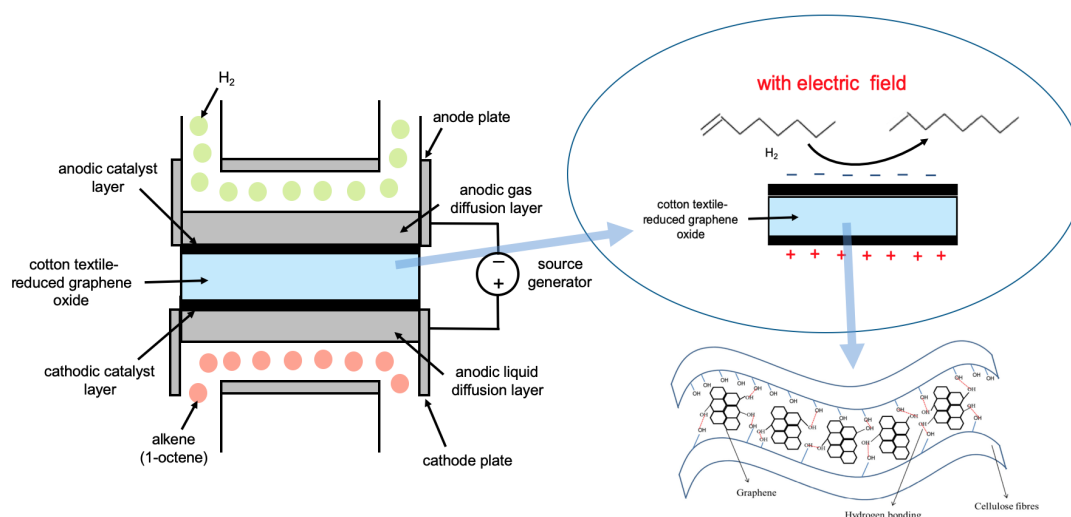


Fig 1. Electric field-driven catalytic activity of cotton textile-reduced graphene oxide for hydrogenation of alkene.

5. Relevance to Government Policy (if any)

The proposed project plays a crucial role in understanding the catalysis phenomena that can benefit frontier technologies in the chemical industry. This is in good agreement with Sustainable Development Goals (SDGs), industry, innovation, and infrastructure.

(b) References

- [1] F. Che, J.T. Gray, S. Ha, N. Kruse, S.L. Scott, J.-S. McEwen., "Elucidating the Roles of the Electric Fields in Catalysis: A Perspective", *ACS Catalysis*, 8 (2018) 5153-5174.
- [2] K. Mathew, V.S.C. Kolluru, S. Mula, S.N. Steinmann, R.G. Hennig, "Implicit self-consistent electrolyte model in plane-wave density-functional theory", *Journal of Chemical Physics*, 151 (2019) 234101.
- [3] C.F. Gorin, E.S. Beh, M.W. Kanan, "An Electric Field- Induced Change in the Selectivity of a Metal Oxide-Catalyzed Epoxide Rearrangement", *Journal American Chemical Society*, 134 (2012) 186–189.
- [4] S. Okada, R. Manabe, R. Inagaki, S. Ogo, Y. Sekine, "Methane Dissociative Adsorption in Catalytic Steam Reforming of Methane over Pd/CeO₂ in an Electric Field", *Catalysis Today*, 307 (2018) 272–276.
- [5] S. Nishimura, "Handbook of Heterogeneous Catalytic Hydrogenation for Organic Synthesis", Wiley-VCH: New York (2001).
- [6] Z.M. Ao, F.M. Peeters, "Electric field: A catalyst for hydrogenation of graphene", *Applied Physics Letters*, 96 (2010) 253106.
- [7] H. Nur, "A Perspective on Catalysis in the Immiscible Liquid-Liquid System". *Journal of the Indonesian Chemical Society*. 2 (2019), 66-71.
- [8] N.H.M. Ran, S. Chandren, H. Nur, "Phase-boundary catalysts for oxidation reactions", in *Recent development of nanostructured heterogeneous catalyst for oxidation reaction*, S.L. Lee (Editor), Penerbit UTM Press, 2014, pp. 1-15.
- [9] H. Nur, S. Ikeda, B. Ohtani, "Phase-boundary catalysis: a new approach in alkene epoxidation with hydrogen peroxide by zeolite loaded with alkylsilane-covered titanium oxide", *Chemicals Communications*, (2000) 2235-2235.
- [10] H. Nur, S. Ikeda, B. Ohtani, "Phase-boundary catalysis of alkene epoxidation with aqueous hydrogen peroxide using amphiphilic zeolite particles loaded with titanium oxide", *Journal of Catalysis*, 204 (2001) 402-408.
- [11] H. Nur, S. Ikeda and B. Ohtani, "Phase-boundary catalysts for acid-catalyzed reactions: the role of bimodal amphiphilic structure and location of active sites", *Journal of Brazilian Chemical Society*, 15 (2004) 719-724.
- [12] S. Ikeda, H. Nur, T. Sawadaishi, K. Ijio, M. Shimomura, B. Ohtani, "Direct observation of bimodal amphiphilic surface structures of zeolite particles for a novel liquid-liquid phase-boundary catalysis", *Langmuir*, 17 (2001) 7976-7979.
- [13] H. Nur, N. Y. Hau, M. N. M. Muhid, H. Hamdan, "Surface structure of alkylsilylated HZSM-5 as phase-boundary catalyst", *Physics Journal of the Indonesian Physical Society*, A7 (2004) 0218.
- [14] H. Nur, S. Ikeda, B. Ohtani, "Amphiphilic NaY zeolite particles loaded with niobic acid: materials with applications for catalysis in an immiscible liquid-liquid system", *Reaction Kinetics and Catalysis Letters*, 82 (2004) 255-261.
- [15] S. Ikeda, H. Nur, P. Wu, T. Tatsumi, B. Ohtani, "Effect of titanium active site location on activity of phase boundary catalyst particle for alkene epoxidation with aqueous hydrogen peroxide", *Studies in Surface Science and Catalysis*, 145 (2003) 251-254.
- [16] H. Nur, N. Attan, N. M. Ran, S. Ikeda, B. Ohtani "On Effective Locations of Catalytic Active Sites in Phase Boundary Catalyst", *ITB Journal of Science*, 44A (2012) 153-163.
- [17] L.S. Yuan, R. Razali, J. Efendi, N.A. Buang, H. Nur, "Temperature-controlled selectivity in oxidation of 1-octene by using aqueous hydrogen peroxide in phase-boundary catalytic system", *Applied Catalysis A: General*, 461 (2013) 21-25.
- [18] N. Y. Hau, I. I. Misnon, H. Nur, M. N. M. Muhid, H. Hamdan, "Biphasic epoxidation of 1-octene with H₂O₂ catalyzed by amphiphilic fluorinated Ti-loaded zirconia", *Journal of Fluorine Chemistry*, 128 (2007) 12-16.
- [19] N.H.M. Ran, L. Yuliaty, S.L. Lee, T. M. I. Mahlia, H. Nur, "Liquid-gas boundary catalysis by using gold/polystyrene-coated hollow titania", *Journal of Colloid and Interface Science*, 394 (2013) 490-497.
- [20] F. Yaghoubidoust, E. Salimi, A. A. Ati, H. Nur*, "Investigating the catalytic activity of a novel phase boundary catalyst in oxidation of styrene", *Asia-Pacific Journal of Chemical Engineering*, (2019), e2350.
- [21] F. Yaghoubidoust, E. Salimi, D.H.B. Wicaksono, H. Nur, "Physical and electrochemical appraisal of cotton textile modified with polypyrrole and graphene/reduced graphene oxide for flexible electrode", *The Journal of The Textile Institute*, in press (Published online: 21 October 2020).

(c) Objective(s) of the Research

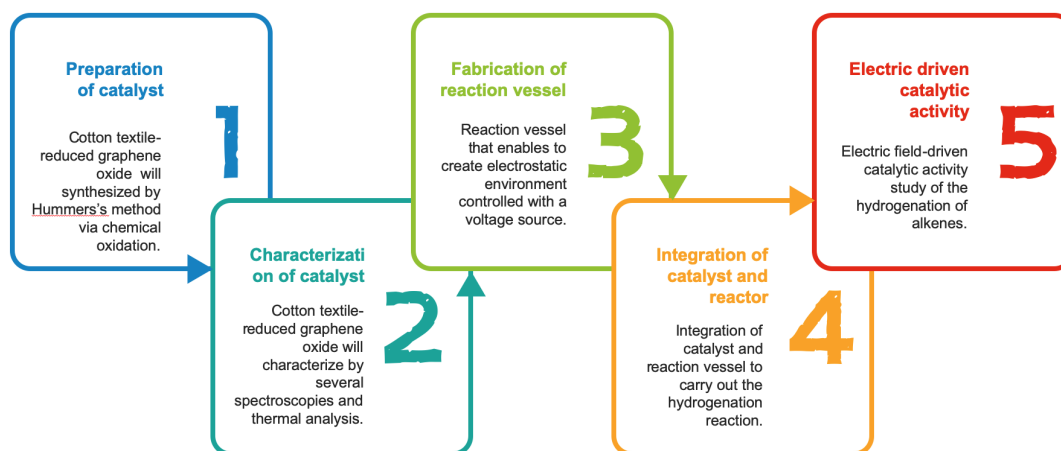
This study embarks on the following objectives:

- To design, synthesize, and characterize cotton textile-reduced graphene oxide as a layered catalyst in the hydrogenation of alkene assisted by the external electric field in controlling the catalytic activity.
- To study the structure-properties-function relationship of electric field-driven catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkene.

1. Description of Methodology

Below is the overall research activities flow chart of this project, which is divided into five stages.

Research activities flow chart



1

Preparation of cotton textile-reduced graphene oxide as a layered catalyst.

1st step

Graphene oxide (GO) is prepared by Hummer's method via chemical oxidation. The solution of GO and deionized water is sonicated for form a stable dispersion. A piece of woven wiper cloth is used. In the scouring treatment, the cotton textile is boiled in deionized water containing Na_2CO_3 . The first treatment is performed using anhydrous sodium carbonate. After the treatment, the samples is washed with water until the pH was reverted to the neutral range (pH = 7).

2nd step

The piece of dewaxed cotton textile is dipped into the dispersed GO solution under stirring, and then, dried. This step is repeated several times to load a high amount of GO, followed by washing with deionized water and ethanol to remove nonattached GO.

3rd step

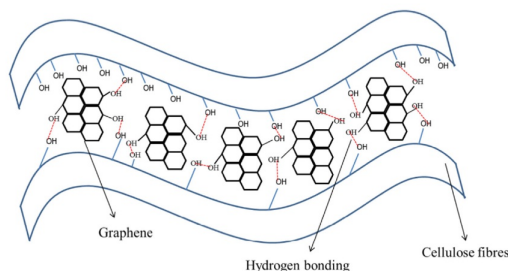
Finally, the cotton with attached graphene oxide (GO) is dried overnight in a vacuum oven.

4th step

In the next step, the piece of GO-cotton is cut into two equal parts. After that one piece of GO-cotton is given the additional treatment of hydrazine to convert the GO to reduce graphene oxide on GO-cotton.

2

Characterization of cotton textile-reduced graphene oxide layered catalyst.



Spectroscopy analysis

X-ray crystallography, Fourier transformed infrared spectroscopy, X-ray photoelectron spectroscopy, Electrochemical impedance spectroscopy, Raman spectroscopy

Electrical analysis

Surface resistivity

Microscopy analysis

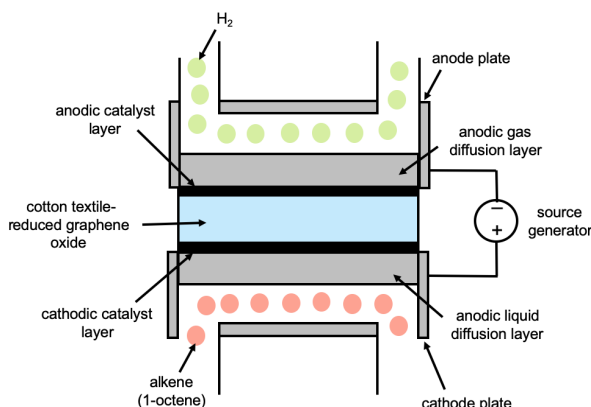
Transmission electron microscopy, Scanning electron microscopy

Thermal analysis

Thermal gravimetric analysis

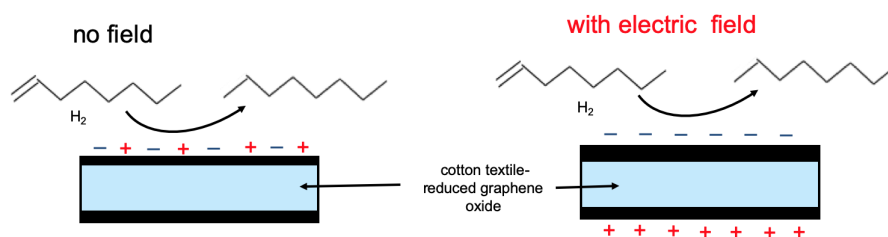
3 & 4

Reaction vessel that enables a solution-exposed layered catalyst electrostatic environment controlled with a voltage source.



5

Electric field-driven catalytic activity study of cotton textile-reduced graphene oxide in the hydrogenation of alkenes.



2. Flow Chart of Research Activities

[Flow Chart of Research Activities.pdf](#)

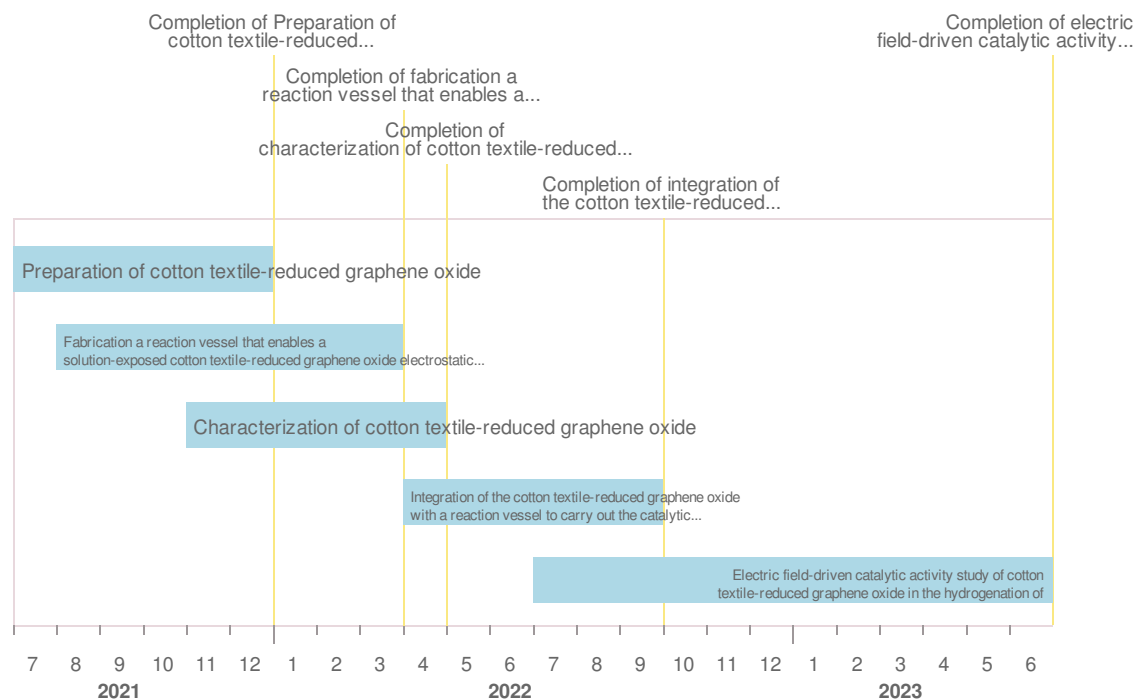
3. Research Activities

Activity	Start Date	End Date
Preparation of cotton textile-reduced graphene oxide	01/07/2021	31/12/2021
Fabrication a reaction vessel that enables a solution-exposed cotton textile-reduced graphene oxide electrostatic environment controlled with a voltage source	01/08/2021	31/03/2022
Characterization of cotton textile-reduced graphene oxide	01/11/2021	30/04/2022
Integration of the cotton textile-reduced graphene oxide with a reaction vessel to carry out the catalytic hydrogenation reaction.	01/04/2022	30/09/2022
Electric field-driven catalytic activity study of cotton textile-reduced graphene oxide in the hydrogenation of alkene	01/07/2022	30/06/2023

4. Milestones

Description	Date	Cumulative Project Completion Percentage(%)
Completion of Preparation of cotton textile-reduced graphene oxide	31/12/2021	20
Completion of fabrication a reaction vessel that enables a solution-exposed cotton textile-reduced graphene oxide electrostatic environment controlled with a voltage source	31/03/2022	40
Completion of characterization of cotton textile-reduced graphene oxide	30/04/2022	60
Completion of integration of the cotton textile-reduced graphene oxide with a reaction vessel to carry out the catalytic hydrogenation reaction.	30/09/2022	80
Completion of electric field-driven catalytic activity study of cotton textile-reduced graphene oxide in the hydrogenation of alkene	30/06/2023	100

Gantt Chart of Research Activities with Milestones



(e) Expected Results/Benefit

1. Novel theories/New findings/Knowledge

The finding in this research will be a guideline for future research that the external electric field can precisely control the catalytic hydrogenation of alkenes. First, a new approach to applying an electric field in heterogeneous catalysis. Second, the structure-properties-function relationship of electric field-driven catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkenes.

2. Impact Statement on Quintuple Helix (please delineate/describe expected research deliverables on Society, Academia, Government, Industry and Environment)

- The high catalytic activity of the heterogeneous catalyst can reduce environmental pollution. The results of this research will be beneficial to the green chemistry process. Through the practice of green chemistry, we can create alternatives to hazardous substances. We can design chemical processes that reduce waste and reduce demand on diminishing resources. We can employ processes that use smaller amounts of energy.
- The project could strengthen the competitiveness of Malaysia in the chemical industry sectors.
- This project will produce a significant educational benefit for young scientists through postgraduate training.

3. Research Publications (Each proposal must produce at least two (2) papers in indexed journals, one of which should be in Web of Science (WoS))

Indexing Body	Indexed Journal	
Number of Publication	Name of Journal	
WoS	2	Chemical Communications (IF = 5,996) (Communication paper on controlling chemical reactions using electric fields). Applied Catalysis A: General (IF = 5,006) (Full paper on the structure-properties-function relationship of electric field-driven catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkene).
SCOPUS		
ERA		
MyCITE		
	Total 2	

4. Specific or Potential Applications of the Research Findings

This layered catalyst system can be applied in the hydrogenation reactions, specifically for the hydrogenation of alkenes. Besides

that, this catalyst can be used to synthesize a useful organic compound.

Total Number of Applications: 2

5. Number of PhD and Masters (by research) Students

Total Number of PhD (by research) Student(s):

Total Number of Masters (by research) Student(s):

1

Remark (if any):

At least one M.Sc. postgraduate student will be trained for the duration of this proposed project.

6. Intellectual Properties (IPs)

The electric field-driven catalytic activity of cotton textile-reduced graphene oxide in the hydrogenation of alkenes

Total Number of IP: 1

Access to Equipment & Material(s)

Type	Description	Owner	Location	Address
Fourier Transform Infrared with Attenuated Total Reflectance (FTIR-ATR)	To examine the functional groups presence in the samples	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
X-ray Photoelectron Spectroscopy (XPS)	To analyze the binding energy of the samples	UTM	University Industry Research Laboratory (UIRL), UTM	University Industry Research Laboratory (UIRL), UTM
Thermogravimetry Analyzer (TGA)	To analyze the thermal properties of the samples	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
Field Emission Scanning Electron Microscopy (FE- SEM)	To study the morphological properties of the samples	UTM	University Industry Research Laboratory (UIRL), UTM	University Industry Research Laboratory (UIRL), UTM
X-ray Fluorescence Spectrometer	To analyze the composition of the sample	UTM	University Industry Research Laboratory (UIRL), UTM	University Industry Research Laboratory (UIRL), UTM
X-Ray Diffraction Spectrometer	To determine the structure of samples	UTM	University Industry Research Laboratory (UIRL), UTM	University Industry Research Laboratory (UIRL), UTM
Gas chromatography	To determine the photocatalytic activity	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
Photoluminescence spectrometer	To determine the electronic properties	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
Diffuse Reflectance UV-vis spectrometer	To determine the electronic properties of samples	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
Catalytic reactor	For catalytic reaction	UTM	Centre for Sustainable Nanomaterials (CSNano), UTM	Centre for Sustainable Nanomaterials (CSNano), UTM
Transmission electron microscope	To study the morphological properties of the samples	UTM	University Industry Research Laboratory (UIRL), UTM	University Industry Research Laboratory (UIRL), UTM

E. Budget

Budget Type	Description	Year 1	Year 2	Grand Total	
11000 - Allowance		24000	24000		
GRA Master (Max RM2,000.00/person for 2 years)	1 M.Sc student (RM 2,000/month)			48000	
Sub-Total		24000	24000	48000	
GRA Ph.D (Max RM2,500.00/person for 3 years)				0	
Sub-Total		0	0	0	
Vot-Total		24000	24000	48000	
21000 - Travelling and Transportation			2000		
Local	Attending seminar			2000	
Sub-Total		0	2000	2000	
Overseas				0	
Sub-Total		0	0	0	
Field work				0	
Sub-Total		0	0	0	
Vot-Total		0	2000	2000	
24000 - Rental				0	
Vot-Total		0	0	0	
27000 - Research Materials and Supplies	Research Pipette Setting. 10 µL – 100 µL 20 µL – 200 µL 100 µL – 1000 µL 10 µL Hamilton syringe needles Justification: Pipettes will be used in the preparation of catalysts and also in the analysis of product results from catalytic reactions.	2500		2500	
	Hydrochloric acid (HCl, 37%), ethanol (96%), sulfuric acid (H2SO4, 97%), sodium sulfate (Na2SO4), and potassium chloride, potassium permanganate (KMnO4, 99%), sodium nitrate (NaNO3, 99.99%), Pyrrole (C4H4NH, 99.99%), 1-octene, 1-octane, 1 cylinder of hydrogen gas, hydrazine and nonwoven wiper cloth, with a mass density of 9.623 mg.cm2 and 160 fibers per inch. Justification: The chemicals to be purchased are precursors to synthesize cotton textile-reduced graphene oxide and for the catalytic reaction.	7000	5000	12000	
Vot-Total		9500	5000	14500	
28000 - Maintenance and Minor Repair Services	Maintenance of PL spectrometer	4220		4220	
	Maintenance of DR UV-vis	4220		4220	
	Maintenance of GC	4700		4700	
Vot-Total		13140	0	13140	

29000 - Professional Services	Analysis of samples (XRD, XPS, EIS, Raman, surface resisivity, SEM, TEM and TGA)	6000	6000	12000
Services/Consultancy				
Sub-Total		6000	6000	12000
Short term course				0
Sub-Total		0	0	0
Journal Page Charges (WoS / SCOPUS / ERA / MyCITE)				0
Sub-Total		0	0	0
Vot-Total		6000	6000	12000
35000 - Accessories and Equipment	Fabrication a reaction vessel that enables a solution-exposed cotton textile-reduced graphene oxide electrostatic environment controlled with a voltage source.	10000 35000 ...		10000
Vot-Total		10000	0	10000
Grand Total		62640	37000	(100.00%) 99640

F(i). Patent Search (describe how your research output shall produce an innovative idea or technology that has the potential to be a solution for stakeholders (community, industry, government etc.) and offers a unique proposition)

To identify if the researcher is able to coherently present a compelling argument for his/her proposal in light of the IP landscape and factors identified in the (Yes/No) Section. The answer would reflect an understanding of the applicant's research advantage and limitations and the prospect of moving the completed research beyond this stage of funding.

The proposed patent search using the chosen keywords revealed that the IP is related to the research objectives' concepts. Using all of the keywords, lens.org returned an increasing trend of 62 published patents for 1997 to 2020. The main topic of this research is the electric field-driven catalytic activity of the layered catalyst. Although there are 62 patents found using used keywords, after looking at them one by one, not the same topic has been patented. This shows that this topic has the potential to be patented.

[Simplified Patent Search Report \(MyGRANTS\) 2021.pdf](#)

F(ii). Research Collaborator

- ☐ Industrial Linkages (Please identify any industry or end-user group involved in the project, and describe its role/contribution to the project)
- ☒ Agency/Organisation (Please identify all agencies/organisations collaborating in the project, and describe their role/contribution to the project)

Center of Advanced Materials for Renewable Energy (CAMRY), Universitas Negeri Malang (UTM), is a well-equipped research center with analytical devices for material testing. Universitas Negeri Malang has a Memorandum of Understanding (MoU) with UTM. This will be a healthy initiative and groundwork for preparing the transformation of this FRGS grant outcome into a more potential project. Currently, Prof. Dr. Hadi Nur is an adjunct professor at U.M.

[MoU UTM - UM.pdf](#)

F(iii). Risk Assessment (Please describe factors that may cause delays in, or prevent implementation of, the project as proposed above; estimate also the degree of risk)

Please consider an appropriate approach to working in the current conditions (pandemic, travel ban, social distancing etc.)

One of the risks that caused delays from this project was the closure of laboratories and universities due to the Malaysian Government Movement Control Order (MCO) due to the pandemic. This will also result in the late delivery of materials to be used in this project. Another risk is the delay in appointing qualified research candidates to conduct the project.

Risk	Low	Medium	High
1. Technical	☒	☐	☐
2. Timing	☒	☐	☐
3. Budget	☐	☒	☐

G. Declaration

- ☒ All details provided in this application are accurate. KPT has the right to reject or to cancel the offer without prior notice if there is any inaccurate information given.
- ☒ This proposal is not currently considered for any other research grant(s).
- ☐ The exact proposed work has not been funded through other research grant(s).
- ☐ Necessary approvals from relevant bodies (i.e.: Ethics Committee) are granted before related research activities commence.
- ☐ I have an on-going Fundamental Research Grant Scheme (FRGS) project.
- ☐ This proposed research is my original work, is not copied from my MSc. or Ph.D. thesis or any other work (published or unpublished), and has not been submitted for grant application either at KPT or elsewhere.

Name: Hadi Nur

Signature:

Date: 15/02/2021

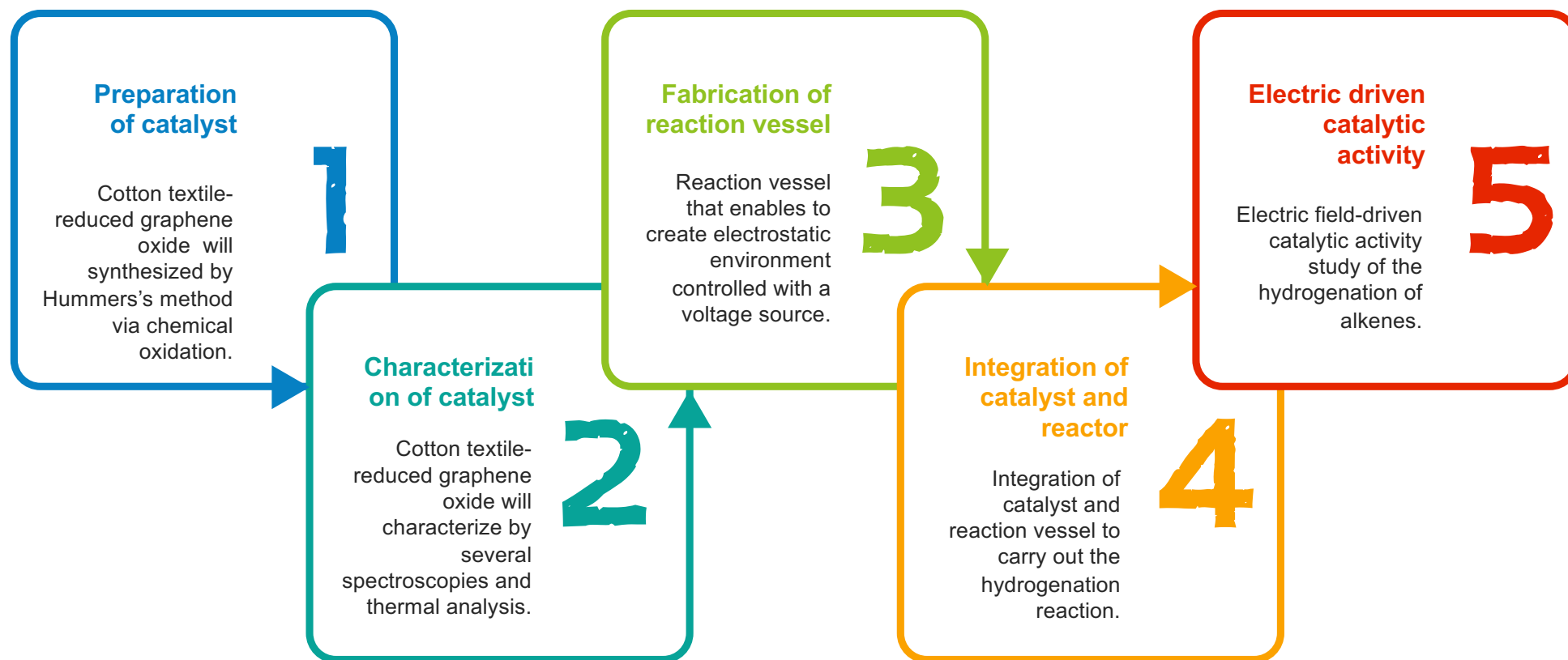
Approved By:

Signature:

RMC
Date:

Appendix	
Flow Chart	Flow Chart of Research Activities.pdf

Research activities flow chart



MEMORANDUM OF UNDERSTANDING

BETWEEN



UNIVERSITI TEKNOLOGI MALAYSIA

AND



UNIVERSITAS NEGERI MALANG

This **MEMORANDUM OF UNDERSTANDING** (herein after referred to as "MoU") is made and entered into this day of 2019

BETWEEN

UNIVERSITI TEKNOLOGI MALAYSIA, a public university established under the Universities and University Colleges Act, 1971 and for the purpose of this MoU is represented by Ibnu Sina Institute for Scientific and Industrial Research having its address at Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor Darul Takzim, Malaysia (hereinafter referred to as "UTM") of the one part;

AND

UNIVERSITAS NEGERI MALANG, a public university having its address at Jalan Tamansari 64, Bandung 40116, Indonesia (hereinafter referred to as "UM") of the second part.

UTM and UM shall hereinafter collectively be referred to as "Parties" and individually as a/the "Party".

WHEREAS:

- A. UTM is an established university which strives to enhance and strengthen its academic and research activities and has taken various initiatives to complement its educational excellence. UTM has entered into various collaborative arrangements with other parties to enhance its research capabilities.
- B. UM is a very established university founded in the year 1954 and one of the most prestigious university in Indonesia. The university is committed to the enhancement of high academic standards and high-quality research activities.
- C. The Parties hereby agree to enter into this MoU to declare their respective intentions and to establish a basis of co-operation and collaboration between the Parties upon the terms as contained herein.

NOW IT IS HEREBY UNDERSTOOD AND WITNESSETH as follows:

ARTICLE 1
SCOPE OF COOPERATION

- 1.1 The Parties, subject to the terms of this MoU and the laws, rules, regulations and national policies from time to time in force in each Party's country, will endeavour to strengthen, promote and develop academic and research cooperation between the Parties on the basis of equality and mutual benefit.

- 1.2 Each Party will endeavour to take necessary steps to encourage and develop academic exchange in the area of education and research and have agreed upon the following activities:
- i. Joint conference;
 - ii. Joint research and supervision (to be mutually agreed);
 - iii. Joint publication;
 - iv. Researcher/faculty/student attachment and exchange;
 - v. Summer School, Short Courses and Training; and
 - vi. Any other areas of co-operation to be mutually agreed upon by the Parties.
- 1.3 The Parties agree that the list of activities above and the list of faculties involved under the implementation of this MoU may be added from time to time with the mutual agreement of the Parties.

For the purpose of implementing the co-operation in respect of any areas stated in Article 1, the parties will enter into a legally binding agreement subject to such further terms and conditions as mutually agreed upon by the Parties.

ARTICLE 2

IMPLEMENTATION AND ADMINISTRATIVE COORDINATORS

- 2.1 The Parties agree to appoint from each Party an overall Administrative Coordinator for the administration of this MoU. The Coordinators will serve as the contact person on campus, being responsible of implementing the decisions and ensuring that necessary approvals are in place and overseeing the productive stay of the visiting students/experts and arrangements associated with their visits.
- 2.2 In order to enable faculty-driven planning and implementation of the activities/programs mentioned in **Article 1**, regular meetings, mutual visits and research workshops between both Parties will be conducted.

ARTICLE 3

FINANCIAL ARRANGEMENT

- 3.1 This MoU will not give rise to any financial obligation by one Party to the other.
- 3.2 Each Party will bear its own cost and expenses in relation to this MoU.

ARTICLE 4 CONFIDENTIALITY

- 4.1 Each Party shall undertake to observe the confidentiality and secrecy of documents, information and other data received from or supplied to, the other Party during the period of the implementation of this MoU or any other agreements made pursuant to this MoU.
- 4.2 For purposes of paragraph 4.1 above, such documents, information and data include any document, information and data which is disclosed by a Party (the Disclosing party) to the other Party (the Receiving party) prior to, or after, the execution of this MoU, involving technical, business, marketing, policy, know-how, planning, project management and other documents, information, data and/or solutions in any form, including but not limited to any document, information or data which is designated in writing to be confidential or by its nature intended to be for the knowledge of the Receiving party or if orally given, is given in the circumstances of confidence.
- 4.3 Both Parties agree that the provisions of this Article shall continue to be binding between the Parties notwithstanding the termination of this MoU.

ARTICLE 5 PROTECTION OF INTELLECTUAL PROPERTY RIGHTS

- 5.1 The protection of intellectual property rights shall be enforced in conformity with the national laws, rules and regulations of the Parties and with other international agreements signed by the government or the authorized organization in the Parties' country.
- 5.2 The use of the name, logo and/or official emblem of any of the Parties as the case may be, on any publication, document and/or paper is prohibited without the prior written approval of either Party.
- 5.3 Notwithstanding anything in sub-article 5.1 above, the intellectual property rights in respect of any technological development, products and services development, carried out –
 - i. jointly by the Parties, or research results obtained through the joint activity effort of the Parties, shall be jointly owned by the Parties in accordance with the terms to be mutually agreed upon;
 - ii. solely and separately by **Universiti Teknologi Malaysia** or **UM**, or research results obtained through the sole and separate effort of **UTM** or **UM**, as the case may be, shall be solely owned by the Party concerned; and

- iii. rights in intellectual property developed by students in the course of exchanges, collaborative or research activities shall be dealt in accordance with the rules and regulations of the Parties, in term of ownership, confidentiality obligations and commercialization.
- 5.4 The Parties shall acknowledge one another for its contributions in any form of writing, publication or presentation based on, or derived from, the collaborative research between the Parties.

ARTICLE 6

EFFECT OF MEMORANDUM OF UNDERSTANDING

This MoU serves only as a record of the Parties' intentions and except in relation to Article 4 and 5 herein, does not constitute or create and is not intended to constitute or create obligations under domestic or international law and will not give rise to any legal process and will not be deemed to constitute or create any legally binding or enforceable obligations, express or implied.

ARTICLE 7

REVISION, MODIFICATION AND AMENDMENT

- 7.1 Either Party may request in writing a revision, modification or amendment of all or any part of this MoU.
- 7.2 Any revision, modification or amendment agreed to by the Parties shall be reduced into writing and shall form part of this MoU.
- 7.3 Such revision, modification or amendment shall come into force on such date as may be determined by the Parties by mutual agreement.
- 7.4 Any revision, modification or amendment shall not prejudice any on-going activities arising from or based on this MoU until their completion..

ARTICLE 8

SUSPENSION

Each Party reserves the right for reasons of national security, national interest, public order or public health to suspend temporarily, either in whole or in part, the implementation of this Memorandum of Understanding which suspension shall take effect immediately after written notification has been given to the other Party.

ARTICLE 9
GOVERNING LAW AND DISPUTE RESOLUTION

- 9.1 Any difference or dispute between the Parties concerning the interpretation and/or implementation and/or application of any of the provisions of this MoU shall be settled amicably through mutual consultation and/or negotiations between the Parties, without reference to any third party.
- 9.2 Any consultation and/or negotiation for the settlement of dispute shall be governed by the laws of the country where such dispute arises.

ARTICLE 10
DURATION AND TERMINATION

- 10.1 This MoU shall come into force on the date of signing and shall remain in force for a period of three (5) years subject to review and modification as mutually agreed upon.
- 10.2 Thereafter, if the Parties hereto wish to extend the terms of this MoU, they shall do so by an express covenant in writing.
- 10.3 Notwithstanding anything in this Article, either Party may terminate this MoU by notifying the other Party to its intention to terminate this MoU by a notice in writing, at least three (3) months prior to its termination date.
- 10.4 Such notice of termination does not affect any individual students who have already commenced or been accepted by either Party. Where such termination occurs, the provision of this MoU shall continue to apply to on-going activities until their completion and each party accordingly shall return any documents retained by the same to the disclosing party.

ARTICLE 11
NOTICES

Any communications under this MoU will be in writing in the English language and delivered by registered mail to the address or sent to the electronic mail address of UNIVERSITI TEKNOLOGI MALAYSIA or UNIVERSITAS NEGERI MALANG as the case may be, shown below or to such other address or electronic mail address as either Party may have notified the sender and shall, unless otherwise provided herein, be deemed to be duly given or made when delivered to the recipient at such address or electronic mail address which is duly acknowledged:

To UTM:

Prof. Dr. Hadi Nur
Director
Ibnu Sina Institute for Scientific and Industrial Research
Universiti Teknologi Malaysia
E-mail: hadinur@utm.my

To UM:

Dr. Hadi Suwono
Dean
Faculty of Mathematics and Natural Sciences
Universitas Negeri Malang
E-mail: hadi.suwono.fmipa@um.ac.id

ARTICLE 12 RELATIONSHIP OF THE PARTIES

- 12.1 The Parties record that it is not their intention that this MoU creates any partnership, agency or other relationship between them under which either Party might be deemed to be responsible for the acts or omissions of the other Party and this MoU should not be construed as to render the Parties liable as partners or as creating any partnership, agency or other similar relationship.
- 12.2 Unless otherwise agreed in writing, Parties shall not transfer or assign all or any of their rights, obligations, interests or benefits hereunder to any third party.

ARTICLE 13 GENERAL

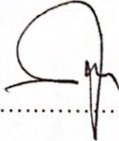
- 13.1 The Parties hereby confirm their express agreement that this MoU and all documents directly or indirectly related thereto be drawn up in English.
- 13.2 Each of the Parties hereto confirms its intention to promote the best interests of the Parties hereto and to consult fully on all matters materially affecting the areas of co-operation. Each of the Parties hereto shall act in good faith towards the other Party in order to promote the success of the contemplated co-operation.

[THE REST OF THIS PAGE HAS BEEN LEFT BLANK]

IN WITNESS WHEREOF, the undersigned being duly authorized thereto, have signed this Memorandum of Understanding.

Signed on this 24 day of January in the year 2020 in TWO (2) original texts.

**SIGNED FOR AND ON BEHALF OF
UNIVERSITI TEKNOLOGI MALAYSIA :-**



.....
PROF. DATUK IR. DR. WAHID BIN OMAR]
Vice-Chancellor]
Universiti Teknologi Malaysia]
Date:]

**SIGNED FOR AND ON BEHALF OF
UNIVERSITAS NEGERI MALANG :-**



.....
PROF. DR. H. AH. ROFIUDDIN]
Rector]
Universitas Negeri Malang]
Date:]

SIMPLIFIED PATENT SEARCH REPORT

[using Lens.org (<http://lens.org/>)]

Version 1/2021

Keywords Used	<i>electric field driven AND heterogeneous catalysis AND reduced graphene oxide AND AND hydrogenation AND chemical reaction AND alkene</i>	The Number of Patents Found using Keywords Used	62
		Link to the Search Result on Lens.org	https://link.lens.org/mDXkPSQ1aSg

Answer these questions using 'YES' or 'NO'

NO.	QUESTIONS	(YES / NO)	REMARKS (IF ANY)
COMPULSORY SECTION			
1.	Has the number of patents published shown an UPWARD trend? If YES, it highlights an increasing interest to protect ideas associated with the keywords used. Increasing interest may indicate developing or sunrise sector showing future potential with substantial growth.	YES	
2.	Has the number of patent published shown a DOWNWARD trend? If YES, it highlights a decreasing interest in sectors associated with keywords used. It may indicate a declining or sunset sector showing diminishing interest to protect ideas or absence of innovation.	NO	
SOCIAL SCIENCES SECTION Please answer Questions 3 and 4, if the research proposal is categorised under the Research Domain of Social Sciences (SS); or Arts and Applied Arts (SSI); or Natural and Cultural Heritage (WAB)			
3.	Does the proposed research output (dataset, knowledge, information) have the POTENTIAL TO BE USED by any of the past patent applicants in the search results?		
4.	Does the proposed research output (dataset, knowledge, information) have the POTENTIAL TO BE USED by any Malaysian Government Ministry/Agency? If YES, please state the name of the Ministry/Agency. If NONE, the research output may not be of use to the national agenda.		

Answer these questions using 'YES' or 'NO'			
NO.	QUESTIONS	(YES / NO)	REMARKS (IF ANY)
SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) SECTION Please answer Questions 5, 6, 7 and 8, if the research proposal is categorised under the Research Domain of Technology and Engineering (TK); or Clinical and Health Sciences (SKK); or Pure and Applied Sciences (STG); or Information and Communication Technology (ICT)			
5.	Does the list of previous patent applicants include potential COLLABORATOR(S)* that are interested in the research output? If YES , it shows that the research output is potentially aligned with the requirements of existing collaborator(s) that have entered the sector earlier.	NO	Although there are 62 patents found using used keywords, after looking at them one by one, not the same topic has been patented. This shows that this topic has the potential to be patented.
6.	Does the list of previous patent applicants include potential COMPETITOR(S)** when applying the research output? If YES , please state the name of the COMPETITOR(S).	NO	
7.	Does the patent search yield similar patents that would prevent the commercialisation of the research?	NO	
8.	Does the patent search yield similar patents already filed in Thailand, Indonesia and Singapore?	NO	

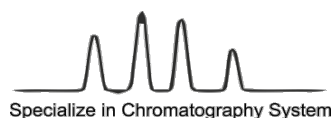
***Collaborators** are past patent applicants listed in the patent search result who have the potential to collaborate with the grant applicants during or after the research project has been completed.

****Competitors** are past patent applicants listed in the patent search result that would compete against the grant applicants and prevent the research output from being utilised or commercialised after the research project has been completed.

NOTE

This is a one page simplified and stripped down version of a patent search that is designed to create intellectual property awareness to KPT (Ministry of Higher Education Malaysia) grant applicants. Using this one-page summary and Lens.org, applicants would be able to:

- (1) Familiarise with the basic patent search process;
- (2) View basic information associated with their research;
- (3) Identify the novelty position of their research application with regards to the intellectual property landscape;
- (4) Identify other actors (potential collaborators/stakeholders/competitors) in the sectors associated with their research areas;
- (5) Identify potential trends in intellectual property interest;
- (6) See historical patent trends associated with their research;
- (7) Identify if neighbouring countries (Singapore, Indonesia, Thailand) have developed similar ideas; and
- (8) Avoid submitting research proposals that lack novelty and potential economic and societal impact.



RSS Instruments Sdn.Bhd(971143-P)

Repair. Service. Supply

No 1118G, Jalan Rahmat, Kg Teras Jernang, 43650 Bandar Baru Bangi, Selangor, Malaysia

43650 Bandar Baru Bangi, Selangor Darul Ehsan

Hp : 016 - 3387567 Office : 03 - 8912 9615 Fax : 03-89266012 email : anazfaudzi@gmail.com

GST No.: 000223739904

QUOTATION

Center For Sustainable Nanomaterials,
Ibnu Sina Institute For Scientific And Industrial Research,
Universiti Teknologi Malaysia,
81310 Skudai, Johor

RSS-0873-AJB

5/2/2021

Attn : Prof. Dr. Hadi Nur

Thanks for your inquiry. We are pleased to submit our quote as follow.

Item	Description	Qty	Price/unit	Total
1	Cell Kit with Hand Carry Casing Integrated cell kit inclusive of heavy duty casing, hydrogen and oxygen storage and supply system, mass flow meter, flow regulating valve, cooling fan, load unit, voltmeter and ammeter <u>Casing type</u> : Briefcase type, heavy duty pastic casing <u>Casing size</u> : approx. 455x340x175mm (final dimension to be confirmed) <u>Refillable H2 and O2 storage and supply include</u> : Detachable gas refill tubing, gas valve, 150ml SS304 gas storage tank 75bar max, pressure gauges to indicate pressure of storage/supply to fuel cell, pressure safety relief device, flow regulating valve, mass flow meter and integrated tubing <u>Load</u> : DC fan with ammeter and voltmeter <u>Cooling fan</u> : AC Fan for FC cooling <u>Electrical supply required</u> : 240VAC/50Hz * Integration of fuel cell MEA Active Area : 3.2x3.2cm (10cm²) MEA Membrane Area : 5.3 x 5.3cm Graphite Plate Overall Dimension : LxWxD (6.3x6.3x0.4cm) 5 Cell - 3V Output Hydrogen Consumption 53ml/min	1	10,000.00	10,000.00
Total				10,000.00

Quotation Notes :

Validity : 30 days

Payment : 30 days

Delivery : 2-3 months

We hope that our quotation is favourable to you and looking forward to receive your valued order in due course.

Thanks and regards

Your faithfully

Abdul Jalal

.....
Abdul Jalal Bin Bilal
Service Engineer