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A Sustainable Research Collaboration of more than 10 years between Malaysia and France on Glycerol Valorization- Challenges and Opportunities

Mohamed Kheireddine Aroua

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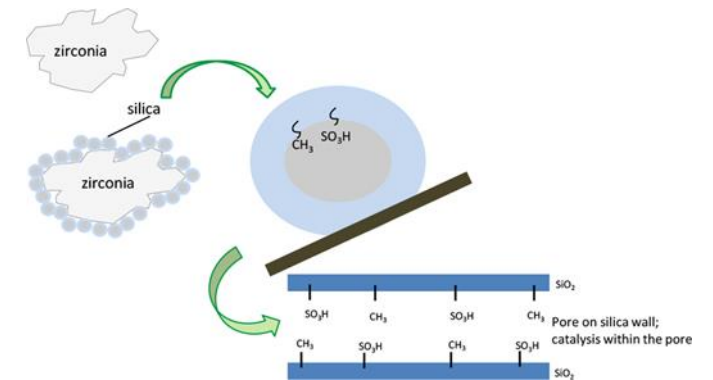
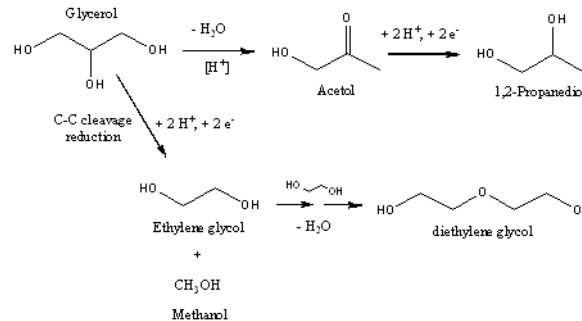
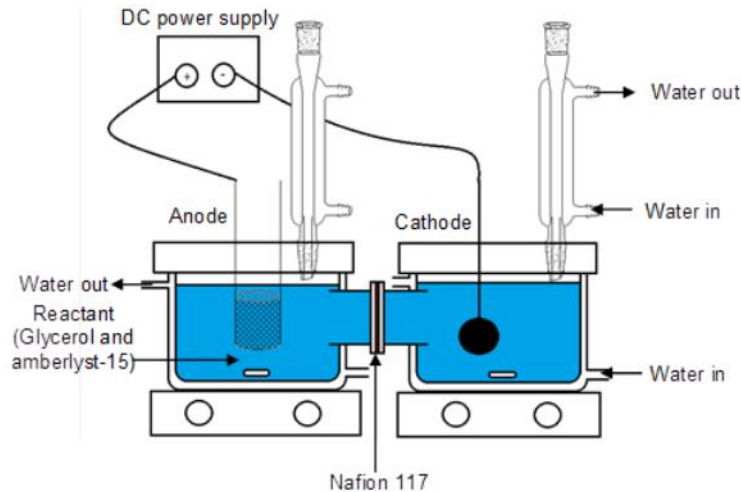
Associate Dean (Research), Head Centre for Carbon Dioxide Capture and Utilization (CCDCU), School of Science and Technology, Sunway University, Malaysia

Professor, Department of Engineering, Lancaster University, UK

Honorary Professor, University of Malaya, Malaysia

Research topics

- Study of glycerol electrochemical conversion into added value compounds
- Development of novel hydrophobic $\text{ZrO}_2\text{-SiO}_2$ based heterogeneous acid catalyst for the esterification of glycerol with oleic acid
- Conversion of Glycerol to value-added products through Biocatalysis reaction using microreactor



1st Green Process Engineering Congress organized in Toulouse University of Toulouse

High Impact Research Grant

Joint PhD supervision
Ching Shya Lee
University of Malaya/ Toulouse INP



Joint PhD supervision
Pei San Kong
University of Malaya/ Toulouse INP



2nd year ENSIACET students internships in Chemical Engineering Department in UM

Joint PhD supervision
Nurul Nadiah Binti Abd Razak
Sunway University/ Toulouse INP



2007

2011

2012

2015

2016

2017

2018



3rd Green Process Engineering Congress organized in Kuala Lumpur University of Malaya

Ching Shya's viva in Toulouse

Pei San's viva in Kuala Lumpur

Frontiers in Chemistry
Green and Sustainable Chemistry
From Glycerol to Value-Added Products
Editors: Mohamed Kheireddine Aroua & Patrick Cognet

Fundamental Research Grant

Mechanism and kinetic parameters of bio-glycerol conversion in a two-compartment electrochemical reactor
University of Malaya/ Toulouse INP

Professor Kheireddine Aroua
Invited Professor in Toulouse

MyPaiR-PHC-Hibiscus

Sunway University/Toulouse INP



SUNWAY UNIVERSITY
TALK BY PROF. PATRICK COGNET
"MICROREACTORS: SOME CONCEPTS AND APPLICATIONS"
BIOGRAPHY
Patrick Cognet is Professor at the Institut National Polytechnique de Toulouse, France. He is an Engineering School (ENSIACET) the Institute for Chemical Engineering Systems from ENSCM (Ecole Nationale Supérieure des Chimistes de Toulouse) in France. He received his PhD in 1981, he carried out his PhD at the Chemical Engineering Laboratory in Toulouse (Chemical Engineering). He joined Institut Polytechnique de Toulouse in 1988 as Assistant Professor. He is Professor since 2003 and Head of the Chemical Engineering Laboratory. He works in focused on Green Process Engineering and more precisely on reactor design, optimization, instrumentation, microreactors, process intensification and process analysis. He has made the overall design of the Green Process Engineering (GPE) center in 2007. He has also Program Advisor at the French National Research Agency (ANR) since 2008 to 2014. Patrick Cognet is the author of 42 journal papers, 2 book chapters, 1 book, 1 patent, 2 Process Engineering and 3-actor with Prof. Mohamed Kheireddine Aroua. A collection entitled from "Glycerol to Value-Added Products" in Frontiers in Chemistry.

ALL ARE INVITED
Free Admission

For Registration
<http://bit.ly/pactrickcognet>

DECEMBER 12, 2019 / THURSDAY
TIME: 10:00 A.M. - 11:00 A.M.

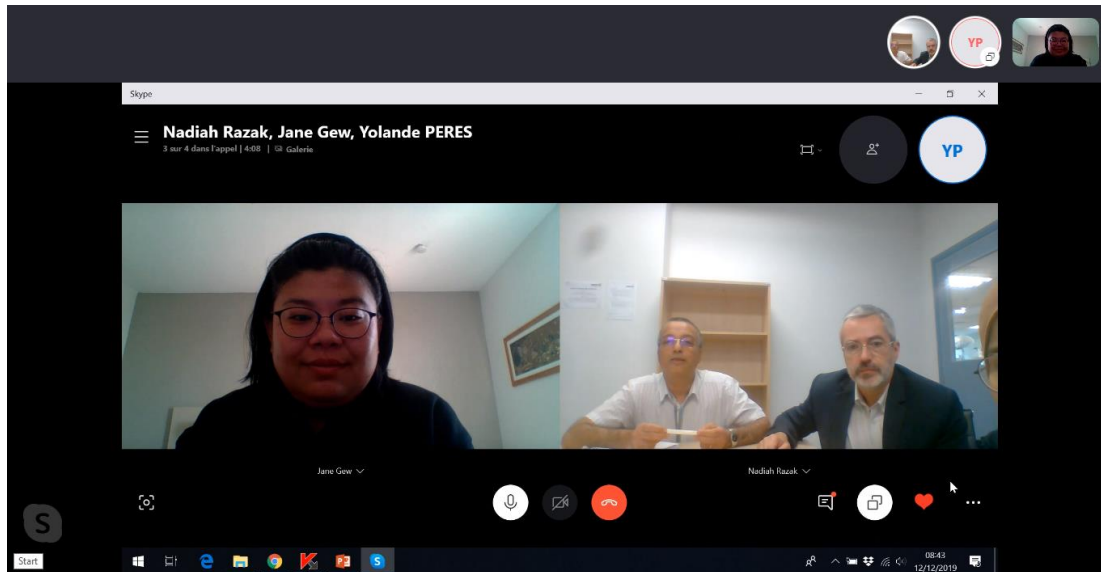
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SUNWAY UNIVERSITY

Dr. Wan Mohd Haniffa - Administration
Centre for Carbon, Hydrogen, Oxygen and Nitrogen (CHOCN)
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Recent Publications

Effect of Reaction Medium Mixture on the Lipase Catalyzed Synthesis of Diacylglycerol

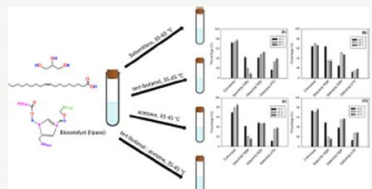
Nurul Nadiyah Abd Razak, Yolande Pérès, Lai Ti Gew,* Patrick Cognet, and Mohamed Kheireddine Aroua*

Cite This: *Ind. Eng. Chem. Res.* 2020, 59, 9869–9881

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ABSTRACT: In this study, the implication of employing blended solvents during the synthesis of glycerol dioleates (GDO) using *Candida antarctica* lipase was investigated. GDO is an example of diacylglycerol (DAG) that comprises two oleic acid chains esterified to one glycerol backbone. A model system consisting of glycerol and oleic acid was used to determine the effects of different solvent systems exhibiting various viscosities and polarities on conversion, yield, and selectivity of glycerol oleates. The study was carried out at different temperatures. The rheological properties of solventless, acetone, *tert*-butanol, and blended solvent systems exhibited Newtonian flow behavior, and their viscosities decreased at elevated temperatures. As compared to GMO and GTO, GDO synthesis showed the highest yield (70%) and selectivity (54%) at 40 °C within 2 h in the reaction medium containing blended solvents of *tert*-butanol/acetone. The rate of reaction and productivity of GDO in *tert*-butanol/acetone were achieved at 0.27 M h⁻¹ and 0.48 M h⁻¹, respectively. The tested systems were found to be endothermic and in a disordered manner at all investigated ranges of temperatures studied. The esterification reaction was found to be spontaneous, and the Gibbs energy decreased with increasing temperature.



NN Abd Razak, Y Pérès, LT Gew, P Cognet, and MK Aroua (2020) Effect of Reaction Medium Mixture on the Lipase Catalyzed Synthesis of Diacylglycerol, **ACS Industrial & Engineering Chemistry Research**. 59 (21), 9869-9881.

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FROM GLYCEROL TO VALUE-ADDED PRODUCTS

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PUBLISHED IN: *Frontiers in Chemistry*



23

Publications

1. Ching Shya Lee, Mohamed Kheireddine Aroua, Wan Mohd Ashri Wan Daud, Patrick Cognet, Yolande Pérès, Paul-Louis Fabre, Olivier Reynes, Laure Latapie, A review: Conversion of bioglycerol into 1,3-propanediol via biological and chemical method, *Renewable & Sustainable Energy Reviews*, 42, 2015, 963–972.
2. Pei San Kong, Wan Mohd Ashri Wan Daud, Hwei Voon Lee, Patrick Cognet, Yolande Pérès, Catalytic role of solid acid catalysts in glycerol acetylation for the production of bio-additives: a review, *RSC advances*, 6, 68885-68905, 2016.
3. Pei San Kong, Mohamed Kheireddine Aroua, Wan Mohd Ashri Wan Daud, Patrick Cognet, Yolande Pérès, Enhanced microwave catalytic-esterification of industrial grade glycerol over Brønsted-based methane sulfonic acid in production of biolubricant, *Process Safety and Environmental Protection*, 104, Part A, 2016, 323–333.
4. Ching Shya Lee, Mohamed Kheireddine Aroua, Wan Mohd Ashri Wan Daud, Patrick Cognet, Yolande Pérès, Selective electroreduction of glycerol to 1,2-propanediol on a mixed carbon black-activated carbon electrode and a mixed carbon black-diamond electrode, *BioResources*, Vol 13, No 1, 2018, 115-130.
5. Kong Pei San; Cognet Patrick, Pérès Yolande, Esvan Jerome, Daud Wan Mohd Ashri Wan, Aroua Mohamed Kheireddine, Development of a novel hydrophobic ZrO₂-SiO₂ based acid catalyst for catalytic esterification of glycerol with oleic acid, *Industrial & Engineering Chemistry Research*, Vol 57, 2018, 9386-9399.
6. PS Kong, Y Pérès, W Daud, WM Ashri, P Cognet, MK Aroua, Esterification of glycerol with oleic acid over hydrophobic zirconia-silica acid catalyst and commercial acid catalyst: optimization and influence of catalyst, *Frontiers in chemistry*, 2019, 7:205
7. CS Lee, MK Aroua, WAW Daud, P Cognet, Y Peres, MA Ajeel, Selective electrochemical conversion of glycerol to glycolic acid and lactic acid on a mixed carbon-black activated carbon electrode in a single compartment electrochemical cell, *Frontiers in chemistry*, 2019, 7:110
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9. Kong Pei San, Aroua M.K., Wan Daud, W.M.A, Cognet P., Pérès Y., Synthesis and characterization of a hydrophobic heterogeneous acid catalyst over zirconia support for glycerol esterification, ISGC 2017, La Rochelle (oral communication)

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**THANK
YOU**