FATTY ACID CATALYSIS

ADDING VALUE TO BIODERIVED FATTY ACIDS AND VEGETABLE OILS VIA CATALYTIC HYDROGENATION

PROJECT DETAILS

Cluster: Energy from Biomass
Knowledge provider: Queen's University Belfast – (PI Dr Haresh Manyar)
Industrial partners: Oleon, Caterwaste, MOF technology
Total project costs: £394,716.00 over 36 months from 1st September 2015 to 31st August 2018

PROJECT BACKGROUND

Hydrodeoxygenation of fatty acids feedstocks into renewable hydrocarbon based drop-in biofuels and bio alcohols has been the subject of a significant amount of attention due to the potential to add significant value to biomass. This is currently performed industrially on a large scale using catalytic hydrogenation; however, the commercial processes typically utilise high pressures (up to 200 bar H2) and temperature (up to 250 ˚C). At Queen's University, we have developed a new low temperature catalytic technology which allows the reactions to be performed under low temperature (60-130 ˚C) and low hydrogen pressure (1-30 bar) using novel tri-metallic catalysts (QUCaT-1). The QUCaT-1 technology not only promotes the reaction rates under mild conditions, but also enhances the selectivity to corresponding alcohols (>95% selectivity at ~100% conversion of fatty acid), as compared to an unpromoted catalysts. We have also tuned the composition of the catalyst to selectively produce corresponding hydrocarbons for use as biofuels.

The UK implementation plan for the use of biofuels states that by 2020 15% of all petrol and diesel for transport purposes should be from renewable resources. However, by 2010 the UK met only 3.3% of the target set in 2009. Northern Ireland has a significant oilseed rape market and whilst FAME based biodiesel is one option, the biofuels produced in this project are drop in fuels, i.e. direct replacements for e.g. diesel or aviation fuels. As well as biofuels, the fatty alcohols produced have a wide range of applications such as lubricants, antioxidants, concrete anti-spalling agents, cosmetics, plasticizers and polymerization stabilisers etc. Additionally, the project has investigated the use of fatty acid feedstocks from Oleon as well as real waste cooking oil collected from local restaurants by Caterwaste.

PROJECT OUTPUTS

We have developed a novel catalyst (QUCaT) technology that we are currently in the process of patenting. With different compositions of this catalyst and by tuning reaction conditions we are able to produce biofuels and fatty alcohols in high conversions and selectivities. (Figure 1) During the project we have expanded from the use of batch reactors and scaled up the process to a continuous flow system. For example, at ambient pressure at 130 ˚C in the continuous flow system, close to 100% conversion of fatty acid feedstock (Oleon) was obtained with 98% selectivity to biodiesel. While in the batch reactor 91% conversion and 88% selectivity was achieved towards fatty alcohols. Once optimization is complete the process will be further scaled up to a pilot plant level.

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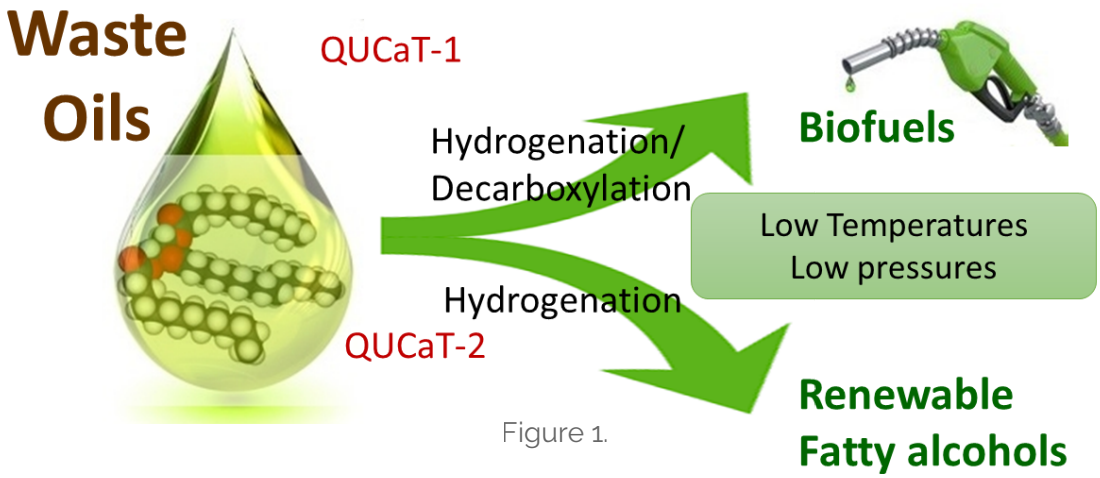

Figure 1.

We are also exploring the solvent free mechanochemical synthesis of our novel catalyst with MOF technology. The catalyst is prepared in the absence of solvent by simply grinding the metal oxides together in a ball mill for 20 min. (Figure 2) Results with ball milled catalysts are very promising in the batch reactor as the ball milled catalyst are almost always more selective to the fatty alcohol product. Catalyst synthesis by mechanochemistry can also be easily scaled on an extruder which would be required for the pilot plant studies.

Figure 2.

CASE
Centre For Advanced Sustainable Energy

CASE is an Invest Northern Ireland funded competence centre with grant funding of £5 million. The centre has successfully funded 18 research projects in renewable energy across biogas, marine renewables and energy systems sectors.

Centre for Advanced Sustainable Energy
David Keir Building
Stranmillis Road
Belfast
BT9 5AG
UK
Tel: 0289097 5577
Email questoratu@qub.ac.uk

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IMPACT OF CASE FUNDING

CASE funding enabled the formation of the consortium bringing together academia and industrial partners following on the preliminary fatty acids catalysis processes developed at Queen's University Belfast. The combined expertise available from multidisciplinary experts from within the consortium has led to successful development of low temperature catalytic technology for production of biofuels and high value added alcohols from waste cooking oils and fatty acid biomass feedstocks.

IBENEFITS FOR CASE MEMBERS

Industrial partners have directly benefitted from the new low temperature catalytic technology developed for upgradation of used vegetable oils and fatty acids to biofuels and fatty alcohols. Industrial partners have significant feedstocks of oil and fatty acids available with them, which has commercial potential to add value to waste biomass resources for production of biofuels and chemicals, as well as, by saving on energy costs and an improvement of the process yield. It is estimated they have made savings of between 15% (for speciality chemicals) and 40% (commodity chemicals) of the manufacturing cost. From this project, we have also gained know-how around the innovative mechanochemical synthesis of highly active catalysts which fits well with their company's strategy to expand to heterogenous catalysis synthesis.

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