EBIO Newsletter

Biofuels Through Electrochemical Transformation Of Intermediate Bio-Liquids

Issue 2 / May 2022

EBIO is a four-year project that is part of the European Union's Horizon 2020 Research and Innovation Programme. It is set to be a game changer in the field of biofuel production with the aim to generate energy dense biofuels through electrochemical transformation of intermediate liquified biomass.

The project launched in December 2020 with a budget of around 4 million euros. After some Covid-19 pandemic related start-up challenges, all PhD students have started their research and the project is now and running and in full-swing and has brought together partners from all over Europe all with the same goal: to turn low value crude bio liquids into sustainable road transport fuels.

The consortium is built on strong foundations of research, innovation, and industrial knowledge. It consists of nine beneficiaries from seven different countries, among them some of the world leaders in the field.

CONTENTS

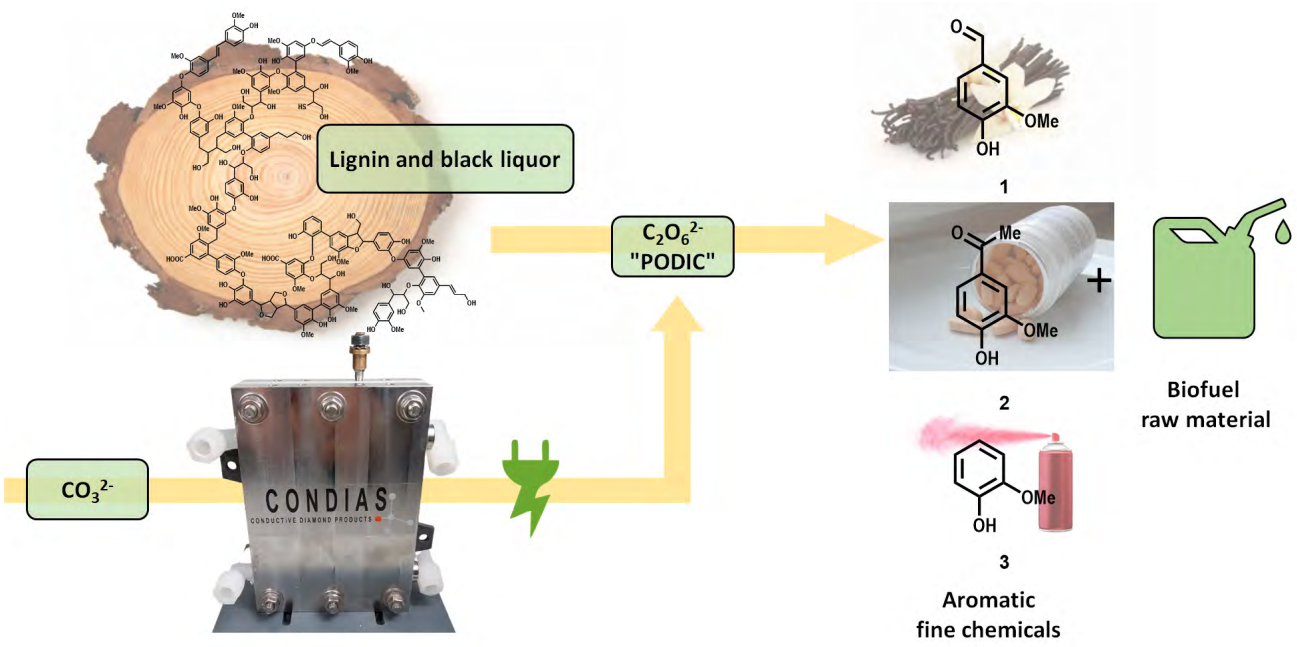
1. EBIO develops an electrochemically supported method to degrade Kraft lignin

We developed in the EBIO Project an electrochemically supported method for the highly selective degradation of Kraft lignin to water-soluble degradation products such as the fine chemicals vanillin (1), acetovanillone (2) and guaiacol (3), but also water-soluble polymer fragments that may function as feedstock for biofuels.

Therefore, the electrochemically ex-situ generated high-performance oxidant peroxodicarbonate (PODIC®) was employed.[1] PODIC® is simply generated in a flow electrolysis cell from an aqueous carbonate solution, which makes it an especially sustained oxidizing agent. We are using a boron-doped diamond (BDD) anode in a flow cell designed by CONDIAS.[2] In more advanced electrolysis cells PODIC® concentration can be strongly enhanced.[3] Addition of the high-performance oxidizer "PODIC®" to a solution of lignin, or even black liquor itself, gives an oxidized polymer that subsequently undergoes thermally induced depolymerization.

Pressures greater than 10 bar are generated in an autoclave. After successful thermal treatment, a solution of water-soluble degradation products is obtained, which can be further processed. In summary, the developed method relying on electrolyzed carbonate as a sustainable oxidizing agent allows for selective degradation of Kraft lignin to vanillin and acetovanillone as well as water-soluble degradation products, which could be implemented into biofuels.

[1] S. Waldvogel, M. Zirbes, R. Neuber, T. Matthée, Process for the oxidation of carbon-containing organic compounds with electrochemically generated oxidizing agents and arrangement for carrying out the process, PCT Int. Appl. 2020, WO 2020099350 A1 20200522.
[2] C. P. Chardon, T. Matthée, R. Neuber, M. Fryda, C. Comninellis, ChemistrySelect 2017, 2, 1037–1040.
[3] A.-K. Seitz, P. Kohlpaintner, T. van Lingen, M. Dyga, F. Sprang, M. Zirbes, S. R. Waldvogel, L. J. Gooßen, Concentrated Aqueous Peroxodicarbonate: Efficient Electrosyn- thesis and Use as Oxidizer in Epoxidations, S-, and N-Oxidations, Angew. Chem. Int. Ed., 2022, accepted.



PODIC® route. Credit Niclas Schupp

2. Meet the Researchers

Talal Ashraf - University of Twente

Talal did his Masters in Energy Transition by EIT Innoenergy with specialisation in Chemical technology, Energy Engineering and Management at AGH University of Science and Technology Krakòw, Poland and Instituto Superior Técnico Lisbon, Portugal.
His research interests and previous experiences are based in electrochemical energy conversion, clean fossils and alternative fuels energy, material science and project management. His current PhD is in electro chemical transformation of pyrolysis oil at University of Twente, The Netherlands.

Niclas Schupp & Elisabeth Oehl - Johannes Gutenberg University, Mainz

Niclas and Elisabeth are PhD students in the Waldvogel group at Mainz University. Niclas finished his master's degree in Chemistry in Mainz before starting his PhD in January 2021. He has a practical lab background from his vocational training as a lab technician at Mainz University. Elisabeth started her PhD in July 2021 after finishing her master's thesis with Sanofi Aventis. She studied Biomedical chemistry in Mainz and spent one semester abroad in Scotland. The two PhD students share a common interest for electroorganic synthesis with a focus on renewable resources such as lignin.

Ferran Torres Martí - Instituto de Tecnología Química (ITQ /UPV /CSIC)

Ferran was born in Moncofa, Spain, in 1995. He received a BSc and MSc in Chemical Engineering from the Universidad Politècnica de Valencia in 2018 and 2020. He is currently preparing a PhD at the Institute of Chemical Technology (ITQ) in Valencia, Spain, under the guidance of Prof. Avelino Corma and Dr. Yannick Mathieu. The main focus of his doctoral work is the direct conversion of crude oil into chemicals and the valorisation of biomass derived fractions into automotive fuel and chemicals.

Thanks to these enthusiastic PhD students EBIO project has been able to begin efficiently progressing towards its research objectives. You can get to know the PhD students better in a series of interviews that **can be seen on the projects YouTube channel - EBIO - YouTube.**

Research Interns for EBIO Project


Inspired by EBIO's energy transition goal, two research interns, Tim van der Weerd, 24 (left), Timo Koopman, 23 (right), from Saxion University of Applied Sciences joined our efforts at the University of Twente Enschede. At the PCS group, both interns will work on the development of electrocatalyst materials and determine their efficiency for application in bulb and non-bulb electrolysis of pyrolysis liquid model compounds. Read more about the two new interns here.

The master students Audrey Minnard and Abilash Anton Rajakumaran conduct their internship at SINTEF Industry in Oslo.
Audrey conducts her Master studies at the European School of Chemistry, Polymers and Materials (ECPM) in Strasbourg/France with a major in organic chemistry and analytics. Within EBIO she tests electrode materials and operational windows for lignin depolymerisation.
Abilash conducts a Master in chemistry and materials science at the Ecole Nationale Superieure de Chimie de Rennes/France. During his EBIO internship he prepares and characterises structured electrode materials.

3. Recent and Upcoming EBIO events

EUBCE, 9th - 12th May 2022 - half day workshop, and four abstract presentations:

- **Electrochemical routes for bio-liquids transformation**
  12 May 2022, 11:30 - 13:00 CEST
- **Glucose Oxidation Applying Electrochemically Produced Green Oxidants**
  12 May 2022, 12:51 - 13:40 CEST
- **Vanillin by Electrochemical Transformation of Kraft Lignin or Black Liquor**
  10 May 2022, 16:15 - 17:15 CEST
- **Pyrolysis Oil Treatment Using Kolbe Electrolysis of Organic Acids**
  12 May 2022, 12:51 - 13:40 CEST
- **EBIO Project, Biofuels through Electrochemical Transformation of Intermediate bio-liquids**
  10 May 2022, 17:30 - 18:30 CEST

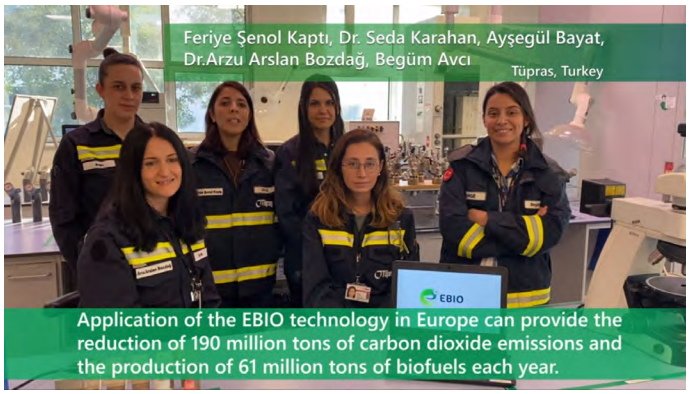
The recording of EBIO at EUBCE 2022 can be found here

Other recent or upcoming events:

- **The Netherlands' Catalysis and Chemistry Conference**
  9-11 May 2022 https://n3c.nl/
- **Bio4Fuels day, Bergen**
  16-18 Nov 2022 https://bit.ly/3v2HnRV
- **Norwegian Catalysis Symposium**
  6-8 June 2022 https://19nsc.fi/
- **MESA+, Twente University**
  13 June 2022 https://bit.ly/3rGBVSH
- **International Society of Electrochemistry - 32nd ISE Topical Meeting Stockholm, Sweden**
  20 - 22 June 2021 https://bit.ly/3uZCfOn

4. Women of EBIO

The EBIO project boasts a gender equal workforce, which is a huge achievement in male dominated research area.
To promote the project and their roles in the consortium a short promotional video was produced for the project, and released for International Women's Day.
It can be viewed here:
https://youtu.be/Hr4QakdznHU



Women of EBIO. Pictured: Tupras

PROJECT PARTNERS

SINTEF · btg biomass technology group · Johannes Gutenberg Universität Mainz · University of Twente. · CONDIAS Conductive Diamond Products · Tüpraş · AFRY AF Pöyry · etaflorence renewableenergies · CSIC Consejo Superior de Investigaciones Científicas

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EBIO H2020 Project

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006612.