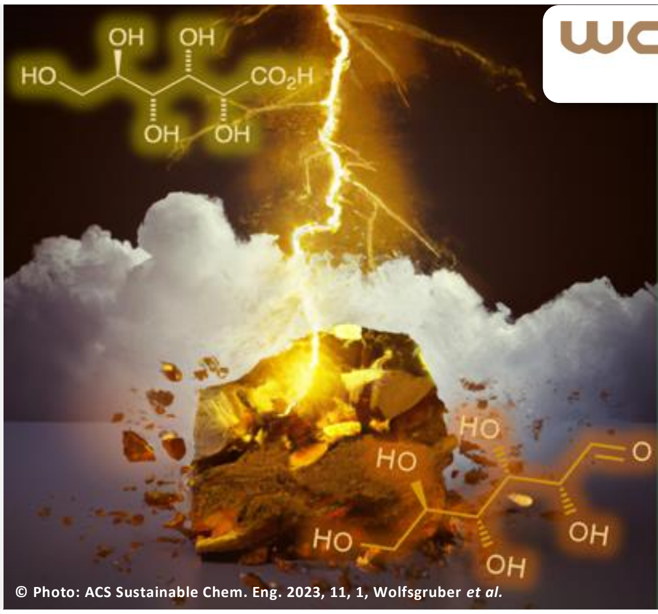
SUCCESS STORY

Wood K plus
WOOD: Transition to a sustainable bioeconomy

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Center (K1)

Type of project: LENZ 1.1 Advanced Biomass Utilisation: Processes for sustainable Biorefineries; 2023 - 2026, single-firm



BIOELECTROREFINERY – ELECTROCHEMICAL SIDE-STREAM VALORISATION IN THE PULP INDUSTRY

INNOVATIVE SIDE-STREAM VALORISATION IN THE CONTEXT OF A PULP BIOELECTROREFINERY IS DEVELOPED FOR A MORE EFFICIENT UTILISATION OF THE RAW MATERIAL WOOD

Economic, ecological, and social factors make the achievement of the global climate targets necessary. Therefore, valorisation of side-streams of sustainable industrial processes into chemicals, energy, fuels, and materials displays great potential. Lignocellulosic biomass, *e.g.* wood or agricultural waste, is favoured for non-competing with the food and feed industry.

The cellulosic fiber manufacturer Lenzing AG has been operating an industrial biorefinery plant in combination with a dissolving pulp production for over 40 years. The utilisation of spent sulfite liquor (SSL), an abundantly available side-stream in the pulp industry, offers great opportunities towards side-stream valorisation. It does not only increase the product yield of the raw material wood, but also raise the capacity of the production processes. Currently, acetic acid and furfural are valuable biorefinery products, in addition to xylose for the xylitol production that is extracted in cooperation with the IFF on site in Lenzing.

Within the *Bioelectrorefinery* project the possibility of electrochemical conversion of aldonic acids to aldoses (especially xylose) and furfural to furfuryl alcohol using renewable electric energy was investigated.

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
Republic of Austria
Labour and Economy

Electrocatalytic conversion of aldonic acids to aldoses

An undesired reaction during the sulfite pulping process is the oxidation of the residual sugar monomers to aldonic acids, *e.g.* gluconic or xylonic acid. Those hamper the biotechnological valorisation of the SSL, but also the conversion of xylose into xylitol. A prospective approach to overcome this obstacle is the electrocatalytic reduction of the aldonic acids to the corresponding monosaccharides increasing the fermentability and leading to greater xylitol yields and process efficiency.

In this project, the electrocatalytic reduction of xylonic and gluconic acids as model components on a gold-coated silver wire was successfully performed. The reaction was not limited to the cell-type of an undivided cell but could also be carried out in a membrane cell. In-line with the experiments a possible mechanism was proposed *via* reactive force-field (ReaxFF) molecular dynamic simulations and quantum chemistry calculations. Silver was chosen as the electrode material as an alternative to the literature described gold, due to its ecological and economic. No measurable effect of the reaction on the electrocatalyst was detected, confirming the applicability of long-term use. The possibility of electrochemical reduction of aldonic acids to aldoses was demonstrated and opens a window of opportunity toward sustainable side-stream valorisation.

Electrochemical reduction of furfural to furfuryl alcohol

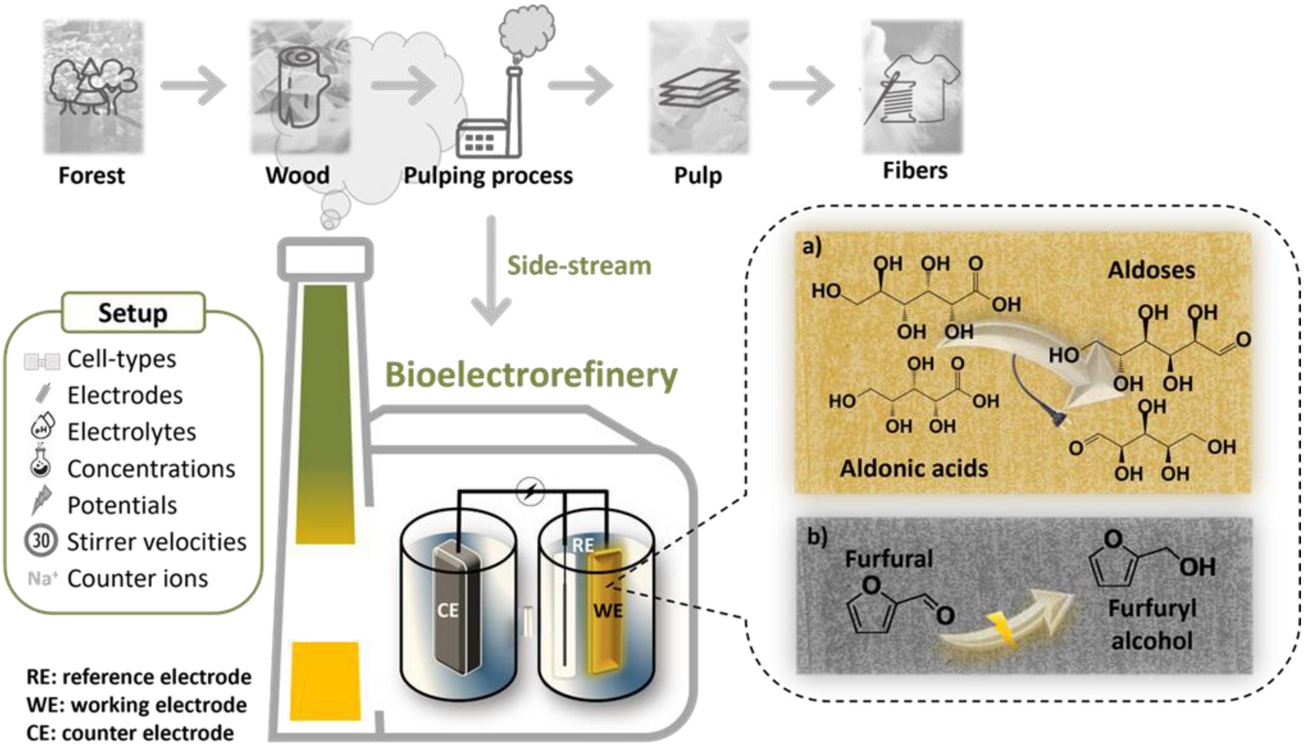
Roughly 80% of the industrially produced furfural is converted into furfuryl alcohol via the thermocatalytic vapor phase process. The high temperature and pressure are suboptimal from an ecologic and economic point of view. The used hydrogen gas consumes a major part of the overall operating costs and is in-line with safety concerns. The sum of these factors makes a more sustainable and better approach necessary.

The electrocatalytic hydrogenation of furfural to furfuryl alcohol represents a *green* way to generate this high value-added product. Part of the project was the to find a setup for the electrochemical reduction based on a biomass-derived electrolyte system. Various electrocatalysts (silver, gold, carbon paper, copper, platinum, tin, gold-coated silver) and bio-based electrolytes, e.g. acetic acid, levulinic acid and sodium acetate, were tested in aqueous media at ambient temperature and atmospheric pressure.

The highest Faraday efficiency (79%) and furfuryl alcohol yield (35%) were achieved with the gold-coated silver electrode in 1 M sodium acetate as electrolyte.

The two proposed approaches of this project serve as starting points for a better utilisation of the SSL based on the necessary milestones of the industrial shift from fossil to sustainable processes. An environmental-friendly and safe alternative to the thermocatalytic hydrogenation processes was provided. *Bioelectrorefineries* and research in this field meet the challenges of the current time and will contribute to sustainable process development.

SUCCESS STORY



General sketch of the overarching aim of the project to valorise side-streams in the pulp and paper industry. The bioelectrorefinery includes the electrochemical reduction of aldonic acids to aldoses (gluconic acid to glucose and xylonic acid to xylose) and furfural to furfuryl alcohol (© Photo: Wolfsgruber)

Project coordination (Story)
Robert Putz, PhD
Area Manager
Wood K plus, Linz

T +43 732 2468 – 6770
r.putz@wood-kplus.at

Wood K plus
Kompetenzzentrum Holz GmbH
Altenberger Straße 69
4040 Linz
T +43 732 2468 – 6750
zentrale@wood-kplus.at
www.wood-kplus.at

Project partner

- Lenzing AG, Austria
- Johannes Kepler University Linz, Austria

This success story was provided by the center management and by the mentioned project partners for the purpose of being published on the FFG website. Wood K plus is a COMET Center within the COMET – Competence Center for Excellent Technologies Programme and funded by BMK, BMAW and the provinces of Carinthia, Lower Austria and Upper Austria. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet