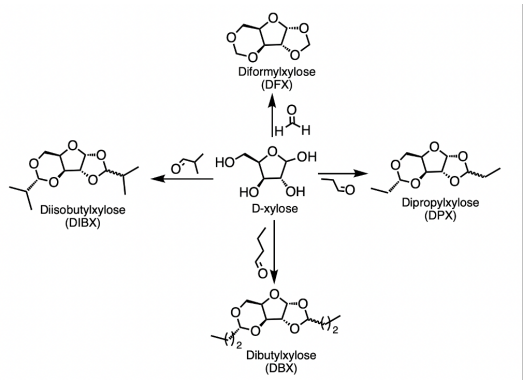
Sustainable Bio-Based Solvents with Acetal Functionalized Carbohydrate Core Produced from Renewable Biomass

A. Komarova[1], J. Luterbacher[1]*

[1]Laboratory of Sustainable and Catalytic Processing, Institute of Chemical Sciences and Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Station 6, 1015 Lausanne, Switzerland.

The manufacturing and disposal of chemicals are among the primary contributors to carbon emissions and environmental pollution. Over 99 % of the most common chemicals are still not produced sustainably. Addressing this challenge requires a collective effort to develop and adopt environmentally friendly and safe chemical processes and products. Biomass plays an important role in this transition since it is the largest source of renewable carbon on Earth. Key to further progress in the industrial implementation of biomass conversion practices is the large-scale production of platform chemicals. We recently discovered Diformylxylose (DFX), a xylose-based platform chemical that can be isolated from lignocellulosic biomass in high yield by a relatively simple process [1]. DFX demonstrated potential as a polar aprotic solvent in model reactions with comparable performance to toxic and environmentally harmful solvents such as NMP, DMAc, and DMF, whose use in industry is currently restricted [2]. In this work, we further expanded DFX application as a solvent for biomass pretreatment, exfoliation of nanoparticles, and as a component of deep eutectic solvents. We also showed the potential of other acetal-functionalized xylose molecules as solvents, namely Dipropylxylose (DPX), Dibutylxylose (DBX), and Diisobutylxylsoe (DIBX) that we isolated from biomass. We demonstrated the application of these solvents in alkylation reactions and in enzymatic polycondensation to produce sustainable polyesters. Notably, we proved that these new ether solvents are not flammable and non-peroxide forming, which are the main concerns over ether solvents in industry.



We performed the pilot-scale production of DFX from pure xylose and from agricultural waste, specifically corn cobs. We also provided insights into the techno-economic viability of DFX production at different scales and scenarios. We conducted a preliminary life-cycle assessment and revealed that production of the acetal-functionalized solvent offers a very low global warming potential as well as minimal environmental impact. Finally, we showed that DFX is inherently biodegradable under aqueous aerobic conditions which facilitates its disposal. Overall, this study provides a practical example of how waste biomass can be sustainably transformed with low cost and high efficacy into valuable platform chemicals that can be applied as solvents.

[1] Talebi A.M., Dick G.R., Questell-Santiago Y.M., Luterbacher J.S., *Nature protocols*, **2019,** 14(3), 921-954.
[2] Komarova A.O., Dick G.R., Luterbacher J.S., *Green Chemistry*, **2021**, 23(13), 4790-4799.