Realization of a low carbon society through game changing technologies

A cost-effective and highly productive process for the production of furan-based monomers aiming for value-added biopolyesters application

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Summary : Furan-2,5-dicarboxylic acid (FDCA) has been widely recognized as a suitable replacement for petroleum-derived terephthalic acid for the production of polyester. For example, FDCA or its methyl ester with bio-based ethylene glycol can be polymerized into poly(ethylene 2,5-furandicarboxylate) (PEF) as a furan analog to fossil fuel-derived PET. Owing to the great potential of FDCA, a number of chemocatalytic strategies have already been reported for the conversion of carbohydrates (glucose or fructose) to FDCA via the formation of (5-(hydroxymethyl)furfural (HMF). However, all reactions have so far been exclusively studied in dilute substrate solutions, which significantly hampers practical FDCA production on an industrial scale. This limitation can be attributed to the highly reactive hydroxymethyl (-CH_2OH) and formyl (-CHO) groups in the intermediate (HMF), which induces complex side reactions. In this project, we develop a step-wise reaction system for FDCA production that involves the conversion of carbohydrates to a stable HMF-derivative, followed by aerobic oxidation using a highly active supported non-precious metal catalyst. The use of highly sophisticated heterogeneous catalysts in all elementary reactions and reactive separation technology will lead to the development of efficient reaction systems at commercially relevant substrate concentrations. The new processes will enable the cost-effective production of FDCA and its esters on an industrial scale, which contributes to popularization of bio-based polyesters.