Synthesis of carbon-based bifunctional Lewis/Brønsted acid catalysts for 5-HMF production from cellobiose

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Lignocellulosic biomass represents a valuable renewable feedstock for the synthesis of numerous green chemicals. Among the possible products that can be obtained from its degradation, 5-hydroxymethylfurfural (5-HMF) is a high added-value platform molecule that can be recovered from its cellulosic component via a three-step reaction promoted by both Brønsted and Lewis acid sites (Figure 1) [1]. In this study, we present a straightforward approach to synthesize efficient bifunctional catalysts by grafting benzyl sulfonic moieties (Brønsted sites) onto a carbon support (SX+ from NORIT, fraction < 50µm) functionalized with aluminosilicate patches (Lewis sites) grown from the precursor di-sec-butoxyaluminoxytriethoxysilane [2]. The resulting bifunctional catalysts (Figure 2) were extensively characterized and their catalytic performance investigated for the upgrading of cellobiose to 5-HMF. Bifunctional catalyst I4@BATEOS/SO_3H, with an average pore size of 45.8 Å and a total acidity of 1.25 mmol g^{-1}, was found to be the best performing material, yielding 37% of 5-HMF out of a 96% conversion of the initial cellobiose feed when tested over 23 h at 423 K in a designed solvent mixture. No significant side products were observed after 23 h, confirming the high selectivity of the catalyst.

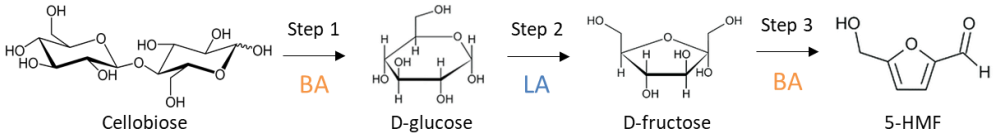

Figure.1 Synthesis of 5-hydroxymethylfurfural from cellobiose.

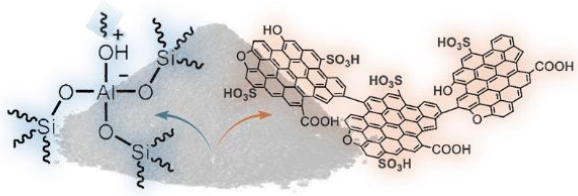

Figure.2 Structure of the bifunctional carbon-based catalysts.

References

[1] Y. Yao, S. Chen, M. Zhang, Front. Chem. 10 (2022), Article 880603.
[2] A. Tonelli et al. ChemCatChem (2025), 17, e202500070