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Mesoporous zirconia-based mixed oxides as versatile acid catalysts for producing bio-additives from furfuryl alcohol and glycerol

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ABSTRACT

Mesostructured zirconium-based mixed oxides (MZM) are versatile solid acid catalysts for the chemical valorisation of biomass, within sugar and fatty acid platforms of biorefineries. MZM catalysts containing tungsten and/or aluminium were prepared via a templating route that allows the texture and acid properties to be improved. Their catalytic potential was explored for synthesising different types of interesting oxygenated fuel bio-additives, specifically levulinate esters, furfuryl alkyl ethers and glycerol acetals of the type 1,3-dioxolane and 1,3-dioxane. Levulinate esters are synthesised from furfuryl alcohol (FA), which is produced industrially from lignocelluloses; the acetals are obtained from glycerol, which is a coproduct of the industrial production of biodiesel. The performances of the MZM catalysts have been compared with those of zirconium–(tungsten and/or aluminium) mixed oxides synthesised via conventional co-precipitation (without a template). Structure–activity relationships were established which reveal advantages of the templating route used for the synthesis of the MZM catalysts. The MZM catalysts were more active and led to higher total yields of bio-additives (e.g. up to 86% yield at 100% FA conversion, 140 °C, 30 min reaction) than the catalysts prepared by co-precipitation (e.g. up to 45% yield at 88% FA conversion), under similar reaction conditions. Detailed catalytic and characterisation studies were carried out for the used catalysts.