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Microwave Carbocatalysis for Biomass Valorization

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Abstract

This talk focuses on carbon-based materials such as graphene, carbon nanotubes, nanodiamonds and hydrochar and their potential applications in addressing issues related to climate change and well-being. We will present our recent work on the development of green approaches such as the use of microwave, H_2O and CO_2 at elevated temperatures and pressures with carbon-based materials for the valorisation of biomass into useful chemicals and fuels. For example, in recent years there has been increasing research into the conversion of biomass to 5-hydroxymethylfurfural (5-HMF), a versatile platform chemical that can be converted to fuels and plastics. In this study, we propose the use of carbocatalysis to convert sugars to produce 5-HMF. Subcritical water, which also readily dissociates into the catalytically active H+ and OH- ions, was used as the reaction medium. Microwaves (MW) were used as the heating source coupled with a carbocatalyst: graphene oxide (GO) or reduced graphene oxide (rGO). GO is a bifunctional catalyst with a graphitic region (MW absorbing, Lewis acidity) and oxygen functionalities (Bronsted acidity). Meanwhile, rGO is a more stable derivative of GO at higher temperatures, but with less oxygen functionalities. Our results show these catalysts to have similar performance in terms of sugar conversion and 5-HMF yield. Localised microwave heating alone can be an effective driving force to produce 5-HMF from the sugar in the proposed system. Future studies will focus on investigating the interaction between the catalysts and the substrates to determine the mechanism. This microwave carbocatalysis approach has also been tested for the conversion of glycerol to fuel additives.

Keywords: Carbocatalysis, Microwave, Graphene, Biomass, Glycerol