Title:	DESIGN AND DEVELOPMENT OF METAL OXIDE CATALYSTS FOR SYNTHESIZING LIQUID FUEL PRECURSORS.
Authors:	Mahala., Sangeeta.
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Abstract:	Day by day, the energy demand is increasing due to population and industrial growth. The currently utilized fossil fuel resources are already in a state of depletion. Furthermore, their continuous usage may severely impact the Earth's ecosystem due to climate change resulting from significant greenhouse gas emissions. Bioderived fuels are being considered as potential substitutes because they are renewable and environmentally friendly. In this context, the thesis addresses the production of liquid fuel precursors, such as fructose and 5-hydroxymethylfurfural (HMF), through a chemical catalysis methodology (heterogeneous) using glucose which can be derived from lignocellulosic biomass, comprising 35% of the total weight. To achieve enhanced product formation, a range of novel metal oxide-based catalysts were developed. For example, sodium niobate was designed by incorporating Na^+ ions into niobium pentoxide, which can offer favourable Lewis basic sites. The heterogeneous salt prepared using 0.25 M NaOH exhibited a dominant $NaNbO_3$ phase and achieved maximum fructose productivity of 35.2% wt. yield and 87.3% selectivity within 7 min under microwave heating conditions in a plain water medium. In another study, ZnO/MgO nanocomposite was designed; the blending of an amphoteric ZnO with MgO can reduce the latter's unfavorable moderate/strong basic sites, which influences the side reactions in the sugar interconversion. An equal ratio mixing of ZnO and MgO attained 20% moderate/strong basic sites reduction in MgO with ~2-2.5 times increased weak basic sites (overall), which is favorable for the reaction. It resulted in 36% fructose yield and 90% selectivity at 90 °C in water/methanol medium after 150 min. Similarly, in the production of HMF, Sn-doped Ta_2O_5 and Ta_2O_5/Nb_2O_5 composite catalysts were prepared. An effective glucose dehydration to HMF can be achieved over both Lewis and Brønsted acidic sites. In this regard, the former catalyst (containing 1% Sn on Ta_2O_5) was able to offer balanced Lewis/Brønsted acidic sites and achieved as high as 57% HMF yield and 80% selectivity under modest reaction conditions in the water-DMSO system. Whereas, the latter catalyst (a mesoporous nanocomposite comprised 25% wt. Nb_2O_5 in Ta_2O_5 and provided both 24% Lewis and 76% Brønsted acid sites with an increased oxygen vacancy) was able to achieve a maximum of 70.1% HMF yield and 77.1% selectivity in a water-DMSO medium (1:4 ratio). Furthermore,the catalytic setups can be represented as sustainable and viable methods based on the catalysts' natural occurrence and abundant availability.
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