INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Glycerol and D-Glucose Valorization to Biorenewable Platform Chemicals by Waste Red Mud Derived Catalysts**

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SHORT ABSTRACT

The growing use of fossil fuels has adversely affected the climate and negatively impacted every aspect of life in the ecosystem. Hence, the energy and chemical industries have periodically pushed through several transitions in technology and raw materials to eliminate the threat of fossil resources. Besides, the accumulation of various wastes in our society has significantly affected the environment, hence demanding effective utilization. Red mud (RM) is such a hugely generated (> 120 million tons/per year) waste from the aluminum industry having high alkalinity (pH 11-13) and few radioactive elements, which makes it an environmental liability. In an effort to utilize RM economically, this research focused on the preparation of various catalysts from RM for the conversion of glycerol (GL) and D-glucose to glycerol carbonate (GC) and 5-hydroxymethylfurfural (5-HMF), respectively. RM sample calcined at 500 ^{o}C (RM-500) produced the highest GL conversion of 95.2% and GC yield of 92.0%. The potassium (K) doped RM catalyst calcined at 800 ^{o}C (RK-30%-800) produced an enhanced activity (93.25%) and stability than the other RM-based catalysts. The better activity and stability of the catalyst were attributed to the maximum surface concentration of active K_2O. The AS-13-H catalyst obtained by doping Sn followed by functionalization of sulfate groups on acid (HCl) treated RM (ARM) showed improved Lewis and Bronsted acid characteristics than RM. The catalyst produced a 5-HMF yield of 53.8% at 180 ^{o}C and 5 min from D-Glucose with water/DMSO (1/1 weight) as the solvent under microwave irradiation. The AD-1:1/SO_3H catalyst produced by the acid (HCl) treatment, carbon coating, and SO_3H grafting on RM exhibited enhanced surface area, mesoporous characteristics, and suitable Lewis and Bronsted acid sites. Different active phases such as $Fe_2(SO_4)_3$, Fe_2O_3, and various carbon functionalities were observed in the AD-1:1/SO_3H catalyst. Under microwave heating at 180 ^{o}C, 30 min, and 90:10 DMSO/water weight percentage ratio, the catalyst produced a 5-HMF yield of 51.5%. Both AS-13-H and AD-1:1/SO_3H produced appreciable stability up to the 4th use. GC and 5-HMF have important industrial applications in polymers, pharmaceuticals, etc. All the catalysts being developed from an inexpensive and abundant industrial by-product have economic advantages over the other synthetic metal-based catalysts. It suggested the potential of these RM-based catalysts for future application in the large-scale synthesis of GC and 5-HMF. The utilization of such a hugely generated waste decreases its adverse environmental effect and helps enable the circular economy.