In Situ Sythesis of Trimeric Ruthenium Cluster-Encapsulated ZIF-11 and Its Carbon Derivatives for Simultaneous Conversion of Glycerol and CO_2

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The development of stable and high-performance heterogeneous catalyst is required to obtained value-added lactate (LA) and formate (FA) from the simultaneous conversion of glycerol and carbonate. For this purpose, here we prepared Ru nanoparticles (NPs) supported on 3D nanoporous carbon (Ru/NCT, T = pyolysis temperature). The Ru/NCTs were prepared by in situ encapsulation of trimeric ruthenium cluster in ZIF-11 pores, followed by pyrolysis. The pyrolysis temperature affected the size and crystallinity of Ru NPs and textural properties of ZIF-11-derived carbon. Optimization of the reaction parameters such as CO_2 source, reaction temperature, time and glycerol/carbonate concentration resulted in Ru/NCT with significantly high turnover number (TON) and space-time yield (STY) for the products (LA and FA). Moreover, Ru/NCTs were stable after three consecutive recycle tests at harsh reaction condition without leaching of Ru and structural damage. The correlation of the reaction performance and detailed characterizations revealed that high crystallinity and large particle size of Ru exhibit superior activity for the combined dehydrogenation-hydrogenation to yield the desired products.