Facile synthesis of nanosized La/ZrO_2 catalysts for ketonization of free fatty acid and biomass feedstocks

ABSTRACT

Various synthesis methods such as deep-deposition-ultrasonication (DPU), co-precipitation-ultrasonication (CPU), deposition-precipitation (DP), co-precipitation (CP) and wet-impregnation (IMP) have been reported for the preparation of lanthanum-modified zirconia (La/ZrO_2) catalysts. The acoustic cavitational effect by the DPU method decreased the particles size and enlarged the pores of the La/ZrO_2 catalysts. Besides, the La ions well-interacted with the ZrO_2 in each catalyst, thus, all the La/ZrO_2 catalysts have a great potential to be employed in ketonization reaction. It had found that both DP and DPU methods exhibited smaller catalyst particles than that of the CP, CPU and IMP methods, in which 15 - 20 nm for the La/ZrO_2-DPU and 28 - 56 nm for the La/ZrO_2-DP. Even though the ultrasonication helped to reduce the particle size notably, adversely the small particles tend to aggregated . Meanwhile, larger nanoparticles can be prevented particle aggregation leading to higher dispersion for the La/ZrO_2-DP as compared to the La/ZrO_2-DPU. All the catalysts were tested in ketonization of palmitic and lauric acids, showing the La/ZrO_2-DP exhibited the best catalyst with free fatty acid (FFA) conversion ~80% and 51% of ketone selectivity. In addition, the 10 wt.% of La dosage gave the optimum concentration for the maximum ketonization activity. The La/ZrO_2-DP catalyst also promising for the ketonization of real feedstocks such as palm kernel oil (PKO) and palm fatty acid distillate (PFAD) into their ketone species.