Hybrid CaO/Al2O3 aerogel as heterogeneous catalyst for biodiesel production

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We report a new hybrid CaO/Al2O3 aerogel and its application as a heterogeneous catalyst for the production of biodiesel. These catalysts were successfully prepared for the first time via the rapid epoxide-initiated sol-gel process and dried under supercritical carbon dioxide conditions. The catalytic activity has been investigated under various conditions for the transesterification reaction of a waste cooking oil in the presence of methanol. The catalysts were characterized by FTIR spectroscopy, nitrogen adsorption-desorption technique, scanning electron microscopy, and powder X-Ray diffraction. The calcined aerogels at low CaO content were not as affected by calcination at 700 °C as their corresponding calcined alcogels and they revealed distinct structures, porosities, surface areas, and morphologies. The 3:1 CaO/Al2O3 calcined aerogel showed the best catalytic activity using the minimum amount of catalyst to produce high biodiesel yield and conversion with no soap formation. The effect on biodiesel production of calcium-to-aluminum molar ratio, catalyst loading, methanol-to-oil molar ratio, and reaction time was investigated. At optimal conditions, a maximum biodiesel yield (89.9%) with high purity (98.0%) was achieved and the transesterification reaction was found to follow pseudo-first-order kinetics. The optimal conditions are 1 wt% 3:1 CaO/Al2O3 calcined aerogel for reactions performed at 65 °C over 4 h using a methanol-to-oil molar ratio equal to 11:1.