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Cu-SiO_2 catalysts made by AASG method as promising materials for ethanol non oxidative dehydrogenation

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Recently, in a move towards more sustainable chemical processes, the interest in using biomass as carbon source to produce chemicals has been reinforced. Among these, ethanol produced by fermentation of lignocellulosic biomass is expected to become a primary platform chemical [1]. One of the most important secondary intermediates that can be obtained from bioethanol is acetaldehyde, that allows producing several other important industrial chemicals [2]. Acetaldehyde can be produced by non-oxidative dehydrogenation of (bio)ethanol. For this reaction, copper-based formulations such as Cu-ZnO-Al_2O_3, Cu-ZnO, Cu-$MgAl_2O_4$, Cu-SiO_2, Cu-Al_2O_3 have been widely studied in literature [3-5].

These studies show a strong impact of the preparation procedure on the catalyst performance. In particular, it is crucial to control precisely the active site speciation and catalyst texture [6]. This prompted us to study the potential of the aerosol-assisted sol-gel process for the preparation of efficient ethanol dehydrogenation catalysts. Aerosol processes are currently emerging as promising synthetic routes to synthesize efficient supported catalysts controlling active site dispersion and porosity [7]. Based on the atomization and fast drying of a precursor's solution or suspension, this bottom-up technique allows the one-step and continuous production of tailored nanomaterials. In fact, the rapid drying of the droplets allows forming solids in metastable states, including highly homogeneous metallo-silicates, which are of wide interest in the field of heterogeneous catalysis. Interestingly, to the best of our knowledge no one still used this process to synthesize active catalysts in ethanol non oxidative dehydrogenation.

Thus, the present work aims at exploiting Aerosol Assisted Sol Gel process (AASG) to prepare Cu-SiO_2 catalysts for (bio)ethanol dehydrogenation, comparing their catalytic performances with conventional impregnated catalyst over SiO_2 support. In particular, the effect of the Cu loading and of synthetic procedure on the catalyst performances were investigated and a deep characterization of fresh and used catalysts were carried out. These catalysts show better catalytic performances, up to 76% acetaldehyde yield with selectivity higher than 95%, respect to the impregnated ones, with higher dispersion of the active phase and more resistance to Cu coalescence.

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