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Electrospun CuO/ZnO/ZrO_2-ZSM-5 fibrillar bifunctional catalysts for the direct DME synthesis

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Abstract
Dimethyl ether (DME) is receiving a great attention as a potential renewable substitute for petroleum derivative due to the possibility of producing it using synthesis gas coming from biomass gasification and its environmentally benign fuel properties [1]. The prospects for the development of a DME economy are related to the implementation of the direct synthesis of DME. In this process, synthesis gas is fed to a reactor containing a bifunctional catalyst, where both methanol synthesis (on the Cu-based sites of the bifunctional catalyst) and methanol dehydration (on the acid sites of the catalyst) take place.

In this work, we present a simple and straightforward method for the preparation of CuO/ZnO/ZrO_2-ZSM-5 fibrillar bifunctional catalysts, by using the electrospinning technique. The prepared fibers presented a high aspect ratio and a mean size of 1.7 μm. Zeolite aggregates, with a mean size of 300 nm, are also attached to the surface of the CuO/ZnO/ZrO_2 fibers. A fairly good dispersion was observed for these particle aggregates along the surface of the fibers, highlighting an enhanced contact between the two phases involved in the syngas-to-DME process (see Fig. 1).

The fibrillar structured bifunctional materials were directly used as catalysts in a fixed-bed reactor for the direct synthesis of DME from syngas. The catalytic results showed high CO conversion values and a selectivity to DME higher than 63 % (95 % when considering only the products in the organic phase). It is also worth mentioning that the fibrillar catalysts made use of the submicrometric effective dimension of the two active phases (radius of the fibers < 1 μm, size of zeolite aggregates < 300 nm), in terms of intraparticle mass and heat transfer, avoiding, at the same time, the problems related to pressure drops of fixed-bed reactors working with such a reduced particle size.

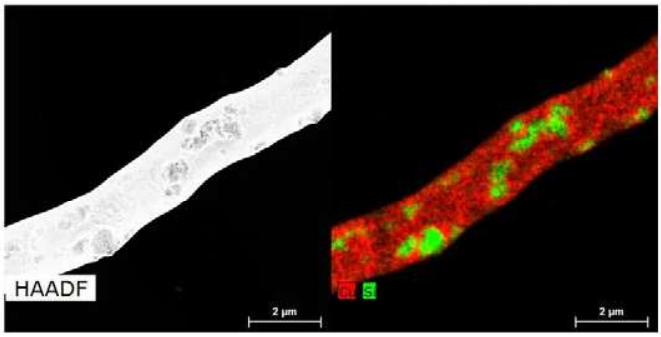

Fig. 1. HAADF-STEM image, and Cu (red) and Si (green) EDXA elemental mappings composite of the bifunctional fibers.

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References
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