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New Trends for Preparing Mesoporous Catalysts to Produce Green Fuel

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DEDICATION

I dedicate my dissertation work to my family. A special feeling of gratitude to my loving father, my mother, sisters and brothers.

I also dedicate this dissertation to my husband Mohamed for continuous support, encouragement and generous help throughout the progress of this study.

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Abstract

The present study was undertaken to synthesize new composite systems consisted of F_2O_3 NPs (5 wt %) loaded on neat SBA-15, Al-modified SBA-15 and Zr-modified SBA-15 supports. The loading process was displayed by adopting microwave-assisted or ultrasonic-assisted routes. Various modification techniques of SBA-15, characterized by its well-ordered hexagonal arrays of mesoporoes, with 25 wt % of Al or Zr (the confirmed optimum ratio) included the following methods: impregnation post synthesis (Al or Zr-S (Imp)), ultrasonic post synthesis (Al or Zr-S(Us)) and in situ direct synthesis (Al or Zr-S(Inst)). The as-synthesized catalytic systems were characterized adopting several techniques, viz., N_2 adsorption–desorption, XRF, XRD, TGA–DSC, FT-IR, TEM, EDX, H_2-TPR and NH_3-TPD. All the synthesized catalyst samples were examined in three different applications, namely, catalytic conversion of ethanol and methanol as two model compounds using micro pulse and continueous flow systems. In addition, the photocatalytic water splitting reaction was applied for hydrogen generation/storage under visible light irradiation. The results revealed that the applied modifications of the mother SBA-15, after incorporation of Al or Zr led to marked increase in the surface parameters as well as the acidity referred mainly to the presence of the favourable moderate Brönsted acid sites. The obtained results showed that all the studied catalytic systems are rather suitable for H_2 storage with maximum capacity. This was interpreted in view of the fitting modifications in the pore system and the whole structure profile of

the catalyst samples used. The catalytic systems synthesized through ultrasonic-assisted route showed more prevailing behavior in the photo-catalytic splitting process. Moreover, these catalysts exhibited the highest activity towards ethylene production, with a distinct increase in their yield and selectivity compared with those samples prepared by microwave assisted technique. Such behaviour was referred to the higher surface area, the change in the pore geometry (bimodal PSD) and the good dispersion mode beside the improvement in the whole texture properties. On the other hand, the yield and the selectivity of dimethyl ether over Fe(M)/Zr-S(Imp) were higher than those of Fe(Us)/Zr-S(Imp) to be 100 and 84.80% at 200^{o} C, respectively. From the formetioned results obtained in this study, it could be suggested that the as-synthesized nanocomposites are promising candidates for green fuel production, in terms of H_2 storage materials through water splitting under visible light irradiation, methanol dehydration into dimethyl ether as alternative fuel, as well as ethanol dehydration into ethylene as a starting material for petrochemical industries.

Keywords: Fe/Al-SBA-15, Fe/Zr-SBA-15, Microwave and Ultrasonic assited synthesis routes, H_2-Storage, Water Splitting, Ethanol and methanol conversions.

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