

Dehydration of glucose to 5-hydroxymethylfurfural using zirconium doped mesoporous silica as catalyst

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In recent years, the valorization of carbohydrates coming from lignocellulosic biomass, such as glucose, is gaining attention to obtain high value-added products like 5-hydroxymethylfurfural (HMF) [1]. The objective of this work was the dehydration of glucose to HMF by using different mesoporous silica doped with Zr (Zr-KIT-6, Zr-MCM-41, Zr-SBA-15, Zr-SBA-15 (HT) y Zr-HMS) as acid catalysts to maximize the HMF yield, and the study of the influence of textural and acid properties.

The mesoporous silicas were synthesized with the same Si/Zr molar ratio= 5. The glucose dehydration was carried out at 150°C and 175°C under magnetic stirring. A biphasic reaction system (water:methylisobutylketone (MIBK)) was used in order to avoid side reactions [2]. It was found that the addition of CaCl₂ to the aqueous phase enhanced the HMF yield, as previously reported for other solid acid catalysts [3]. The reaction products were analyzed by HPLC. High glucose conversion is achieved for all the catalysts at 175°C, but maximum values were obtained with the Zr-HMS catalyst (Fig. 1a). However, the HMF yield begins to decrease after the maximum value is attained due to side reactions. Despite this fact, high HMF yields were observed in all cases, but it should be noted that the HMF yield with Zr-HMS is higher at shorter reaction times, in comparison with the other catalysts. For this reason, the catalytic performance of Zr-HMS was studied at 150°C, in such a way that similar values of HMF yield than those obtained at 175°C can be reached, but at longer reaction time (Fig.1b). The optimization of different experimental variables has been performed, and structure-activity-stability relationships were proposed after the characterization of fresh and spent catalysts.

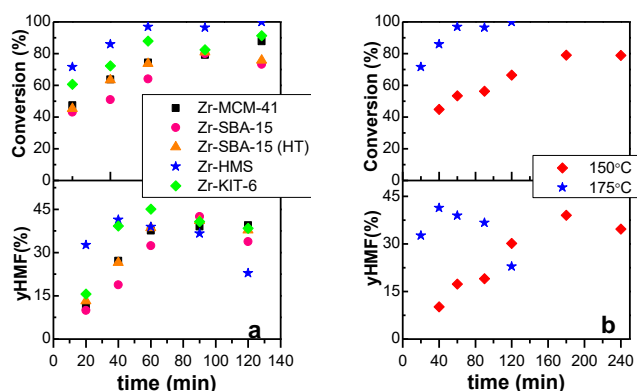


Figure 1. a) Influence of reaction time on the glucose dehydration using different Zr doped mesoporous silicas as catalysts, b) Catalytic behavior of Zr-HMS at 150°C and 175°C.

References

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