Advanced Characterization of HZSM-5/Al2O3 Extrudates after Catalytic Fast Pyrolysis

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Production of renewable aromatics from lignocellulosic biomass is possible via Catalytic Fast Pyrolysis (CFP) using acidic zeolite catalysts. ZSM-5-based catalysts are the most widely reported catalyst for CFP of biomass, but little is known about the actual catalytic activity and deactivation processes that they undergo during reaction. In addition, upscaling requires shaping of the catalyst with a binder and little has been reported on the performance of extrudates in CFP. Here, we have studied a HZSM-5/Al2O3 extrudate before and after CFP of biomass and cellulose with a combination of spectroscopy, microscopy and textural techniques to investigate coking and regeneration of such composites. Distribution of zeolite-binder domains of the extrudates was visualized by means of SEM-EDX and Confocal Fluorescence Microscopy (CFM), showing homogeneous mixing of the zeolite and binder after extrusion. Notably, the acidity and structural integrity of the regenerated catalysts was found to be almost restored, even though regeneration required large amounts of coke (24 wt. %) to be removed after a cycle of 180 min time-on-stream (TOS). CFM and EPR analyses revealed accumulation, nature and distribution of bulky carbon species trapped within the spent composites as function of TOS. The knowledge gained can contribute to improvements in solid catalyst life-time for this important process.


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