Studies of Zeolite-based Catalysts for Upcycling of Polymer Waste by use of Positron Annihilation Spectroscopies

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Most efforts in plastic upcycling have focused on polyolefins justified by their high volume. But other high-volume polymers such as polyols and polyurethanes—those incorporating oxygen, exemplified by polyether polyols building blocks—are essential targets too. Polyols are overlooked plastics, ZSM-5 has been shown to selectively convert polyols into propionaldehyde with a selectivity of up to 90% [1].

In this study we utilize PAL to provide in depth information about catalysts nano- and meso-porous structure-changes during the conversion process. Three different catalytic materials were used: "ZSM-5 pure", "ZSM-5 reacted with polyurethane" and "ZSM-5 reacted with polypropylene glycol". A catalytic process was conducted in a fluidized bed reactor with a catalyst comprised of a zeolite with modifiers and metals at the University of South Carolina [2]. The recovered catalysts were pelletized and measured by use of TechnoAP spectrometer in short/long timing ranges [3], analyzed by Kansy program [4].

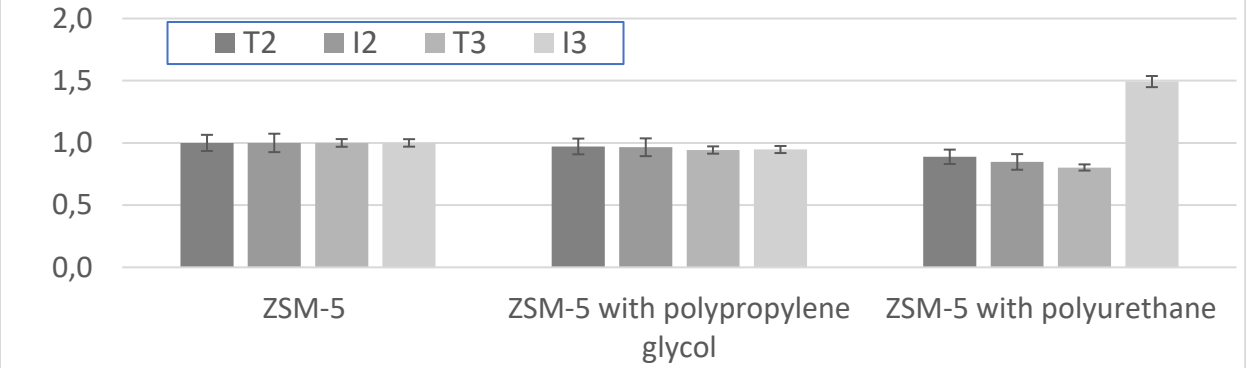

Fig. 1. PAL Average Values for normalized to ZSM-5, with 95% Confidence

Reaction with polyurethane introduced significant change, while the reaction with polypropylene does not show a significant alteration in the range of error, Fig (1). The most change is in the meso-porous region expressed by T_3 and I_3. This may be related to the blockage of the pores' connectivity by coke or a collapse of the internal meso-porous structure [5]. The lack of significant alteration in polypropylene is encouraging since it suggests that this reaction does not lead to a strong modification in catalyst's internal structure or coke buildup. We work on optimizing working conditions to achieve the highest possible selectivity as a function of reaction temperature, catalyst to polyol ratio and also steam percentage.

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[4] J. Kansy, *Nucl. Instrum. Methods Phys. Res.*, Sect. A. **374**, 235–244, (1996)
[5] C.N. Taylor C.N., J. Urban-Klaehn, T. T. Le, R. Zaleski, J.D. Rimer, and K.L. Gering, "Catalyst Deactivation Probed by Positron Annihilation Spectroscopy", to be published.