Improved Catalysts for the Heavy Oil Upgrading Based on Zeolite Y Nanoparticles Encapsulated in Stable Nanoporous Host

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ABSTRACT

The focus of this project is to improve the catalytic performance of zeolite Y for petroleum hydrocracking by synthesizing nanoparticles of the zeolite (~20-25 nm) inside the nanoporous silicate or aluminosilicate hosts such as SBA-15. The encapsulated zeolite nanoparticles will have reduced diffusional path length, hence hydrocarbon substrates will diffuse in, are converted and the products quickly diffused out. This prevents over-reaction from occurring and the blocking of the zeolite pores and active sites are minimized. The nanoporous hosts also serves to: a) perform as a mild hydyrocracking catalyst in their own right, to do the initial breaking down of bulky heavy oil substrates and b) screen bulky hydrocarbon substrates from blocking the entrance to the zeolite pores, and reduce the extent of non selective, undesirable reactions on the external surfaces of the zeolite nanocrystals.

The project consists of six major tasks as follows: a) synthesis of the 30 nm pore diameter nanoporous materials. This will be done using poly (alkylene oxide) copolymers as template around which inorganic precursors are organized. Subsequently removal of the copolymer will yield a nanoporous material, the pore sizes of which will depend on the number of poly (alkylene oxide) units; b) synthesis of the nanoparticles of zeolite Y (of various chemical compositions) within the pores of the nanohosts using various techniques such subjecting a conventional zeolite Y synthesis mixture to temperatures below <5°C, high speed and/or, ultrasonic agitation and crystal growth suppression controlled by the pore size of the nanohosts. (c) further increase in the thermal stability and acid strength of the encapsulated zeolite Y by dealumination.

Preliminary results to date show that all-silica and aluminosilicates mesoporous materials of different chemical compositions and quality were synthesized over a wide range of synthesis variables such as temperature, Si/Al ratio, pH, and surfactant polymer concentrations. Nitrogen porosimetry of selected calcined samples showed various absorption isotherms with some samples showing type IV with a large step in at relative pressure, P/Po at approximately 0.25 from capillary condensation with the mesopores. Surface areas of the samples varied and maximized at approximately 1000 m^2/g, which is typically reported for materials of this type.

List of Published Journal Articles, Completed Presentations and Students Receiving Support from the Grant

Publications

None

Conference Presentations

None

Names of Students Receiving Support

Yohannes Ghirmazion	First year graduate student (Chemistry)
Ifedapo Adeniyi	Sophomore undergraduate (Chemistry & Engineering)