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Pt-promoted HY@KCC-1 as a highly selective catalyst for hydroisomerization of *n*-dodecane with enhanced mass transfer limitation.

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EXTENDED ABSTRACT

A unique core-shell fibrous silica zeolite HY (HY@KCC-1) catalyst with high surface area of 568 m²/g was successfully synthesized via a facile silica solvothermal procedure coupled with zeolite crystal-seed crystallization, and subsequently investigated for *n*-dodecane hydroisomerization. Field Emission Scanning Microscope (FESEM) combined with X-ray Diffraction (XRD) revealed the fibrous silica growth. Probing of the Brønsted (BAS) and Lewis (LAS) acid sites with 2,6-dimethylpyridine (2,6-DMP) via Fourier Transform Infrared Spectroscopy (FT-IR) revealed that Pt/HY@KCC-1 had abundant strong acid sites with improved accessibility relative to unmodified Pt/HY catalyst. The Pt/HY@KCC-1 has displayed complete *n*-dodecane conversion coupled with an incredibly enhanced isomer yield of 72 % at 350 °C, nearly two-fold higher than unmodified Pt/HY catalyst. Additionally, the unique morphology and increased mesopores on Pt/HY@KCC-1 led to the superb catalytic activity via enhanced acid site accessibility by bulky *n*-dodecane reactant molecules and easy desorption of product isomers prior to being cracked. Remarkably, Pt/HY@KCC-1 had an internal effectiveness factor (η) of unity, thus suggesting its potential application in hydroisomerization of higher hydrocarbons for enhancing fuel properties.

Figure 1a shows the FESEM image of the synthesized fibrous silica HY (HY@KCC-1) catalyst. Obviously, the HY@KCC-1 formed as uniformly sized spherical balls, with the HY zeolite seed located in the core of the structure. Interestingly, large pores of varying sizes can be seen from the external morphological surface of the catalyst. These played vital role in enhancement of the diffusion limitation suffered by parent HY zeolite during the *n*-dodecane hydroisomerization reactions. As depicted on Table 1, the N₂-adsorption showed that the mesoporosity has tripled upon the silica modification, and probing of the Brønsted (BAS) and Lewis acid (LAS) sites with 2, 6-dimethylpyridine revealed that more sites became accessible in the Pt/HY@KCC-1 relative to the unmodified Pt/HY. Consequently, Pt/HY@KCC-1 displayed superb *n*-dodecane hydroisomerization performance, nearly two-fold isomer yield relative to unmodified Pt/HY as depicted on Figure 1b.

Additionally, evaluation of the mass transfer parameters at 350 oC revealed that the Pt/HY@KCC-1 had improved effective diffusivity, nearly three-fold as depicted in Table 1. Notably, the catalyst also had internal effectiveness factor (η) of unity and a Weisz-Prater Criterion (C_{wp}) of far less than unity, suggesting the absence of internal diffusion limitation relative to the unmodified Pt/HY catalyst. Thus, the Pt/HY@KCC-1 catalyst holds great potential application in hydroisomerization of higher hydrocarbons for enhancing fuel properties.

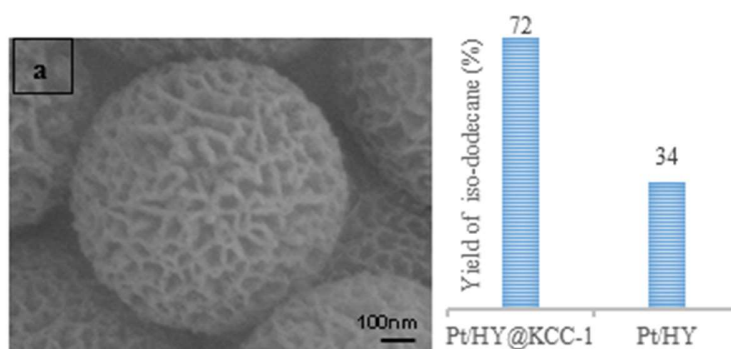


Figure 1: (a) FESEM image of synthesized HY@KCC-1 catalysts (b) n-dodecane hydroisomerization performance for Pt/HY@KCC-1 and Pt/HY at 350 oC.

Table 1: Properties of catalysts and mass transfer parameters

Catalysts	N ₂ adsorption		Acid functionality ($\mu\text{mol/g}$) ^c		Mass transfer parameters		
	S _{BET} ^a (m ² /g.cat)	Mesopore Volume ^b (cm ³ /g.cat.)	BAS	LAS	Effective diffusivity m ² /s (D_{eff})	Internal effectiveness factor (η)	Weisz-Prater Criterion(C_{wp})
HY	473	0.2439	36	12	-	-	-
Pt/HY	468	0.2435	43	16	3.28×10^{-11}	0.84	2.6
HY@KCC-1	568	0.6798	13	27	-	-	-
Pt/HY@KCC-1	578	0.6531	19	51	8.39×10^{-11}	1.00	8.9×10^{-2}

Keywords: Hydroisomerization; *n*-dodecane; hydrocracking; mesopores; fibrous silica zeolite.

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