Supporting Information

Enhanced light aromatics yield from lignite pyrolysis by remedying the acid sites of different hierarchical HZSM-5

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Catalytic pyrolysis

A drop tube reactor was used, which consists of a gas feed system, an electric furnace, temperature control system and a condenser unit.[1] Approximately 2.0 g of SL was fed to a drop tube reactor (ID 2.2 cm, height 36 cm) at a rate of 0.1 g/min. 3.0 g catalyst was placed on the quartz baffle and located in the hot reactor zone. Quartz wool was used to separate pyrolysis char and spent catalysts. The vapors from lignite pyrolysis was transferred to the catalyst bed directly and then passed through the catalyst bed under Ar atmosphere. The volumetric flow in the whole heating time was controled at 120 mL/min to ensure the residence time of 1.0 s. After the tube reactor cooling to room temperature, the spent catalyst and pyrolysis char were separated and weighed for calculating the coke yield and material balance. The BTEXN content in liquid was quantitatively analyzed by a gas chromatograph. Besides, the non-condensable gases were gathered with a gas bag and detected by another gas chromatograph. After the experiment, material balance method was applied to verify the accuracy of the experiments including char, gas, coke and tar.

Process of instrument test system

The gases were analyzed with a Shimadzu GC-2014 gas chromatograph equipped with two detectors, a thermal conductivity detector (TCD) and a flame ionization detector (FID. External standards were employed for the quantitative analysis of main gases species and BTEXN.

The catalyst was measured by a Glod APP V-Sorb 4800TP N_2 adsorption-desorption instrument at 77 K. The catalysts were outgassed about 7 h at 300 °C under vacum before measurement. Surface area and pore size were calculated by BET equation and BJH method, respectively. The contents of Al and Si in $AT_{0.2}$/H5 were determined by Optima 8300 inductively coupled plasma optical emission spectroscopy (ICP-OES). The crystal morphology of the catalyst was measured using a Zeiss Merlin field-emission scanning electron microscope. X-ray diffraction (XRD) patterns of zeolites were collected on Bruker D8 ADVANCE X-ray diffractometer using Cu-Kα radiation at 40 kV and 30 mA. The 2θ angel range was scanned from 3 ^{o} to 90 ^{o} at a step size of 4 ^{o}/min. NH_3-TPD curve was obtained on a Quantachrome ChemBET Pulsar TPD installation to characterize the acid distribution of zeolites. A TCD detector was used to continuously record the concentration of ammonia removal during the heating process.

The coke deposition on spent zeolites were measured using a Mettler-Toledo TGA/DSC1 analyzer with a heating rate of 10 °C/min from 30 to 800 ^{o}C under air flow.

Characterization of HZSM-5

Table S1 Physical properties of parent HZSM-5.[2]

Catalyst	S_{BET} (m^2/g)[a]	S_{ext} (m^2/g)	S_{micro} (m^2/g)	V_{pore} (cm^3/g)	V_{ext} (cm^3/g)	V_{micro} (cm^3/g)	D_{pore} (nm)
H5	326	123.5	202.5	0.36	0.30	0.065	3.95

Table S2 Acidity amount of parent HZSM-5 by NH_3-TPD.[2]

Catalyst	Weak acid amount (mmol/g)	Medium acid amount (mmol/g)	Strong acid amount (mmol/g)	Total acidity (mmol/g)
H5	0.66	0.21	0	0.87

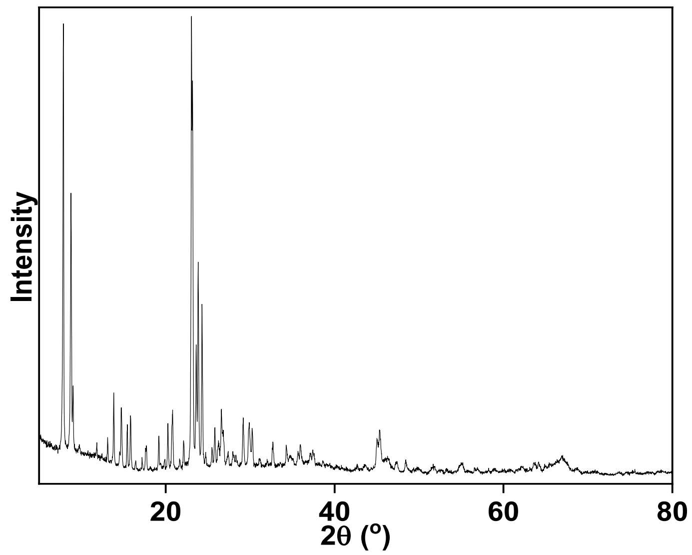

Fig. S1 XRD pattern of HZSM-5.[2]

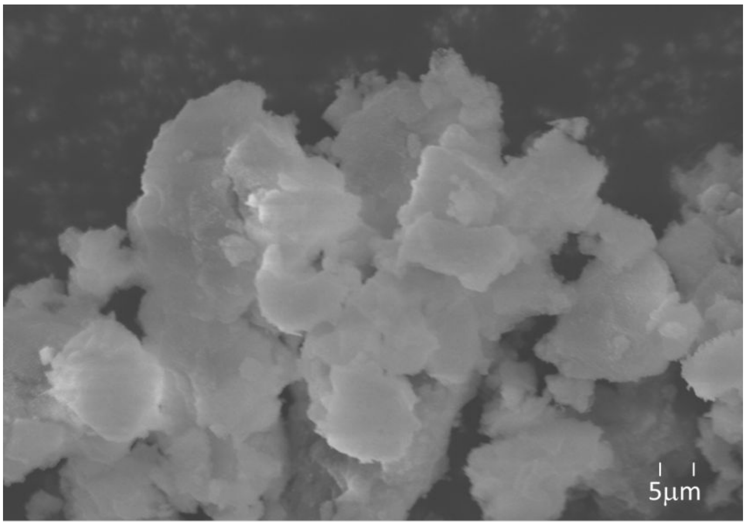

Fig. S2 SEM image of HZSM-5.[2]

(1) Cao, J. P.; Li, L.Y.; Morishita, K.; Xiao, X.B.; Zhao, X.Y.; Wei, X.Y.; Takarada, T. *Fuel* **2013**, 104, 1–6.

(2) Yang, Z.; Cao, J. P.; Ren, X. Y.; Zhao, X. Y.; Liu, S. N.; Guo, Z. X.; Shen, W. Z.; Bai, J.; Wei X.Y. *Fuel* **2019**, 237, 1079-1085.