Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

Supplementary information

Experimental Section

Synthesis of zeolite beta samples.

Fumed silica (Aerosil®90, 90 m^2/g, Evonik Industries), Aluminum sulfate ($Al_2(SO_4)_3 \cdot 18H_2O$, Shanghai Feida Chemical Company, China), NaOH (Shanghai Feida Chemical Company, China), tetraethylammonium hydroxide (25% aqueous solution, Yixing Dahua Chemical Company, China) were used as raw materials for the synthesis of zeolite beta. A series of samples (denoted as xT-yS-$^oC/h$, where x, y, ^oC, h are TSR, seed/SiO_2 ratio (wt.%) of their parent gel, crystallization temperature and time) were prepared by steam-assisted conversion (SAC) method. The standard gel molar ratios were $1.0SiO_2$:$0.023Al_2O_3$:(0.52-w)NaOH:wTEAOH:$9.4H_2O$. The crystallization was carried out as the following procedure, serving as a typical example for molar ratio of $1.0SiO_2$:$0.023Al_2O_3$:0.42NaOH:0.1TEAOH:$9.4H_2O$ and 0.1% zeolite beta seeds (seeds/SiO_2 mass ratio) at 140 °C for 28 h: (1) 1.53 g of $Al_2(SO_4)_3 \cdot 18H_2O$ and 1.68 g of NaOH were dissolved in 12.46 mL of H_2O, followed by addition of 5.89 g of TEAOH solution (25%). (2) 0.006 g of zeolite beta seeds supplied from Sinopec Catalyst Co. (China) were introduced in the solution and stirred for 10 min. (3) 6 g of fumed silica was added in the solution, which was stirred tempestuously for 15 min to form heterogeneous gel mixture. (4) The gel mixture was heated to complete dryness at 60 °C for about 24 h, which was coarsely crushed to obtain the seeded and templated dry gel denoted as 0.1T-0.1S. (5) 3.0 g of 0.1T-0.1S dry gels were transferred into a 3 mL Teflon cup, which itself was placed into a 45 mL stainless steel autoclave with 0.75 mL water in the bottom, and then the autoclave was sealed and transferred into a preheated oven at the desired reaction temperature of 140 °C and heated for 28 h ($^oC/h$ for 140/28). (6) After centrifugation at 10,000 rpm for 15 min at room temperature and dried at 60 °C for 24 h, the crystalline product of 0.1T-0.1S-140/28 was achieved. The as-synthesized samples were ion-exchanged in 1.0 mol/L NH_4NO_3 solution for 6 h at room temperature, after dryness, the samples were calcined in air flow (100 mL/min) in a tubular furnace at 550^{o}C for 5 h, and then the corresponding H-type zeolite beta samples were obtained for catalytic tests of low-density polyethylene (LDPE) cracking.

Methods of Characterization.

X-ray diffraction (XRD) data were collected on a Persee XD-2 diffractometer in a scanning range of 5-45 °(2θ) at a rate of 8 °(2θ)/min with Cu K_{α} radiation, 40 kV/30 mA. Nitrogen isotherms were measured using a Micromeritics ASAP 2010M system. The samples were degassed at 350 ^{o}C for 3 h before measurement. The size and morphology of samples were observed on a Philips XL30 SEM with accelerating voltage of 20 kV. TEM images were taken on a Jeol JEM-2010 TEM instrument with accelerating voltage of 200 kV to investigate the fine structure, morphology and crystal size. The thermal analysis was performed on a TA-Q600 thermal analyzer. Each sample of 10-15 mg was used for measurement. The temperature rises to 800 ^{o}C from room temperature at a rate of 10 ^{o}C/min in air flow of 100 mL/min.

Catalytic activity measurement.

The LDPE cracking behaviors of the catalysts were evaluated in TG analyzer with programmed temperature. The LDPE used in this work was provided by Alfa Aesar (Stock #42607) with shape of powder (≤400 μm), density of 0.92 g/mL, and melting point of 117 ^{o}C measured by differential thermal analysis (DTA). The catalysts were first mixed with LDPE powder at room temperature with catalyst/LDPE weight ratio of 1/10. Then, the mixture was put into the corundum crucible of the TG analyzer (HTC-1/2, Beijing Henven Scientific Instrument Factory) and was pre-swept to remove the air in the oven with nitrogen at the flow rate of 50 mL/min. The temperature-programmed catalytic tests were carried out in the TG analyzer from 30 to 600 ^{o}C with a ramp rate of 10 ^{o}C/min in N_2 flow (50 mL/min). The conversion of LDPE was recorded by the weight loss percent during the reaction process.

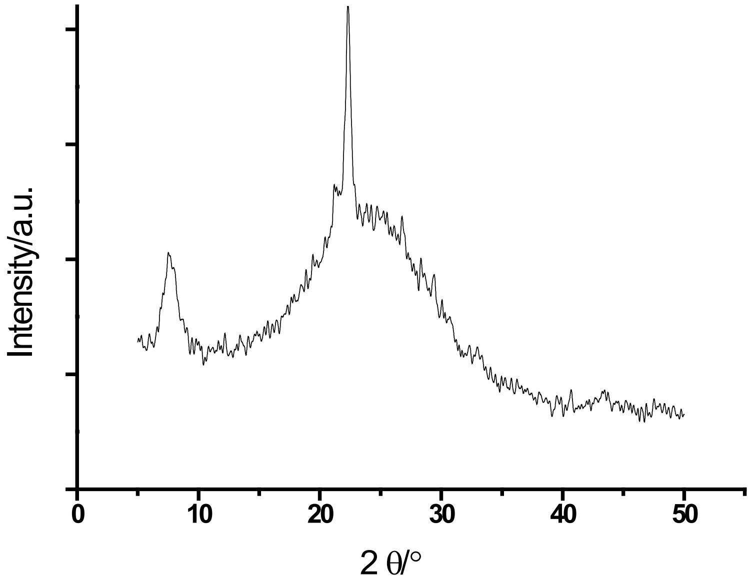


Fig. S1 XRD pattern of zeolite beta synthesized by conventional hydrothermal method (TEAOH/SiO_2 = 0.1, 10% zeolite beta seeds, at 140 °C for 28 h).

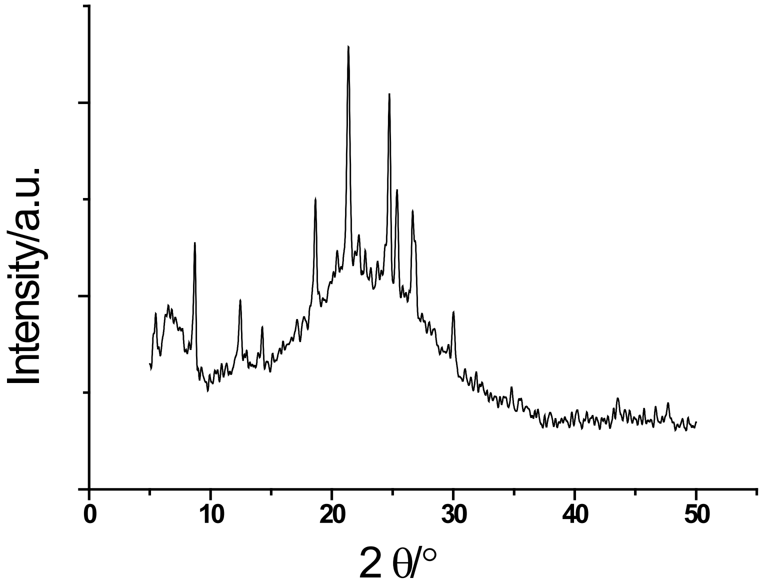
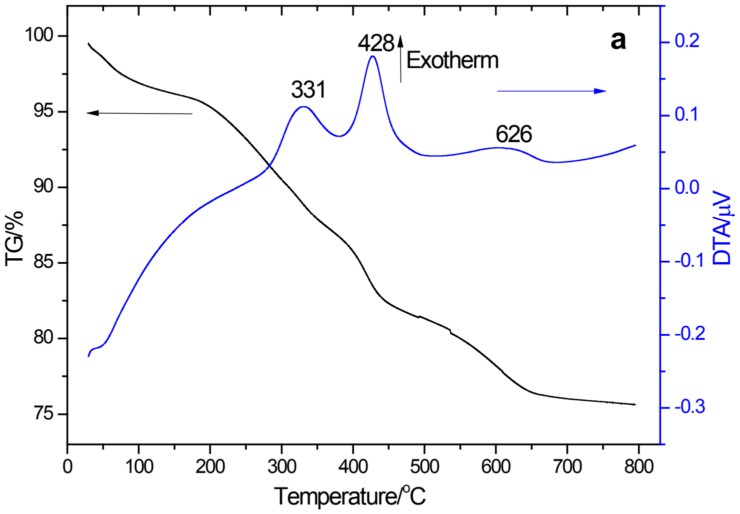


Fig. S2 XRD pattern of zeolite MOR prepared from seed-free dry gel with TEAOH/SiO_2 = 0.1 by SAC method at 140 °C for 48 h (0.1T-0S-140/48).



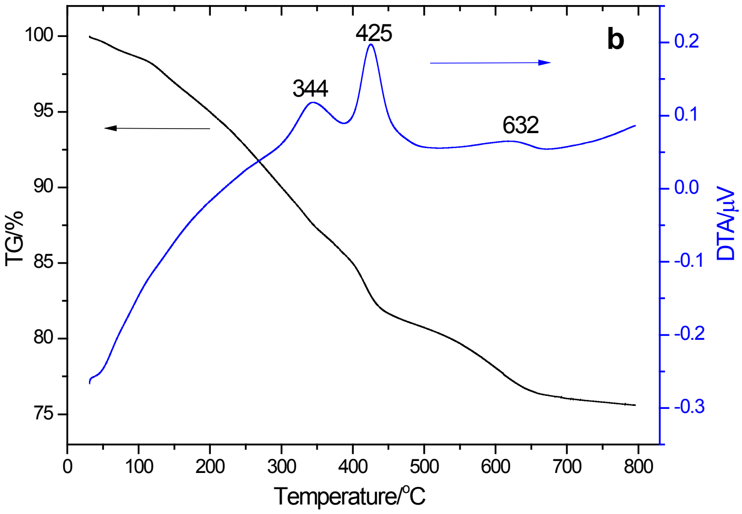


Fig. S3 TG and DTA curves of zeolite beta prepared from dry gel with the same seeds in content of 10% at 140 °C for 28 h but different TEAOH/SiO_2 ratios of : (a) 0.1 (0.1T-10S-140/28), (b) 0.3 (0.3T-10S-140/28).

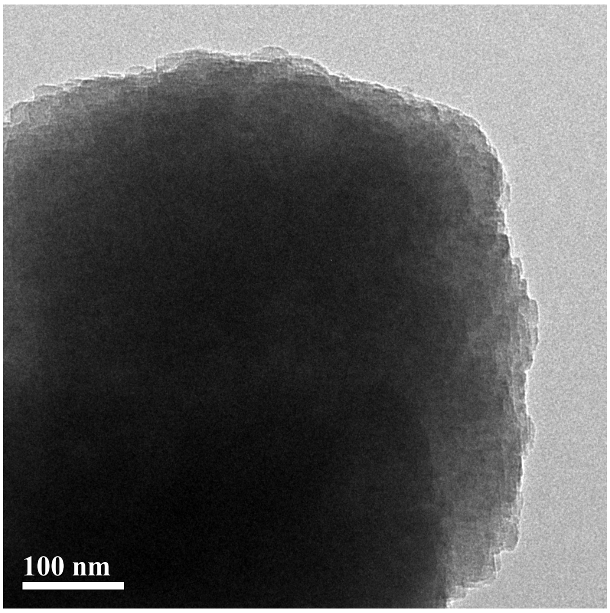


Fig. S4 TEM image of zeolite beta synthesized from dry gel with TEAOH/SiO_2 = 0.1 and seed/SiO_2 = 0.1% at 140 °C for 36 h (0.1T-0.1S-140/36).

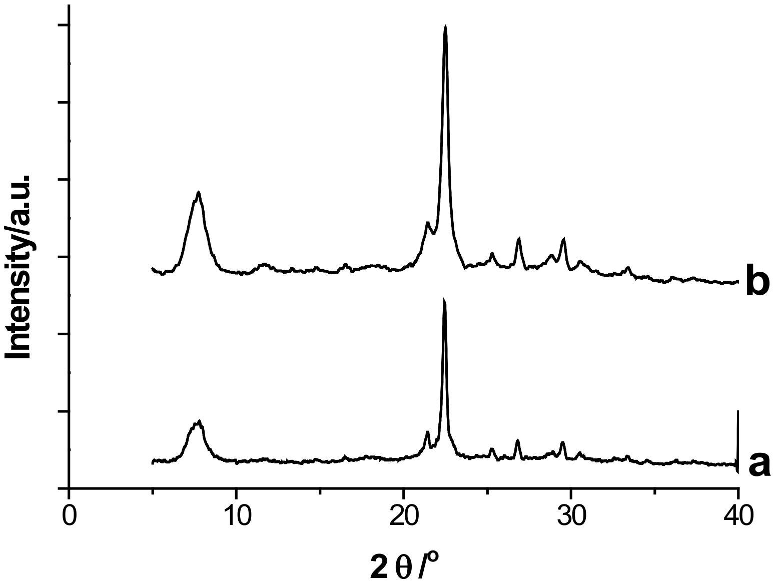


Fig. S5 XRD patterns of (a) commercial NKF-6, and (b) zeolite beta prepared from dry gel with seed/SiO_2 = 1% and TEAOH/SiO_2 = 0.1 by SAC method at 140 °C for 28 h (0.1T-1S-140/28).

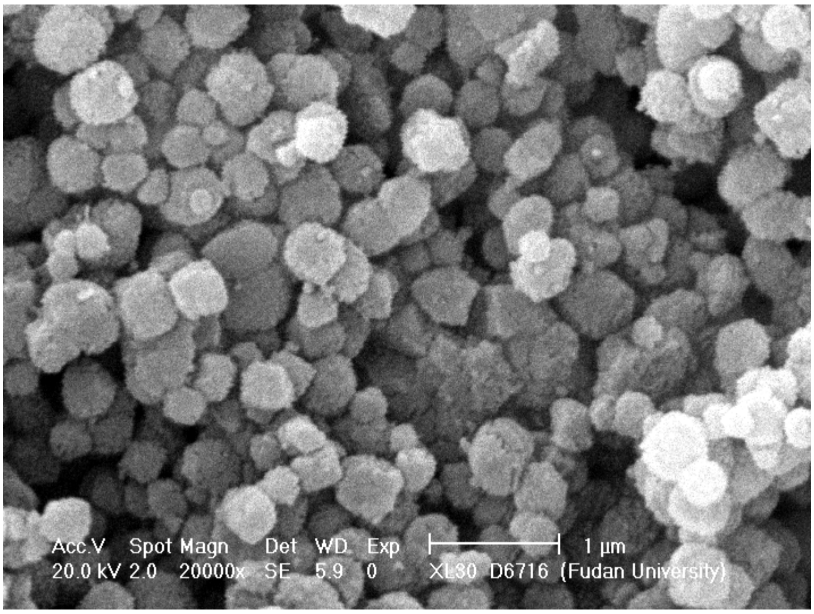


Fig. S6 SEM image of commercial NKF-6.

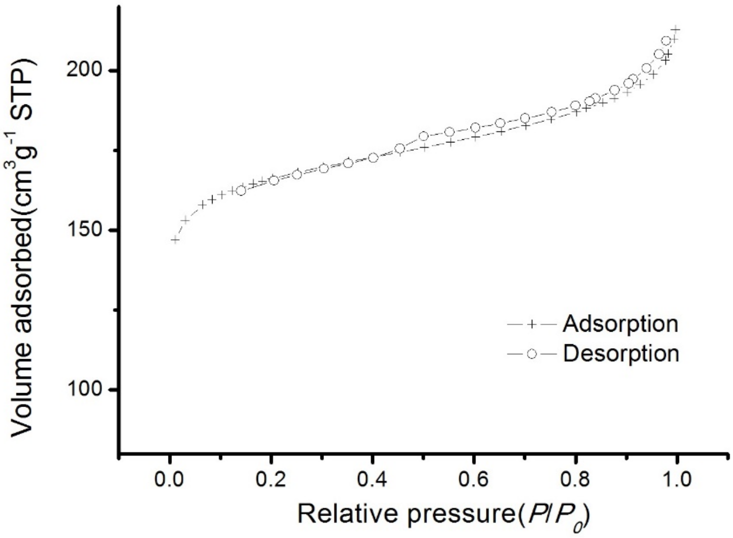


Fig. S7 N_2 sorption isotherm curves of commercial NKF-6.