Electronic Supplementary Information (ESI)

Hydrothermal preparation of a platinum-loaded sulphated nanozirconia catalyst for the effective conversion of waste low density polyethylene into gasoline-range hydrocarbons

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Experimental

Characterization of $Pt/nanoZrO_2-SO_4$ reaction products using GC-MS

The GC-MS analyses were performed using a Shimadzu QP 2010S (Japan) with electron ionization detector and Helium as the carrier gas. An Rtxi-5MS column (length 30 m, diameter 0.25 mm and thickness 0.25 µm) was employed, with an initial oven temperature of 50 °C (held for 5 min), followed by an increase to 300 °C at 5 °C/min and a final hold for 15 min. The injection inlet temperature was 310 °C. The individual components of each sample were identified by matching their mass spectra with standard spectra in the NIST 08 and WILEY 8 libraries, using the software system associated with the instrument.

Results and discussion

The hydrocarbons generated from the hydrocracking of waste LDPE over the $nanoZrO_2$, $nanoZrO_2-SO_4$ and $Pt/nanoZrO_2-SO_4$ were almost exclusively olefins and linear paraffins with a wide range of molecular weights. Large amounts of linear paraffins and olefins were generated, with proportions of 32.73% and 49.50%, respectively. The majority of these compounds in the hydrocracking experiments were associated with extensive random-chain scission occurring in the pyrolysis step. However, the presence of isoparaffins, naphthenes and aromatics in the gasoline fraction is highly desirable, as these compounds increase the octane number. The products obtained from the hydrocracking reaction over $Pt/nanoZrO_2-SO_4$ showed the highest proportions of these compounds (5.39%, 8.46% and 1.16%, respectively). Future work involving nanozirconia-based catalysts should be able to advance the techniques reported in this paper, especially with regard to tuning the conversion reactions to induce isomerization and aromatization.

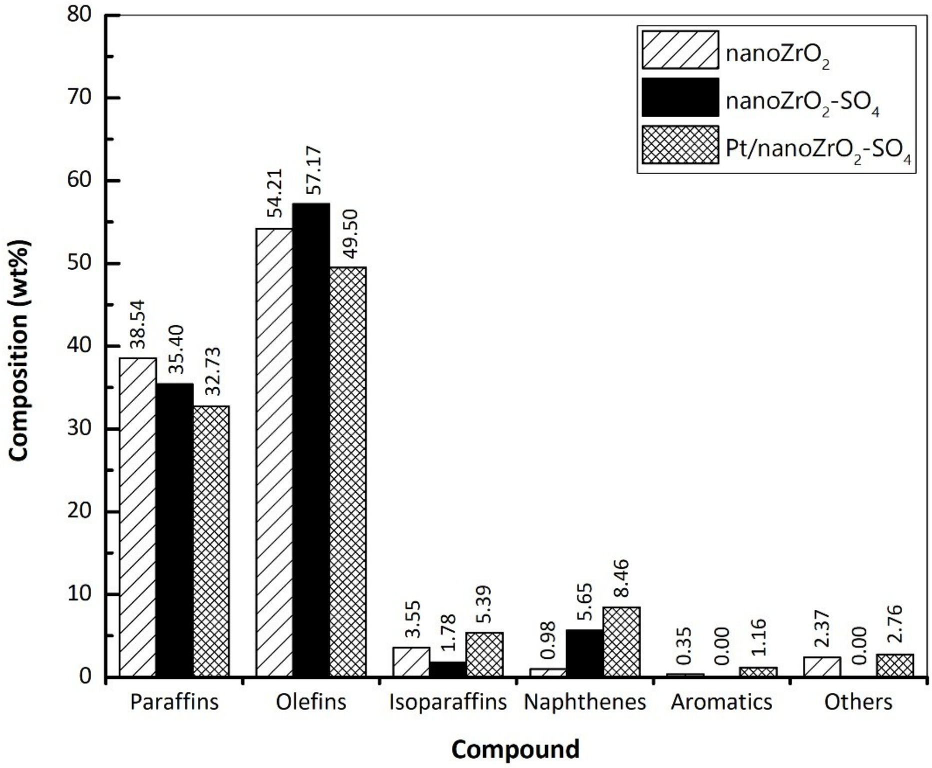

Fig. S1 The chemical compositions of the liquids obtained from the hydrocracking of waste LDPE over nanoZrO_2, nanoZrO_2-SO_4 and Pt/nanoZrO_2-SO_4 (T = 250 °C, t = 60 min, catalyst-to-feed proportion = 1 wt%).

Table S1 The chemical compositions of pyrolysis oil and hydrocracking oil over nanoZrO_2, nanoZrO_2/SO_4 and Pt/nanoZrO_2-SO_4

Sample	Composition (%)	Chemical compound
pyrolysis oil	23.9	1-decene
	21.3	1-undecanol
	14.5	2,3,5-trimethyldecane
	21.4	1-tridecene
	18.9	3-methyl-5-propylnonane
nanoZrO_2	2.7	methylbenzene
	10.9	2,4-dimethylheptane
	5.1	3-methylnonane
	77.1	1-undecene
	4.2	Butylcyclohexane
nanoZrO_2-SO_4	11.5	*n*-oktane
	3.3	ethylcyclohexane
	48.7	1-decene
	34.2	*n*-decane
	2.3	3-methyldecane
Pt/nanoZrO_2-SO_4	17.2	*n*-heptane
	4.5	methylcyclohexane
	3.5	methylbenzene
	34.5	2,4-dimethylhexane
	40.3	1-nonene

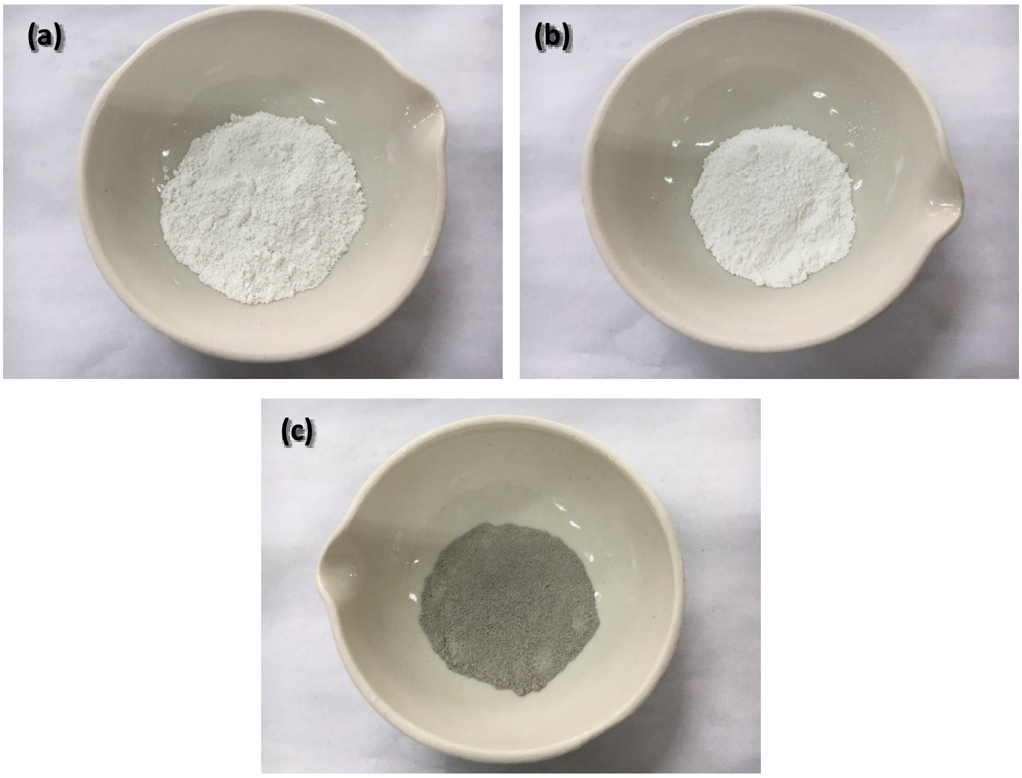

Fig. S2 Photographic images of (a) nanoZrO_2, (b) nanoZrO_2-SO_4 and (c) Pt/nanoZrO_2-SO_4 catalysts.

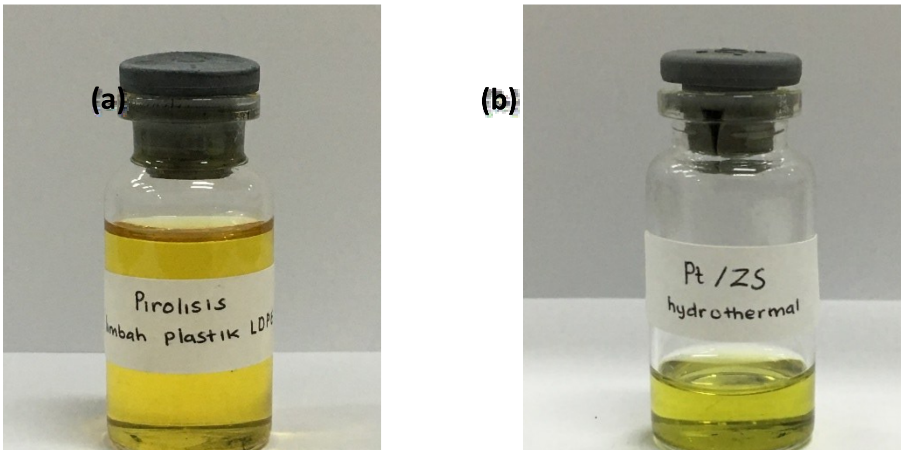

Fig. S3 Photographic images of (a) pyrolysis oil and (b) hydrocracking oil over Pt/nanoZrO_2-SO_4.