Supplementary Material (ESI) for Chemical Communications

Low temperature catalytic combustion of propane over Pt-based catalyst with inverse opal microstructure in microchannel reactor

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1. The method to prepare aluminium sol

A stable aluminium sol was synthesised at first. During the synthesis, in solution A Pluronic P123 ($EO_{20}PO_{70}EO_{20}$, EO=ethylene oxide, PO=propylene oxide; BASF) was dissolved in absolute ethyl alcohol (Aldrich) and stirred for 30min at room temperature. Solution B was prepared in the following way: aluminum-tri-sec-butylate ($Al(OC_4H_9)_3$; Fluka) was diluted with absolute ethyl alcohol and stirred in a capped bottle for 15min, and then a mixture of acetylacetone (AcAcH; Aldrich) and ethylacetoacetate (EAA; Aldrich) as stabilizer was added and stirred for 1h. Afterwards, the two solutions were mixed together, and further stirred for 2h. Then, deionized water and concentrated nitric acid were added drop by drop to adjust the pH value to 4.5, and a clear sol was formed. The molar ratio of $Al(OC_4H_9)_3$:EtOH:AcAcH:EAA:P123:HNO_3:H_2O in the final solution was fixed to 1:20:0.2:0.8:0.008:0.02:3.

2. Micropore properties

Table 1 summarizes the micropore properties of the prepared original and catalyst-loaded Al_2O_3 powders with inverse opal microstructure, which were determined by nitrogen sorption using a Sorptomatic 1990 (Carlo Erba Instruments) automatic apparatus. The prepared original Al_2O_3 inverse opals have a high BET surface area of 230.3m^2g^{-1} and micropore volume of 0.69cm^3g^{-1}at p/p^0=0.95 with a median pore radius of 6.7nm. Here, the formation of this kind of microporous structure is attributed to the addition of Pluronic P123 as a micropore structure directing agent in the prepared sol[15] It should be noted that the larger macropores such as 300nm pores in the inverse opals (Fig.1(d)) were not detectable in such sorption experiments. On the other hand, the BET surface area, micropore volume and median pore radius were reduced to 144.4 m^2/g, 0.34cm^3g^{-1} and 4.2nm, respectively, when Mo and Pt were loaded on it, indicating that Mo and Pt particles deposited on the surface of Al_2O_3 inverse opals could block the open micropores to some extent, and reduce the total BET surface area.

Reference

15 K. Niesz, P. Yang, G. A. Somorjai, *Chem. Commun.,* 2005,198.

Table 1 Micropore properties of the original and catalyst-loaded Al_2O_3 powders with inverse opal microstructure

Sample	Specific surface area (m^2g^{-1})	Total micropore volume (cm^3g^{-1})[a]	Median pore radius (nm)[b]
Al_2O_3	230.3	0.69	6.7
Pt/Al_2O_3	177.1	0.45	4.3
$Pt/Mo/Al_2O_3$	144.4	0.34	4.2

[a] Taken from the volume of N_2 adsorbed at $P/P^0=0.95$.
[b] Estimated using the desorption branch of the isotherm and the Barrett-Joyner-Halenda (BJH) formular.