Electronic Supplementary Information (ESI)

Zanthoxylum bungeanum seed oil based carbon solid acid catalyst for the production of biodiesel

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1. Experimental

1.1 Preparation of activated carbon based solid acid catalyst

1 g activated carbon was mixed with the acid solution (10 ml nitric acid and 30 ml concentrated sulfuric acid) under the condition of ultrasound for 1 h. And then heating the reactants at 100℃ under the condition of reflux for 4 h. After the reaction the reactants were washed to neutral by distilled water and filter, and then dry at 120℃ oven for 3h. The obtained solid is activated carbon based solid acid catalyst.

1.2 Preparation of carbon nanotubes solid acid catalyst

CNT based solid acid was prepared with modified mothed reported in [S1]. 1 g carbon nanotubes was mixed with the acid solution (10 ml nitric acid and 30 ml concentrated sulfuric acid) under the condition of ultrasound for 1 h. And then heating the reactants at 100℃ under the condition of reflux for 4h. After the reaction the reactants were washed to neutral by distilled water and filter, and then dry at 120℃ oven for 3h. The obtained solid was carbon nanotubes based solid acid catalyst.

Reference

[S1] Y.Z. Wei, X.L. Ling, L.M. Zou, et al., Colloid Surface A, **2015**, 482, 507-513.

2. Supporting Figures

Fig. S1 showed the TEM images of the solid acid catalyst and the corresponding energy dispersive X-ray spectrometry (EDS) of C, O and S maps. The observations of high dispersion of elemental S in the as-prepared samples indicated that the existence of the $-SO_3H$ groups, which was consisted with the IR and the XPS spectra.

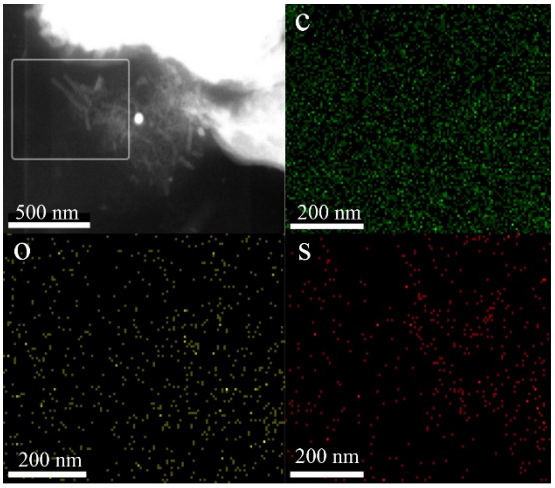

Fig. S1. TEM images of catalyst and the corresponding EDS mapping of C, O and S.

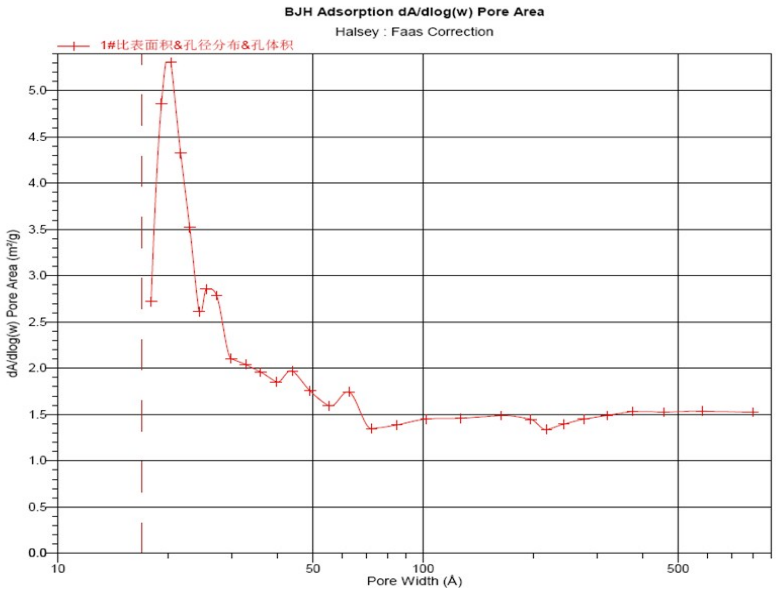

Fig. S2 Pore size distributions of the ZSO based solid acid.

3. Supporting Tables

Table S1. The textural properties of the ZSO based solid acid

BET Surface Area	Pore Volume [a]	Pore Size [b]
3.5425 m^2/g	0.028956 cm^3/g	207.865 Å

[a] Pore volume, obtained from the volume of nitrogen adsorbed at the relative pressure of 0.99; [b] BJH Adsorption average pore width (4V/A).

The catalytic performance of the comparison catalyst was shown in the Table S2. It can be found that under the same reaction condition, the ZSO based solid acid gave the best catalytic performance. Though the CNT based solid acid showed the similar catalytic performance, the CNT based solid acid catalyst could not easily be separated by centrifugation due the highly dispersion of the acidified CNT.

Table S2 Comparison catalyst for the title reaction

Catalyst	Yield / %
Activate carbon based solid acid	63.1
CNT based solid acid	91.0
ZSO based solid acid	95.2

Reaction condition: the methanol-to-oil molar ratio was 30:1, the catalyst loading was 8 wt.% at 140 ^oC for 4.0 h.