Electronic Supplementary Material for Catalysis Science & Technology

Silica coated magnetic Fe_3O_4 nanoparticles supported phosphotungstic acid: a novel environment-friendly catalyst for the synthesis of 5-ethoxymethylfurfural from 5-hydroxymethylfurfural and fructose

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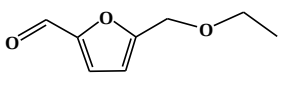
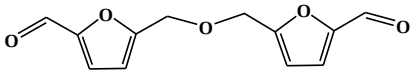
Calculated the carbon balance for the synthesis of EMF by the etherification of HMF

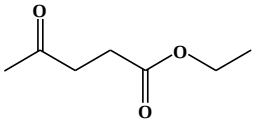
The procedures for the synthesis of EME from HMF was described as in the test. The possible byproducts including ethyl levulinate (EL), the 5-(diethoxymethyl)-2-f uranmethanol (DEF), 5,5'(oxy-bis(methylene))bis-2-furfural (OBMF), the insoluble humins and others beyond our detection. After reaction, the reaction mixture was diluted, and analyzed by gas by gas chromatography. EL and OBMF were detected in our reaction during the synthesis of EMF from HMF at 100 ^{o}C and 120 ^{o}C. The insoluble humins were obtained by the filtration of the reaction mixture after removal of the catalyst by a permanent magnet.



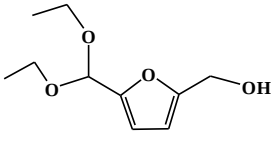
EMF



OBMF



Ethyl levulinate



DEF

Table S1. Carbon balance calculation for the synthesis of EMF from HMF [a]

Reaction temperature	HMF conversion (%)	Percentage of HMF used for EMF (%)	Percentage of HMF used for EL (%)	Percentage of HMF used for OBMF (%)	Percentage of HMF used for DEF (%)	Percentage of HMF Humins (%)	Others (not detected)
100 °C	97.9	83.6	5.8	2.3	ND	3.3	1.2
120 °C	98.9	57.8	21.3	3.5	ND	12.4	5.0

[a] Reaction conditions: HMF (126 mg, 1 mmol) and Fe_3O_4@SiO_2-HPW (150 mg) were added into 5 mL of ethanol, then the reaction was carried out at desired temperature.

Comaprsion with the characterization of the fresh catalyst and the reused catalyst

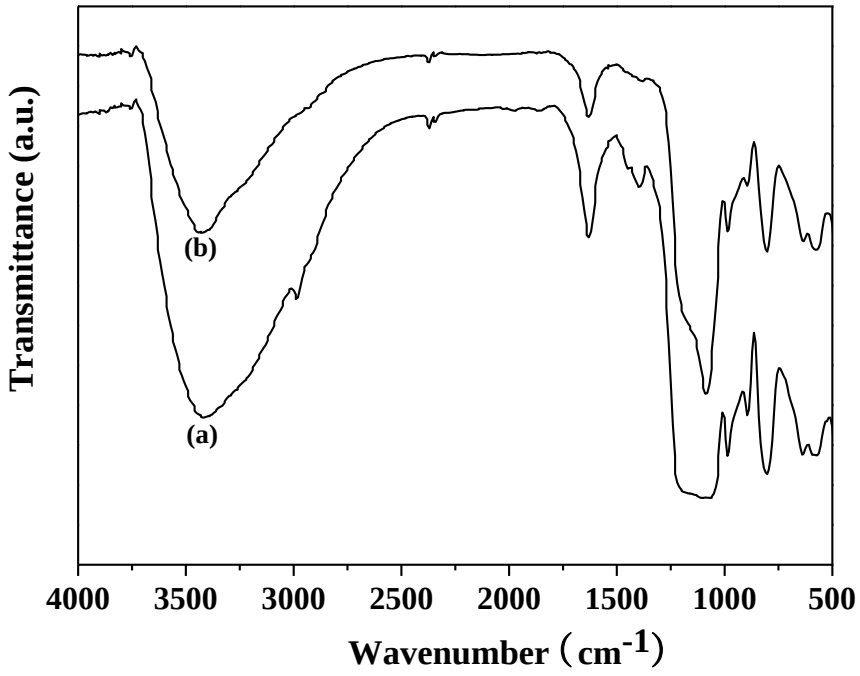


Fig. S1 IR spectra of Fe_3O_4@SiO_2-HPW (a) Fresh (b) after reused for 5 times.

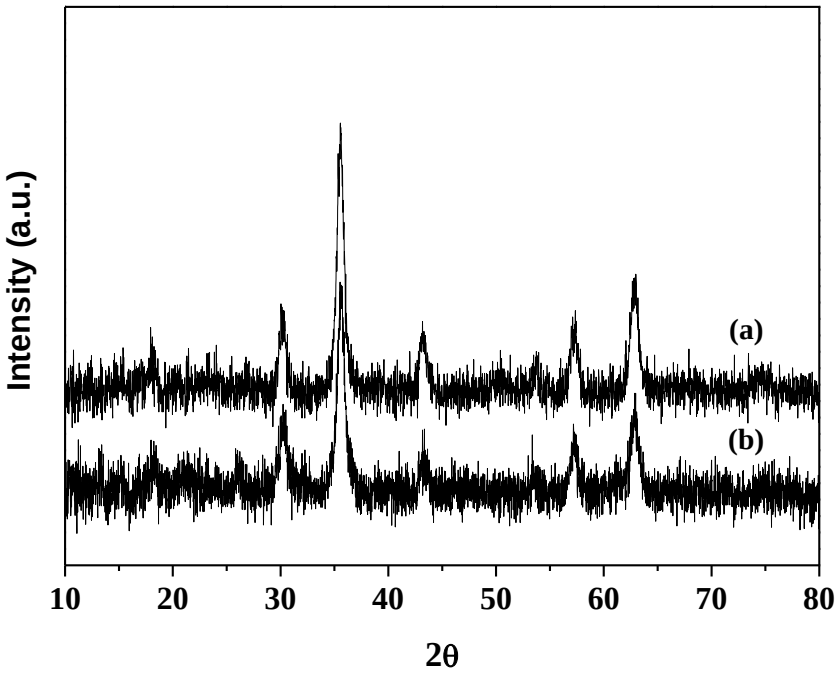


Fig. S2 XRD patterns of Fe_3O_4@SiO_2-HPW (a) Fresh (b) after reused for 5 times.

Recycling expriments for the synthesis of EMF from fructose

The recycling experiments of Fe_3O_4@SiO_2-HPW were also carried out in the reaction of the conversion of fructose to EMF. The reaction conditions were as follows: 180 mg of fructose and 150 mg of Fe_3O_4@SiO_2-HPW were added into 5 ml of ethanol, and the reaction was carried out 100 ^oC for 24 h. The recover and the recycling expriments were the same as described for the recycling expriments by the etherification of HMF, and the resluts were showed in Fig. S3. From the recycling results, it also indicated that the catalyst was stable without the loss of catalytic activity.

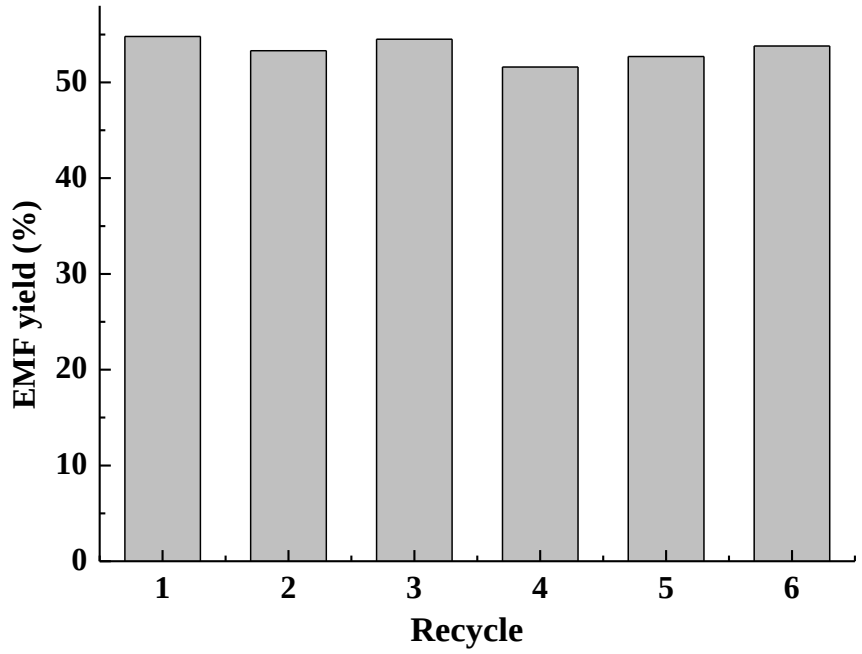


Fig. S3 The recycling expriments of Fe_3O_4@SiO_2-HPW by the synthesis of EMF from fructose.