Figure captions

Fig. S1. MS signals of CO_2 (—) and CO (----) over 20FeAl-N catalyst.

Fig. S2. IR spectra of 20FeAl catalysts with different precursor: (a) 20FeAl-SA (III), (b) 20FeAl-SA (II), (c) 20FeAl-SA (II) after reaction for 3 h, (d) 20FeAl-SA (II) after reaction for 24 h.

Fig. S3. H_2-TPR profiles of (a) 20FeAl-N; (b) 20FeAl-SA (III); (c) 20FeAl-SA (II); (d) 20FeAl-560-SO_2.

Fig. S4. Py-FT-IR spectra of (a) 20FeAl-N, (b) 20FeAl-560-SO_2, (h), (c) 20FeAl-SA (II).

Fig. S5. Reaction results over (a) 20FeSi-SA (II), (b) 20FeZr-SA (II), (c) pure Al_2O_3 in the reactant consisting of N_2, SO_2 and C_3H_8 at a molar ratio of 19:1:30 (Reaction conditions: T=560 °C, P=1 atm, F_{C3H8}=12 mL/min).

Fig. S6. Al 2p spectra of unsulfated and sulfated Fe_2O_3/Al_2O_3 catalysts.

Fig. S7. Propane conversion (■), propylene yield (●) and methane yield (▲) over 20FeAl-N after reaction for 3 h, then: (a) introduced SO_2 at a molar ratio of N_2: SO_2: C_3H_8=19:1:30; (b) pre-treated with SO_2 for 3 h (Reaction conditions: T=560 °C, P=1 atm, F_{C3H8}=12 mL/min).

Fig. S8. MS signal of CO_2 during the reaction-regeneration cycles over 20FeAl-SA (II) catalyst.

Fig. S9. Effect of reaction-regeneration-sulfuration cycles on the performance of 20FeAl-N (Reaction conditions: T=560 °C, P=1 atm, F_{C3H8}=12 mL/min).

Table captions

Table S1. Reaction results of the blank experiment as well as the reaction over pure Al_2O_3 (Reaction conditions: T=560 °C, P=1 atm, FC3H8=12 mL/min).

Table S2. SO_2-TG results at different temperature.

Table S3. The areas of reduction peaks quantified by peak deconvolution for sulfated and

unsulfated catalysts

Table S4. S 2p peak fitting calculation and analytical data of surface content (Fe, Al and S).

Table S5. Textural properties of fresh, reacted, regenerated 20FeAl-SA (II) and 20FeAl-560-SO_2.

Table S1

Reaction results of the blank experiment as well as the reaction over pure Al_2O_3 (Reaction conditions: T=560 °C, P=1 atm, F_{C3H8}=12 mL/min).

Catalyst	Conversion, wt%	Yield of propylene, wt%	Yield of methane, wt%
Blank	1.13	0.4	0.15
Al_2O_3	1.05	0.47	0.10

Table S2

SO_2-TG results at different temperature

T, °C	Weight increase rate, wt%
450	19.1
560	11.9
600	8.6
Al_2O_3-700	5.5
Fe_2O_3-700	2.8

Table S3

The areas of reduction peaks quantified by peak deconvolution for sulfated and unsulfated catalysts

Catalyst	Peak 1	Peak 2’	Peak 2	Peak 3
20FeAl-N	2695.7	--	2204.8	13627.2
20FeAl-SA (III)	40.5	--	6917.5	10923.8
20FeAl-SA (II)	76.9	--	12386.4	9456.8
20FeAl-560-SO_2	134.0	1702.5	4531.9	10994.8

Table S4

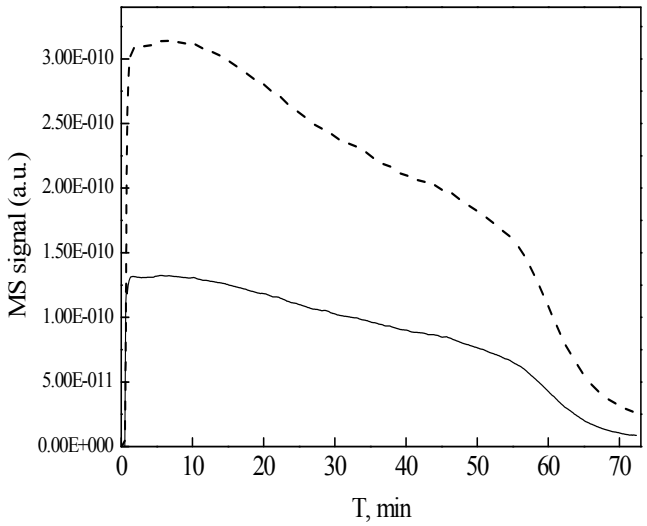
S 2p peak fitting calculation and analytical data of surface content (Fe, Al and S)

Catalyst	E_b, eV	% area	Surface content of S, %
20FeAl-560-SO_2	169.8	-	1.6
20FeAl-SA (II)	169.8	-	2.2
20FeAl-SA (II) after	168.9	57.5	0.8
reaction for 3h	162.5	42.5	
20FeAl-SA (II) after	168.7	51.1	0.8
reaction for 24h	162.4	48.9	
20FeAl-SA (III) after	168.5	44.5	0.9
reaction for 24h	161.7	55.5	
20FeAl-560-SO_2 after	168.9	62.2	
reaction for 6 h	162.2	37.8	1.0

Table S5

Textural properties of fresh, reacted, regenerated 20FeAl-SA (II) and 20FeAl-560-SO_2

Catalysts	S_{BET}, m^2/g	Pore diameter, nm	Particle volume, cm^3/g
Fresh 20FeAl-SA (II)	125.4	6.53	0.263
20FeAl-SA (II) after reaction for 24 h	108.3	5.62	0.170
Regenerated once 20FeAl-SA (II)	117.0	6.50	0.258
Fresh 20FeAl-560-SO_2	149.1	6.60	0.258
Reacted (one cycle) 20FeAl-560-SO_2	140.8	5.65	0.249
Regenerated once 20FeAl-560-SO_2	145.8	6.58	0.254
Reacted (four cycle) 20FeAl-560-SO_2	136.9	6.44	0.245
Regenerated four times 20FeAl-560-SO_2	142.2	6.50	0.249



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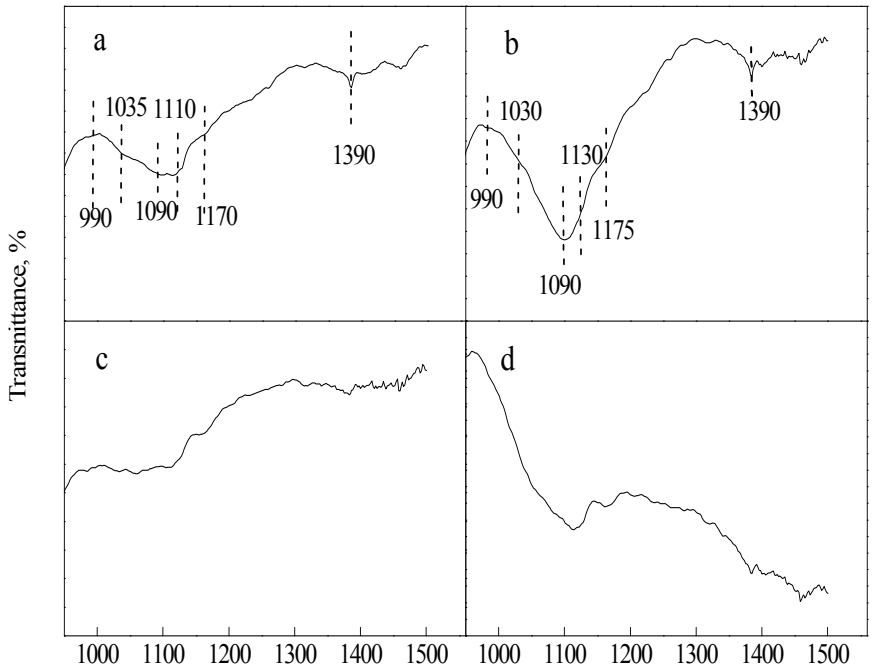

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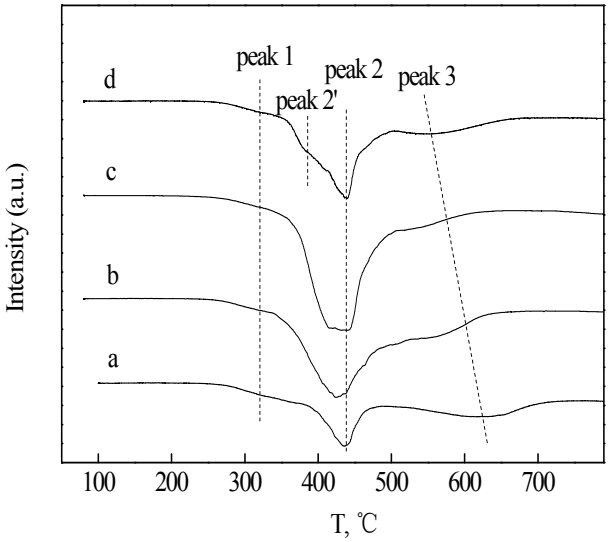

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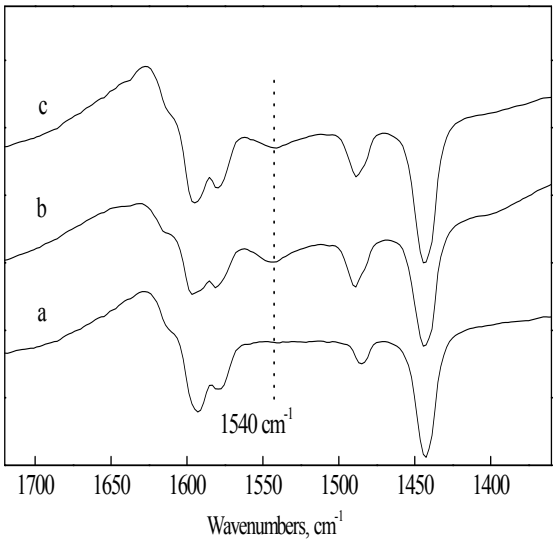
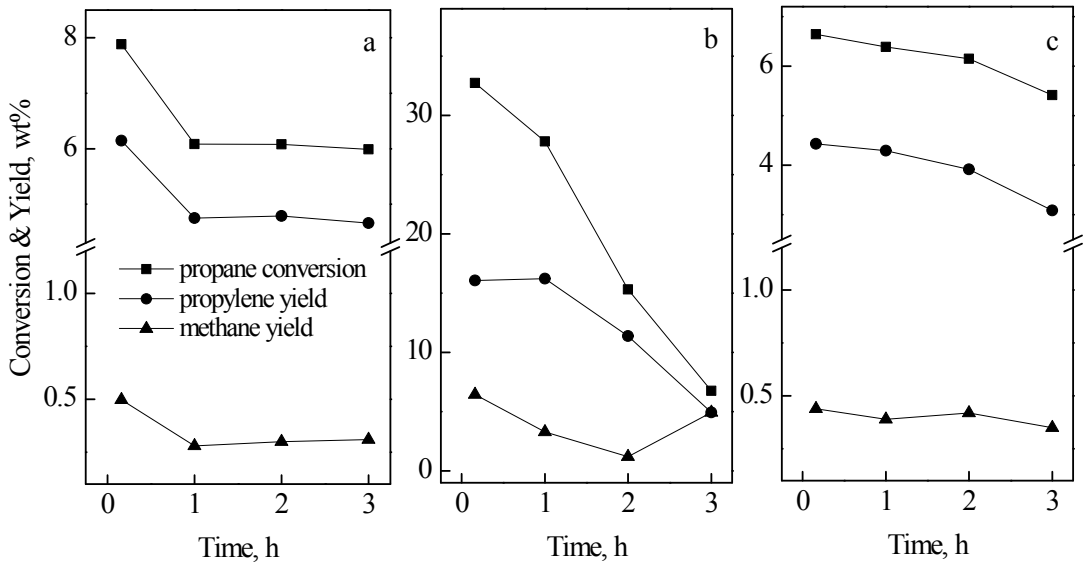


Fig. S4. Py-FT-IR spectra of (a) 20FeAl-N, (b) 20FeAl-560-SO_2, (c) 20FeAl-SA (II) (desorption at 200 °C).



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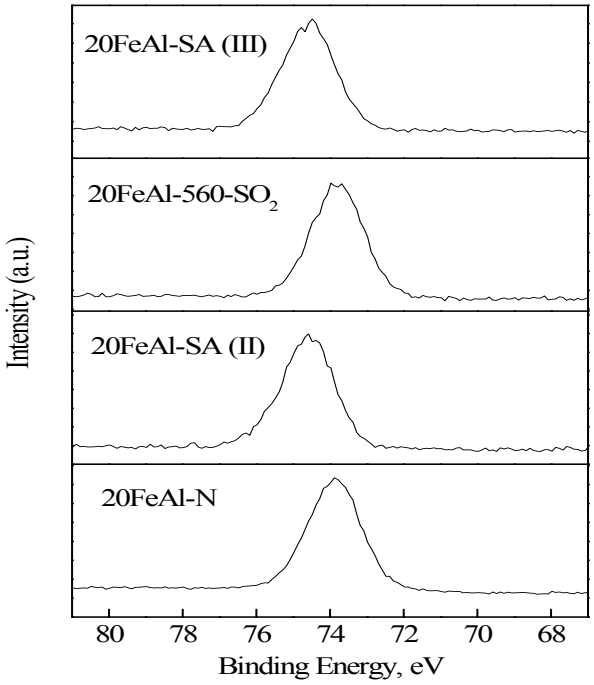

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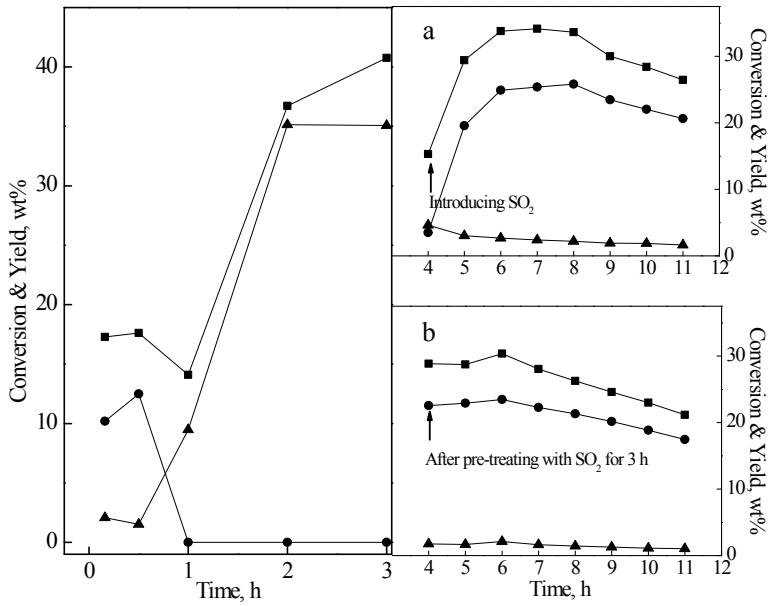

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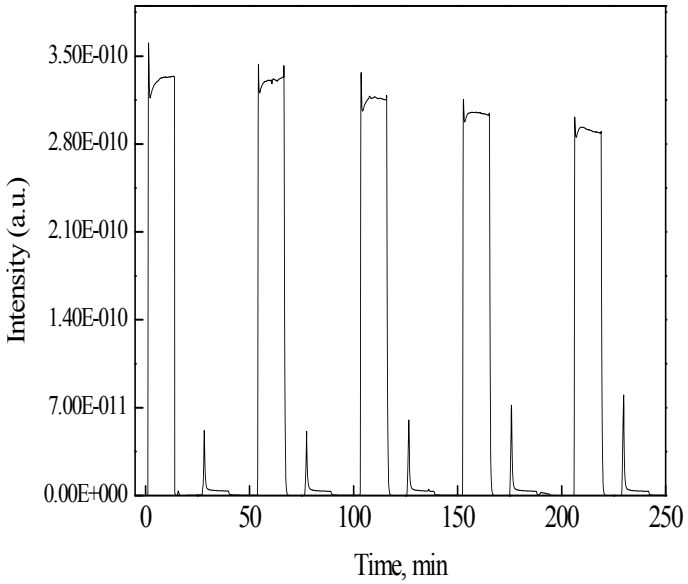

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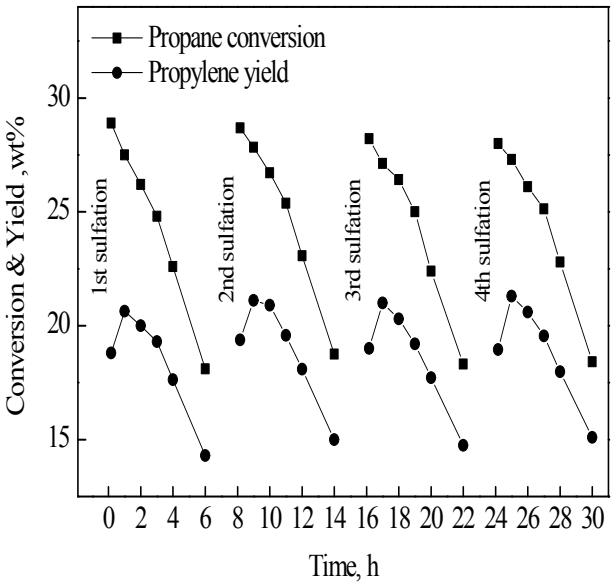

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