

## Support information

### The confined space electron transfer enhances phosphotungstate intercalated ZnAl-LDHs for photocatalytic oxidation/extraction desulfurization of fuel oil with air

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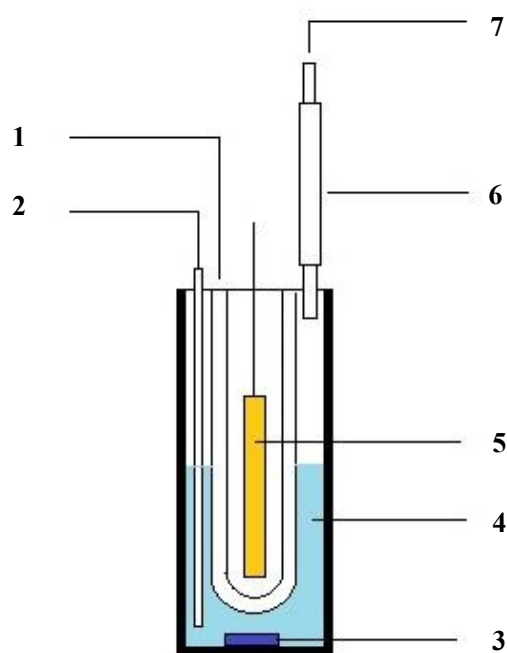
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**Table S1** Elemental composition of different proportions of ZnAl-PW<sub>12</sub>O<sub>40</sub>.

Catalyst	Wt %					
	Zn	Al	P	W	N	H
Zn <sub>0.66</sub> Al <sub>0.34</sub> (OH) <sub>2</sub> (NO <sub>3</sub> ) <sub>0.34</sub> · 2.3H <sub>2</sub> O	28.8	6.1	-	-	3.2	4.44
Zn <sub>0.63</sub> Al <sub>0.37</sub> (OH) <sub>2</sub> (PW <sub>12</sub> O <sub>40</sub> ) <sub>0.04</sub> (NO <sub>3</sub> ) <sub>0.25</sub> · 2.1H <sub>2</sub> O	22.8	5.5	0.63	45.4	1.38	2.45
Zn <sub>0.64</sub> Al <sub>0.36</sub> (OH) <sub>2</sub> (PW <sub>12</sub> O <sub>40</sub> ) <sub>0.06</sub> (NO <sub>3</sub> ) <sub>0.19</sub> · 2.6H <sub>2</sub> O	20.3	4.7	0.75	54.5	0.98	2.27
Zn <sub>0.63</sub> Al <sub>0.37</sub> (OH) <sub>2</sub> (PW <sub>12</sub> O <sub>40</sub> ) <sub>0.07</sub> (NO <sub>3</sub> ) <sub>0.16</sub> · 1.7H <sub>2</sub> O	15.3	3.7	0.87	61.6	0.81	1.65

**Table S2** Asymmetric vibration bands position in FT-IR spectra

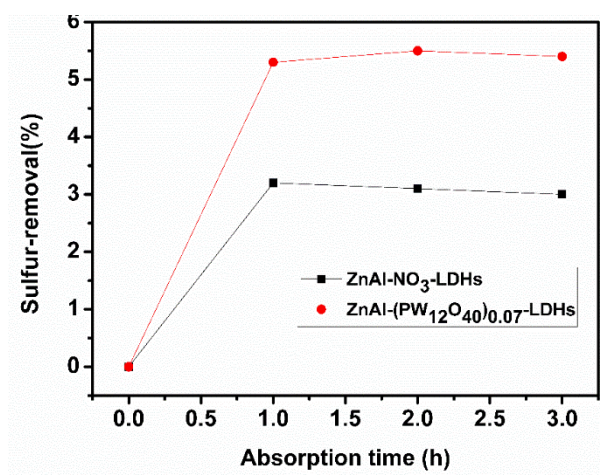
Samples	N-O	P-O <sub>a</sub>	W = O <sub>d</sub>	W-O <sub>b</sub> -W	W-O <sub>c</sub> -W
H <sub>3</sub> PW <sub>12</sub> O <sub>40</sub>	-	1086	987	895	803
ZnAl-(PW <sub>12</sub> O <sub>40</sub> ) <sub>0.07</sub> -LDHs	1384	1064	960	895	803
ZnAl-(PW <sub>12</sub> O <sub>40</sub> ) <sub>0.06</sub> -LDHs	1384	1064	961	895	804
ZnAl-NO <sub>3</sub> -LDHs	1384	-	-	-	-



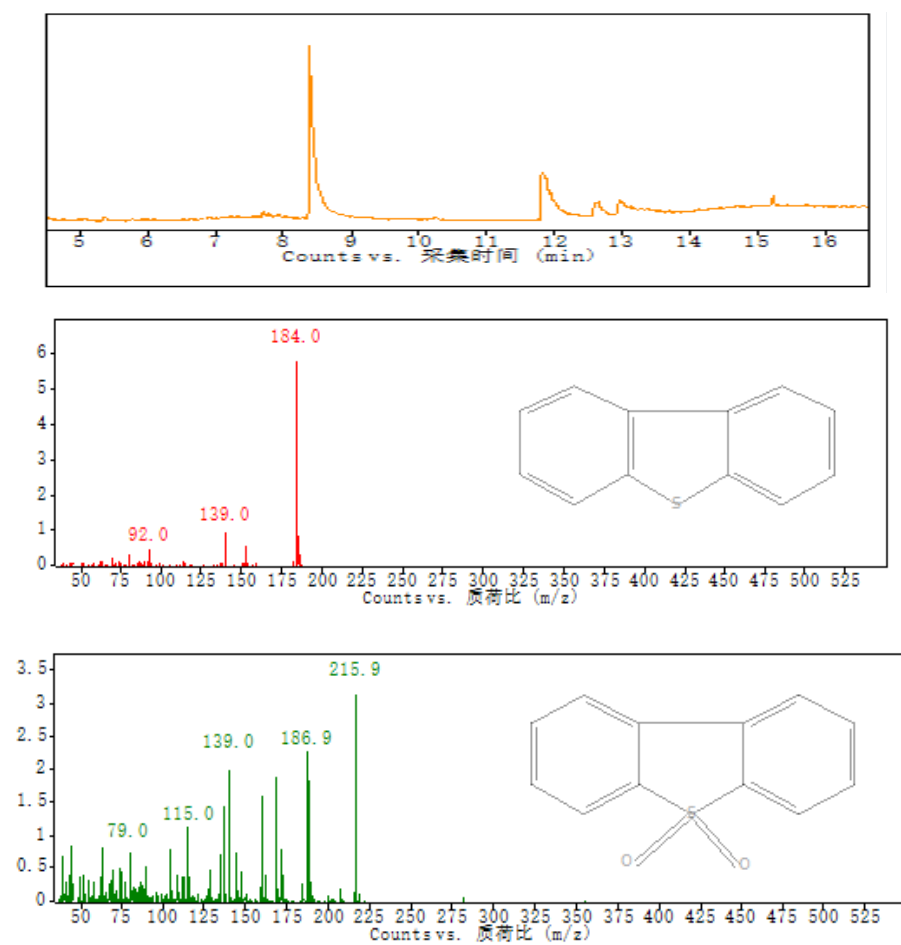
**Fig. S1** Schematic illustration of the PODS reactor (1-cooling water, 2- air inlet, 3- stirrer, 4-reaction liquid, 5-mercury lamp, 6- condenser, 7-air outlet)

**Table S3** Electron binding energy of related elements.

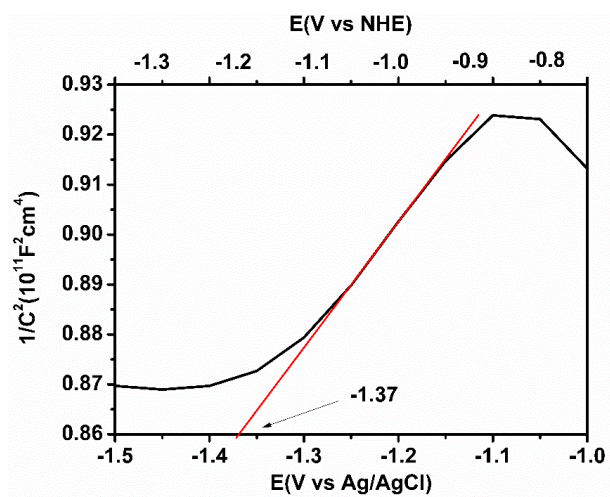
Samples	Zn2p <sub>1/2</sub>	Zn2p <sub>3/2</sub>	Al2p <sub>3/2</sub>	W4f <sub>7/2</sub>	W4f <sub>5/2</sub>
ZnAl-NO <sub>3</sub> -LDHs	1045.0	1021.9	74.3	-	-
ZnAl-(PW <sub>12</sub> O <sub>40</sub> ) <sub>0.07</sub> -LDHs	1045.6	1022.5	74.7	35.9	37.9
H <sub>3</sub> PW <sub>12</sub> O <sub>40</sub>	-	-	-	36.3	38.4



**Fig. S2** Experimental results of catalyst adsorption  
Condition: 500ppm oil(90 mL), catalyst dosage 1g/L



**Fig. S3.** GC-MS analysis of the acetonitrile phase after reaction.



**Fig. S4.** Mott-Schottky plots of LDHs, measured in 1 kHz at room temperature in the dark, Solution: 0.1 M NaSO<sub>4</sub>.