

Supplementary Information

Tungstate promoted vanadium phosphate catalysts for the gas phase oxidation of methanol to formaldehyde

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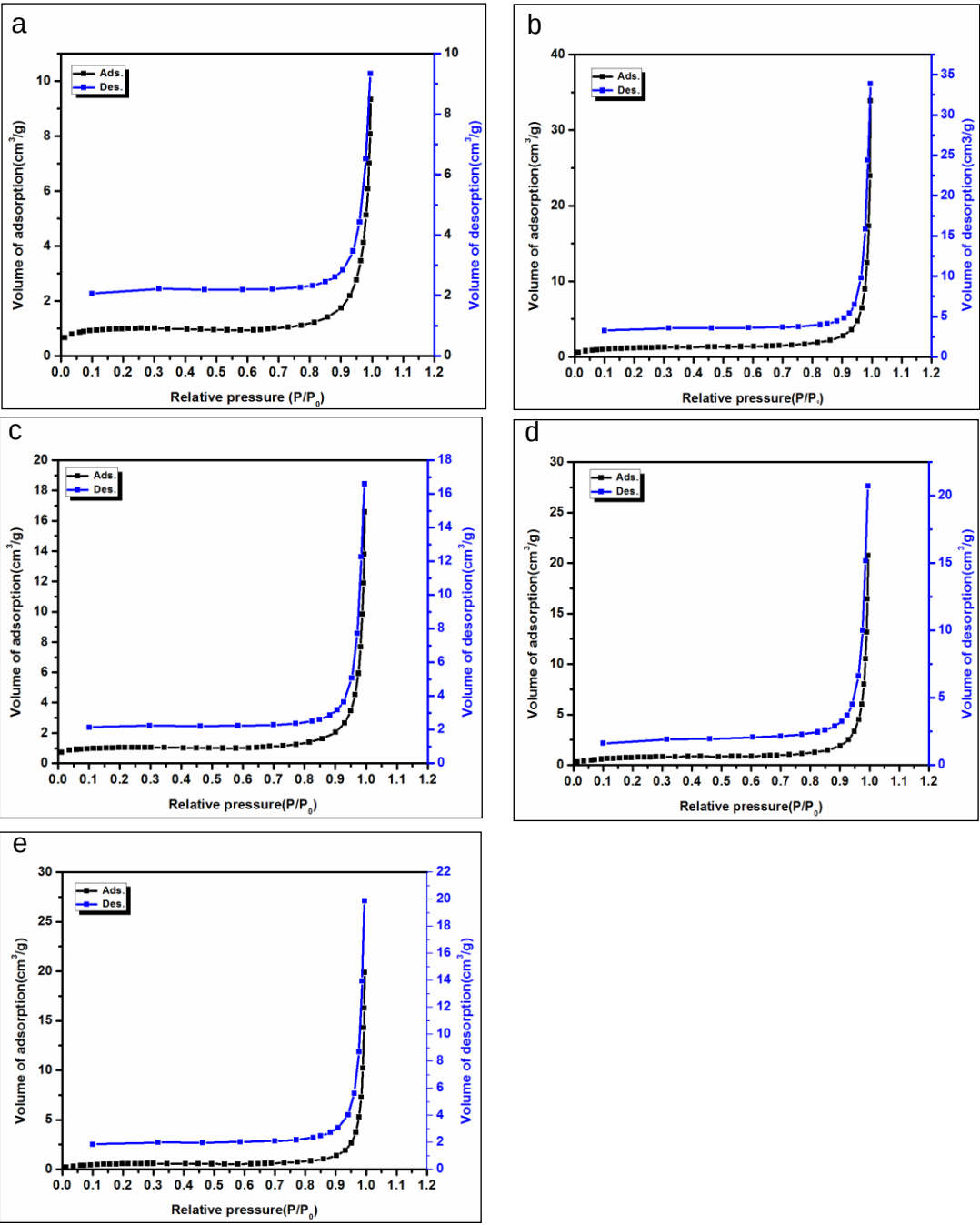


Figure S1: N₂ adsorption-desorption isotherm for: (a) 5 wt.% WO₃-VPO, (b) 10 wt.% WO₃-VPO (c) 15 wt.% WO₃-VPO (d) 20 wt.% WO₃-VPO (e) 25 wt.% WO₃-VPO

Selectivity of formaldehyde and minor products over different WO₃-VPO catalysts

Table S1: Selectivity of formaldehyde and minor products over 5 wt.% WO₃-VPO

Temp. (°C)	FA*	DME*	MF*	CO ₂ *	CO*
100	0	0	0	0	0
200	100	0	0	0	0
250	97.7	2.32	0	0	0
300	94.6	4.14	0	1.2	0
350	91.7	4.46	0	1.3	2.5
400	54.7	17.68	0	2.9	24.6

Note: * selectivity, FA: formaldehyde, DME: dimethyl-ether, MF: methyl formate

Reaction conditions: Total flow rate: 60 ml min⁻¹ (MeOH:O₂:He = 5:10:85), catalyst mass: 0.3 g, reaction time: 40 min

Table S2: Selectivity of formaldehyde and minor products over 10 wt.% WO₃-VPO

Temp. (°C)	FA*	DME*	MF*	CO ₂ *	CO*
100	0	0	0	0	0
200	99.7	0.2	0	0	0
250	99.6	0.4	0	0	0
300	97.7	1.0	0	1.22	0
350	91.2	3.0	0	1.39	4.3
400	60.6	12.9	0.1	3.59	22.8

Note: * selectivity, FA: formaldehyde, DME: dimethyl-ether, MF: methyl formate

Reaction conditions: Total flow rate: 60 ml min⁻¹ (MeOH:O₂:He = 5:10:85), catalyst mass: 0.3 g, reaction time: 40 min

Table S3: Selectivity of formaldehyde and minor products over 15 wt.% WO₃-VPO

Temp. (°C)	FA*	DME*	MF*	CO ₂ *	CO*
100	0	0	0	0	0
200	99.8	0.21	0	0	0
250	99.7	0.32	0	0	0
300	98.8	0.24	0	0.9	0
350	82.7	1.32	0	1.98	13.9
400	47.4	6.52	0	3.03	45.9

Note: * selectivity, FA: formaldehyde, DME: dimethyl-ether, MF: methyl formate

Reaction conditions: Total flow rate: 60 ml min⁻¹ (MeOH:O₂:He = 5:10:85), catalyst mass: 0.3 g, reaction time: 40 min

Table S4: Selectivity of formaldehyde and minor products over 20 wt.% WO₃-VPO

Temp. (°C)	FA*	DME*	MF*	CO ₂ *	CO*
100	0	0	0	0	0
200	99.1	0.9	0	0	0
250	96.9	1.1	0	1.95	0
300	95.8	2.0	0	2.18	0
350	91.2	5.0	0	3.74	0
400	70.6	23	0	6.3	0

Note: * selectivity, FA: formaldehyde, DME: dimethyl-ether, MF: methyl formate

Reaction conditions: Total flow rate: 60 ml min⁻¹ (MeOH:O₂:He = 5:10:85), catalyst mass: 0.3 g, reaction time: 40 min

Table S5: Selectivity of formaldehyde and minor products over 25 wt.% WO₃-VPO

Temp. (°C)	FA*	DME*	MF*	CO ₂ *	CO*
100	0	0	0	0	0
200	98.9	1.14	0	0	0
250	96.8	0.4	0	2.8	0
300	95.8	0	0	2.1	2.1
350	91.6	0	0	3.1	5.3
400	79.6	0	0	8.2	12.2

Note: * selectivity, FA: formaldehyde, DME: dimethyl-ether, MF: methyl formate

Reaction conditions: Total flow rate: 60 ml min⁻¹ (MeOH:O₂:He = 5:10:85), catalyst mass: 0.3 g, reaction time: 40 min