Supplementary Information

New insight into enhanced catalytic performance of ZnPt/HZSM-5 catalysts for direct dehydrogenation of propane to propylene

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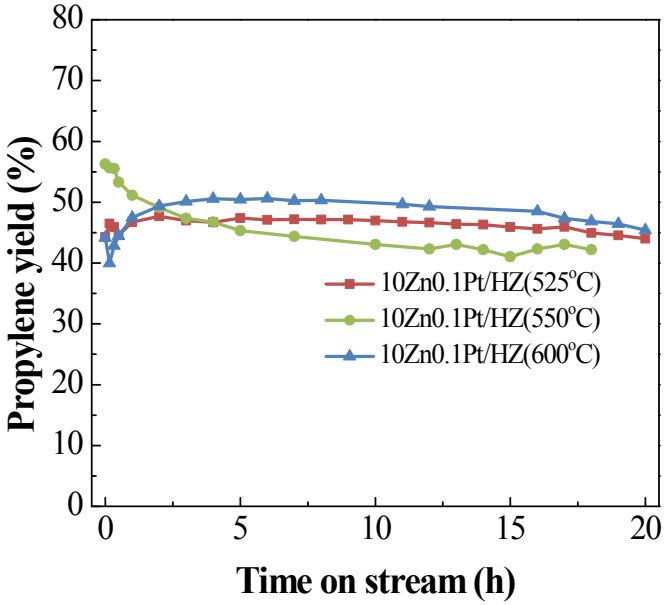

Fig. S1 Propylene yield *vs.* reaction time over 10Zn0.1Pt/HZ catalyst at different reaction temperature. (Reaction conditions: Temperature: 525 °C, WHSV: 0.24 h^{-1})

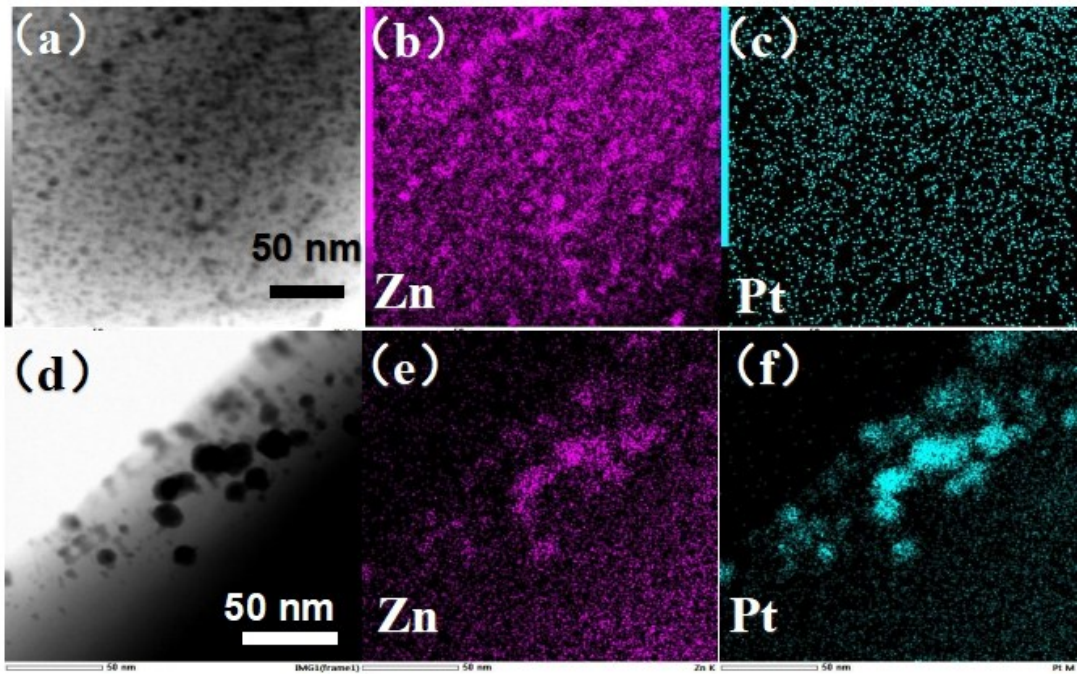

Fig. S2 TEM images of 10Zn0.1Pt/HZ (a) and 10Zn1Pt/HZ (d); (b, c) and (e, f) show the corresponding EDX elemental mappings of the 10Zn0.1Pt/HZ and 10Zn1Pt/HZ catalysts, respectively.

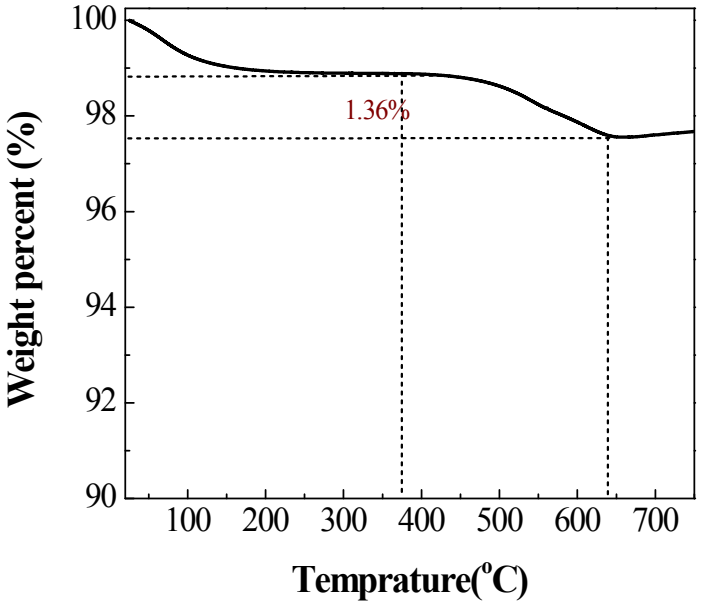

Fig. S3 TGA profile of the spent 10Zn0.1Pt/HZ catalyst after 65 h time on stream.

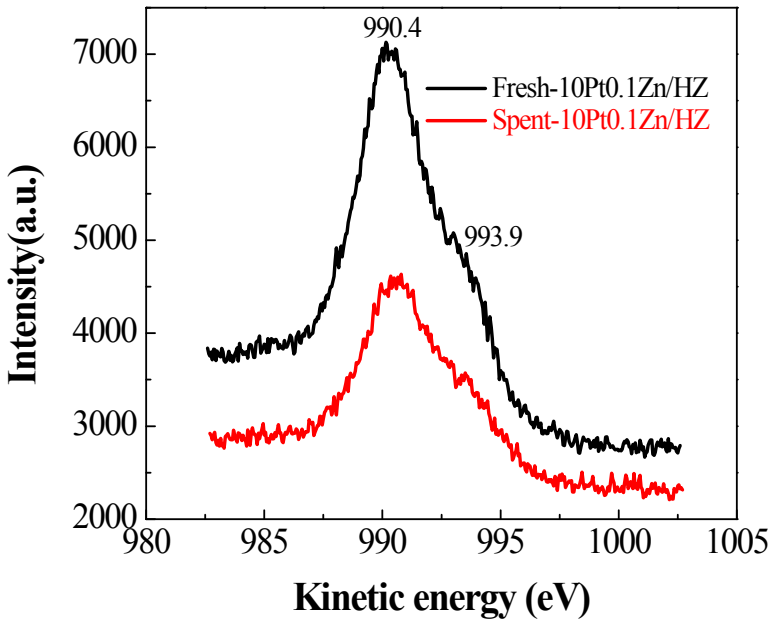

Fig. S4 Zn LMM spectra of the fresh and spent 10Zn0.1Pt/HZ catalysts.

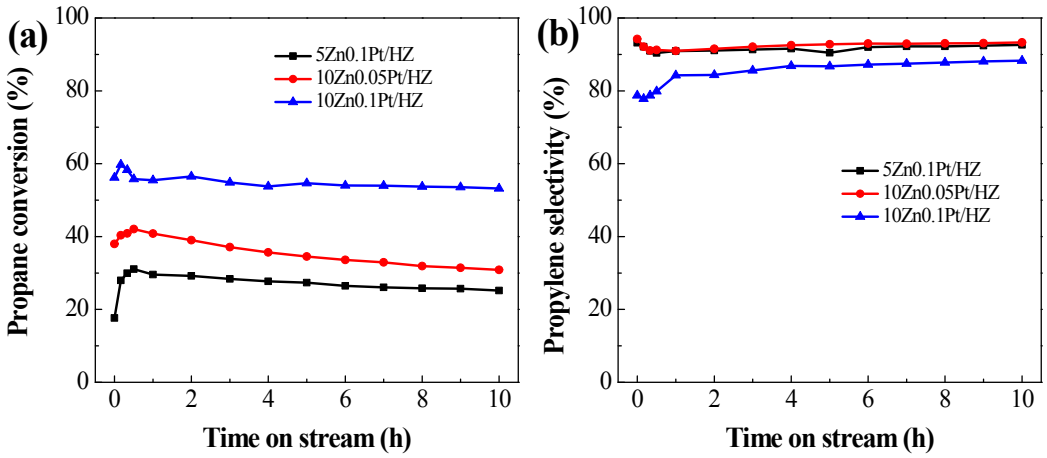

Fig. S5 Propane conversion (a) and propylene selectivity (b) *vs.* reaction time over the 10Zn0.05Pt/HZ, 5Zn0.1Pt/HZ and 10Zn0.1Pt/HZ catalysts. (Reaction conditions: Temperature: 525 °C, WHSV: 0.24 h^{-1})

Table S1 Summary of catalytic propane dehydrogenation at 525 °C utilizing 10Zn0.1Pt/HZ at various WHSVs.

Catalyst	10Zn0.1Pt/HZ			
Total Flow (mL/min)	20.0 (5% C_3H_8/N_2)			
WHSV (h^{-1})	0.24	0.4	2.0	4.0
Mass Cat. (g)	0.5	0.3	0.1	0.05
Conversion – Initial (%)	56.2	52.73	46.52	37.28
Selectivity –Initial (%)	C_3H_6 - 77.8 C_2H_4 - 7.0 C_2H_6 - 11.6 CH_4 - 3.6	C_3H_6 - 85.3 C_2H_4 - 4.5 C_2H_6 - 8.5 CH_4 -1.7	C_3H_6 - 91.5 C_2H_4 - 2.3 C_2H_6 - 1.0 CH_4 - 5.2	C_3H_6 - 95.0 C_2H_4 - 3.0 C_2H_6 - 1.0 CH_4 -1.0
Conversion - 5 h (%)	54.63	45.1	30.0	25.68
Selectivity - 5 h (%)	C_3H_6 - 88.4 C_2H_4 - 6.4 C_2H_6 - 2.9 CH_4 - 2.3	C_3H_6 - 92.3 C_2H_4 - 4.6 C_2H_6 - 2.1 CH_4 - 1.0	C_3H_6 - 95.4 C_2H_4 - 3.0 C_2H_6 - 0.5 CH_4 - 1.1	C_3H_6 - 96.5 C_2H_4 - 2.2 C_2H_6 - 0.1 CH_4 - 1.2

Table S2 Catalytic performance comparison of various catalysts in PDH.

Catalysts	RT(°C) [a]	WHSV (h^{-1})	Con.(%)[b]	Sel.(%)[c]	Yie.(%) [d]	Ref.
$PtGa/CeO_2$-Al_2O_3	600	10	39.4	99.6	39.2	1
$PtSn/Al_2O_3$ Nanosheet	590	9.4	48.7	98.3	47.9	2
PtSn/SAPO-34	600	5.6	25.1	88.4	22.2	3
0.6Pt1.5In/Mg(Al)O-x	620	3.3	61.3	96.0	58.8	4
PtSn/HZSM-5	590	3.0	26.0	75.0	19.5	5
PtSn/mesoporous alumina	590	3.0	30.0	80.1	24.0	6
0.5Pt0.6Sn/TS-1	590	3.0	53.8	92.0	49.5	7
PtSnNa/Ce-ZSM-5	590	3.0	41.8	95.8	40.0	8
PtSnNa/SUZ-4	590	3.0	20.5	92.4	18.9	9
PtZn/Na-Beta	555	2.6	29.0	90.0	26.1	10
0.5Pt1Sn0.2Al/SBA-15	590	2.5	51.2	98.5	50.4	11
Pt/Zn,Na-MCM-22	555	2.3	31.0	82.9	25.7	12
Pt^0/SiO_2	550	2.2	19.0	59.2	11.2	13
$Ga^{\delta+}Pt^0/SiO_2$	550	2.0	40.7	63.5	25.8	13
$Cu_{0.6}Pt_{0.1}$@S-1	610	1.5	46	93.2	42.9	14
0.1Pt10Zn/HZSM-5	525	2.0	46.8	91.5	42.6	This work

[a] Reaction temperature. [b] Conversion of propane. [c] Selectivity of propylene. [d] Yield of propylene.

Table S3 The property parameters of selective samples.

Samples	Weak acidity ($mmol_{NH3}\ g^{-1}$)	Medium acidity ($mmol_{NH3}\ g^{-1}$)	Strong acidity ($mmol_{NH3}\ g^{-1}$)	Total acidity ($mmol_{NH3}\ g^{-1}$)
HZ	0.42674	0	0.62258	1.04932
10Zn/HZ	0.17545	0.35868	0.3233	0.85743
10Zn1Pt/HZ	0.09642	0.15104	0.16538	0.41284
10Zn0.5Pt/HZ	0.10027	0.16337	0.09004	0.35368
10Zn0.1Pt/HZ	0.05428	0.18888	0.08264	0.32582

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