Supporting Information

PtZn intermetallic compound nanoparticles in mesoporous zeolite exhibiting high catalyst durability for propane dehydrogenation

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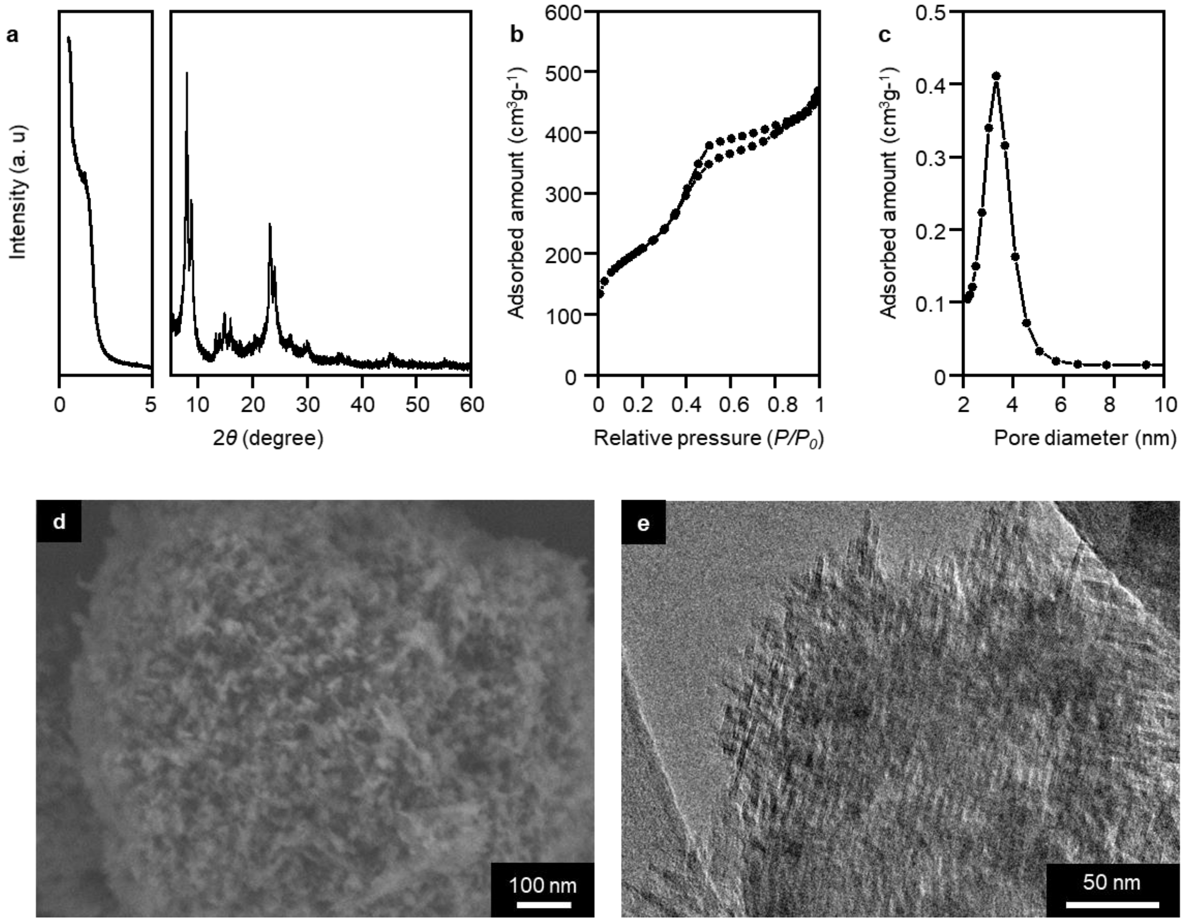

Figure S1. a) XRD pattern, b) N_2 adsorption-desorption isotherm, c) pore size distribution, D) SEM image, and E) TEM image of MZ

Table S1. Pore textural properties of MZ, MCM-48, silica gel, and BZ

	S_{BET} [a] (m^2 g^{-1})	V_{total} [b] (cm^3 g^{-1})	V_{micro} [c] (cm^3 g^{-1})	V_{meso} [d] (cm^3 g^{-1})
MZ	740	0.69	0.05	0.64
MCM-48	905	1.10	0.00	1.10
Silica gel	450	0.83	0.00	0.83
BZ	365	0.20	0.14	0.06

[a] BET surface area. [b] Total pore volume. [c] Micropore volume. [d] Mesopore volume.

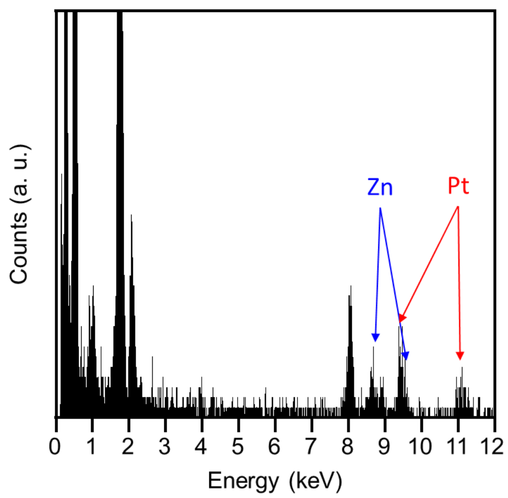

Figure S2. EDS spectra of 1Pt1Zn/MZ obtained from a metal nanoparticle

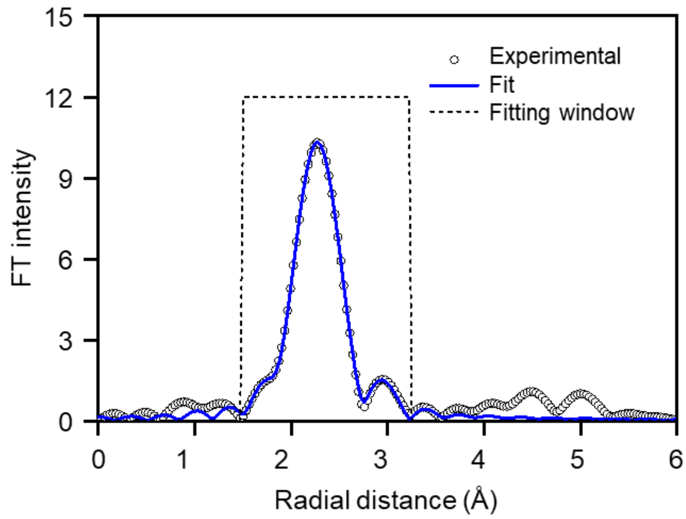

Figure S3. Fourier transformed EXAFS at the Pt L_3-edge of 4Pt4Zn/MZ

Table S2. Structural parameters obtained from the curve fitting of Pt L_3-edge EXAFS spectrum of 4Pt4Zn/MZ

	Shell	N	R (Å)	$\Delta\delta^2$ (Å^2)	R-factor	ΔE_0 (eV)
Pt foil	Pt-Pt	12.0	2.768 (±0.00285)	0.00472 (±0.00034)	0.00145	8.159 (±0.647)
4Pt4Zn/MZ	Pt-Zn	6.4 (±0.0037)	2.618 (±0.00327)	0.00895 (±0.00054)	0.00125	6.442 (±1.026)
	Pt-Pt	4.0 (±0.4679)	2.857 (±0.01335)	0.01359 (±0.00307)		

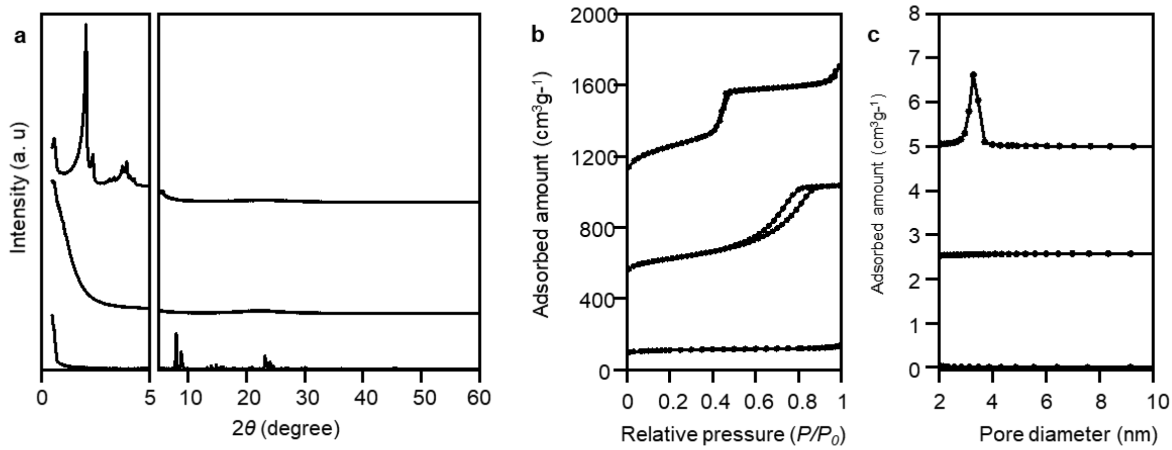

Figure S4. a) XRD patterns, b) N_2 adsorption-desorption isotherms, and c) pore size distribution of MCM-48, silica gel, and BZ (offsets: b) 500 $cm^3\ g^{-1}$, c) 2.5 $cm^3\ g^{-1}\ nm^{-1}$)

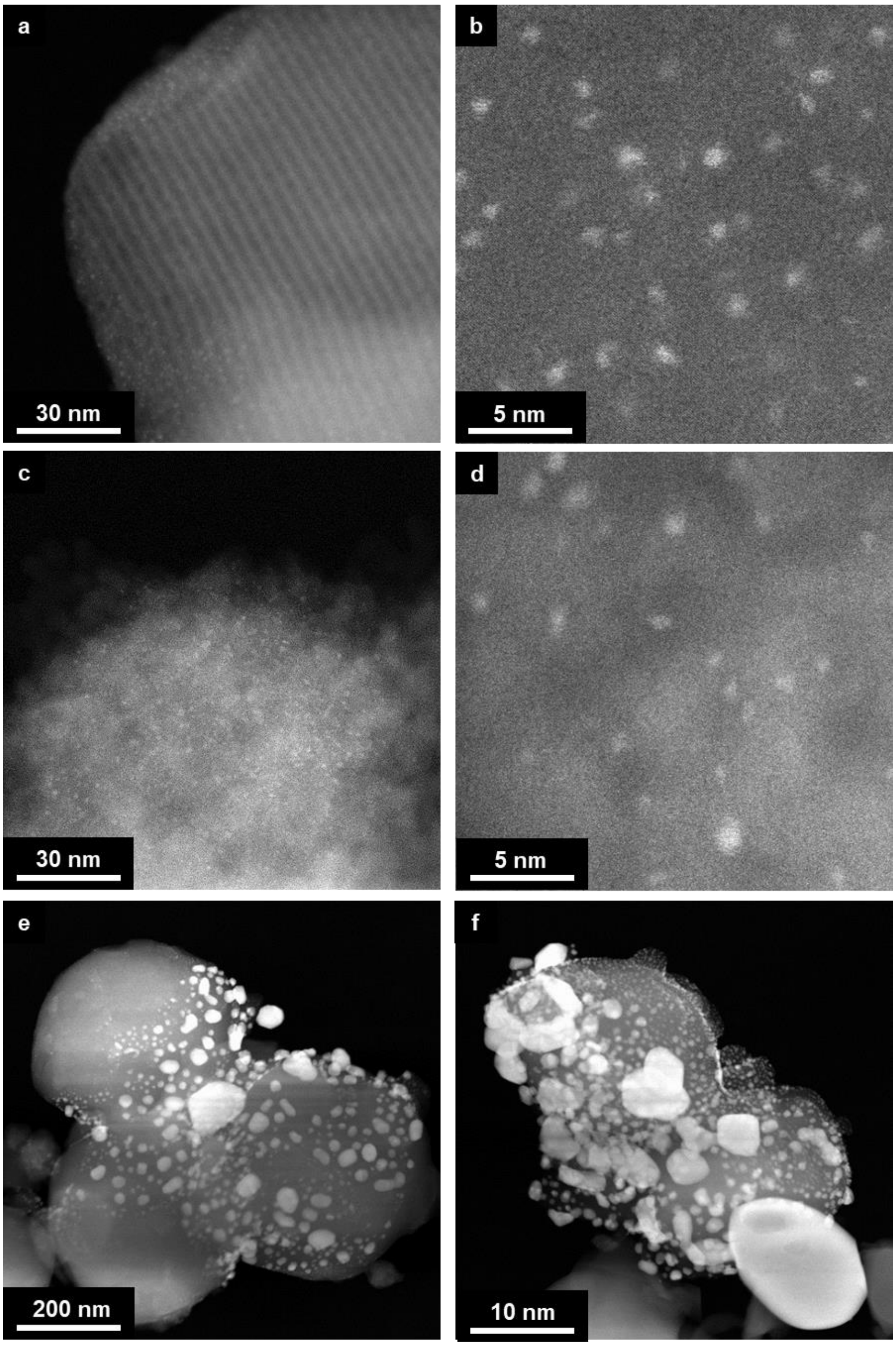

Figure S5. High-resolution HAADF-STEM images of a, b) 1Pt1Zn/MCM-48, c, d) 1Pt1Zn/silica gel, and e, f) 1Pt1Zn/BZ

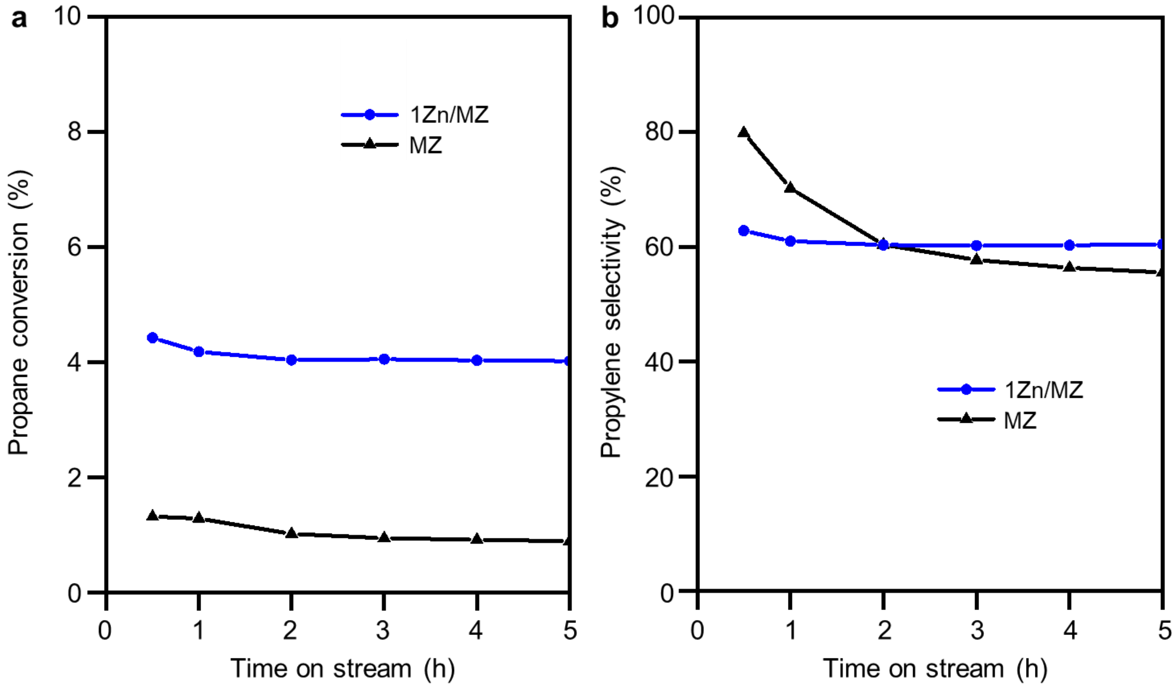

Figure S6. a) Propane conversion and b) propylene selectivity measured from 1 wt% Zn supported on MZ and MZ ($WHSV_{total}$ = 13 h^{-1}, pure propane flow, temperature = 580 °C)

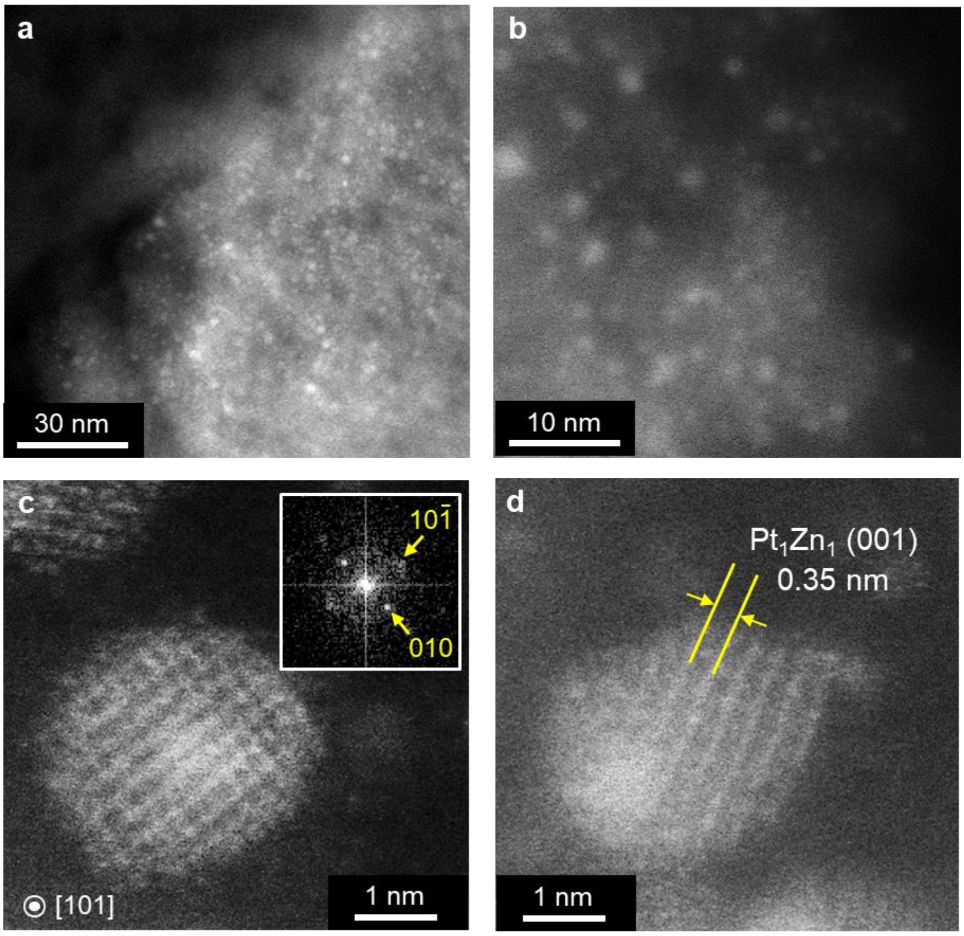

Figure S7. a) Low-magnification and b) high-magnification HAADF-STEM images of spent 1Pt1Zn/MZ c,d) AR-HAADF STEM image of the PtZn intermetallic compound-type alloy nanoparticle in spent 1Pt1Zn/MZ and the corresponding FFT images in inset of c.

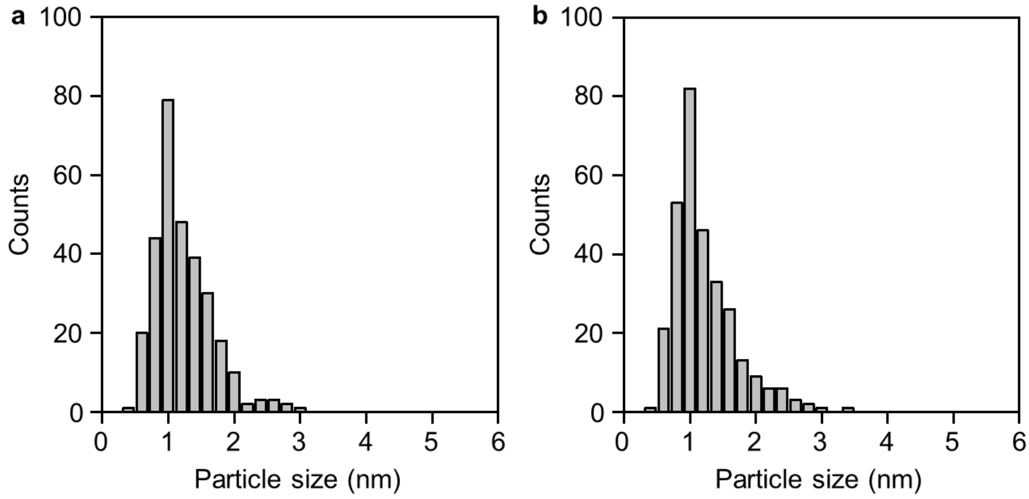

Figure S8. Particle size distribution plots obtained from a) fresh 1Pt1Zn/MZ and b) spent 1Pt1Zn/MZ

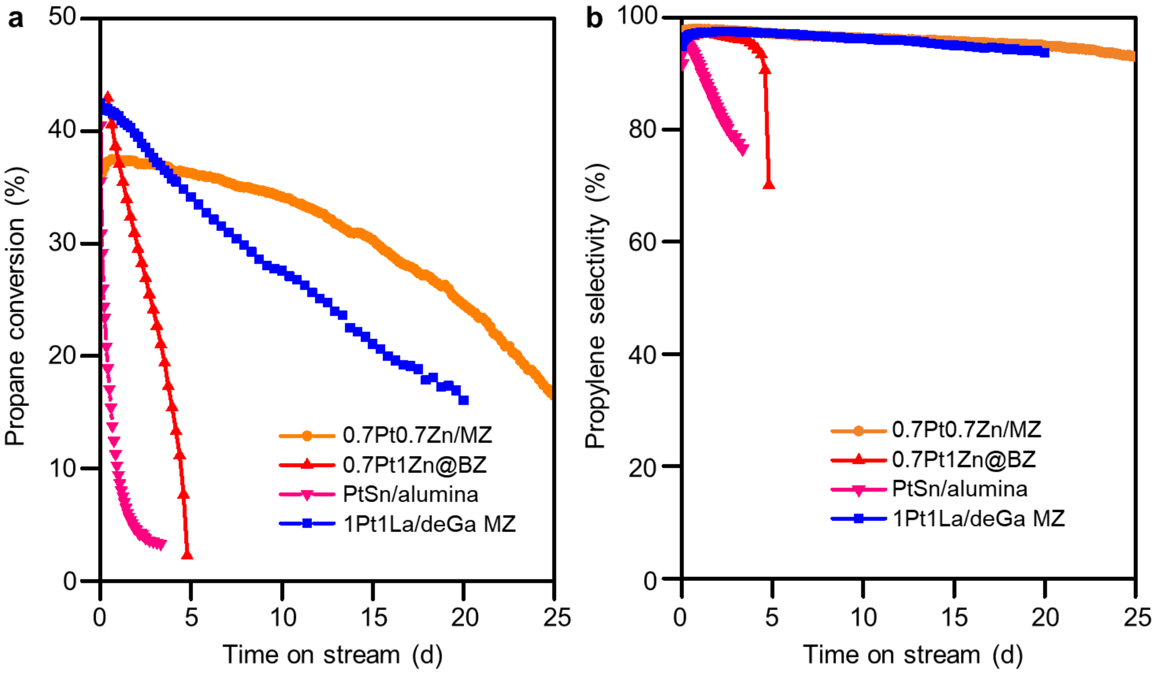

Figure S9. a) Propane conversion and b) propylene selectivity measured from 0.7Pt0.7Zn/MZ, 0.7Pt1Zn@BZ, PtSn/alumina and PtLa interemtallic alloy nanoparticles supported on degallated mesoporous zeolite (denoted as 1PtLa/deGa MZ) ($WHSV_{Pt}$ = 1300 h^{-1}, pure propane flow, temperature = 580 °C)

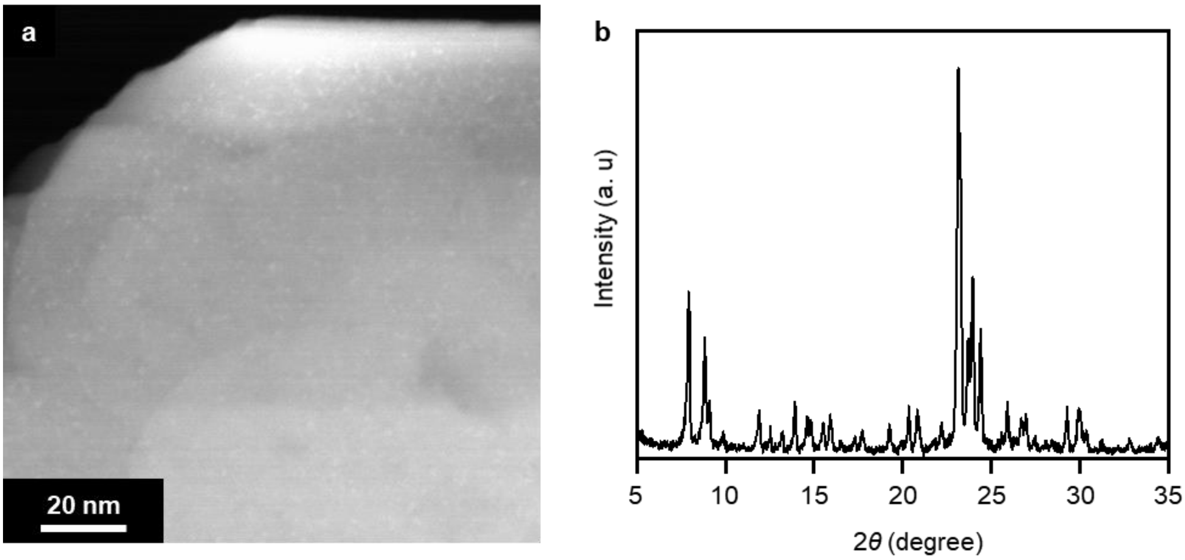

Figure S10. a) TEM image and b) XRD pattern of 0.7Pt1Zn@BZ

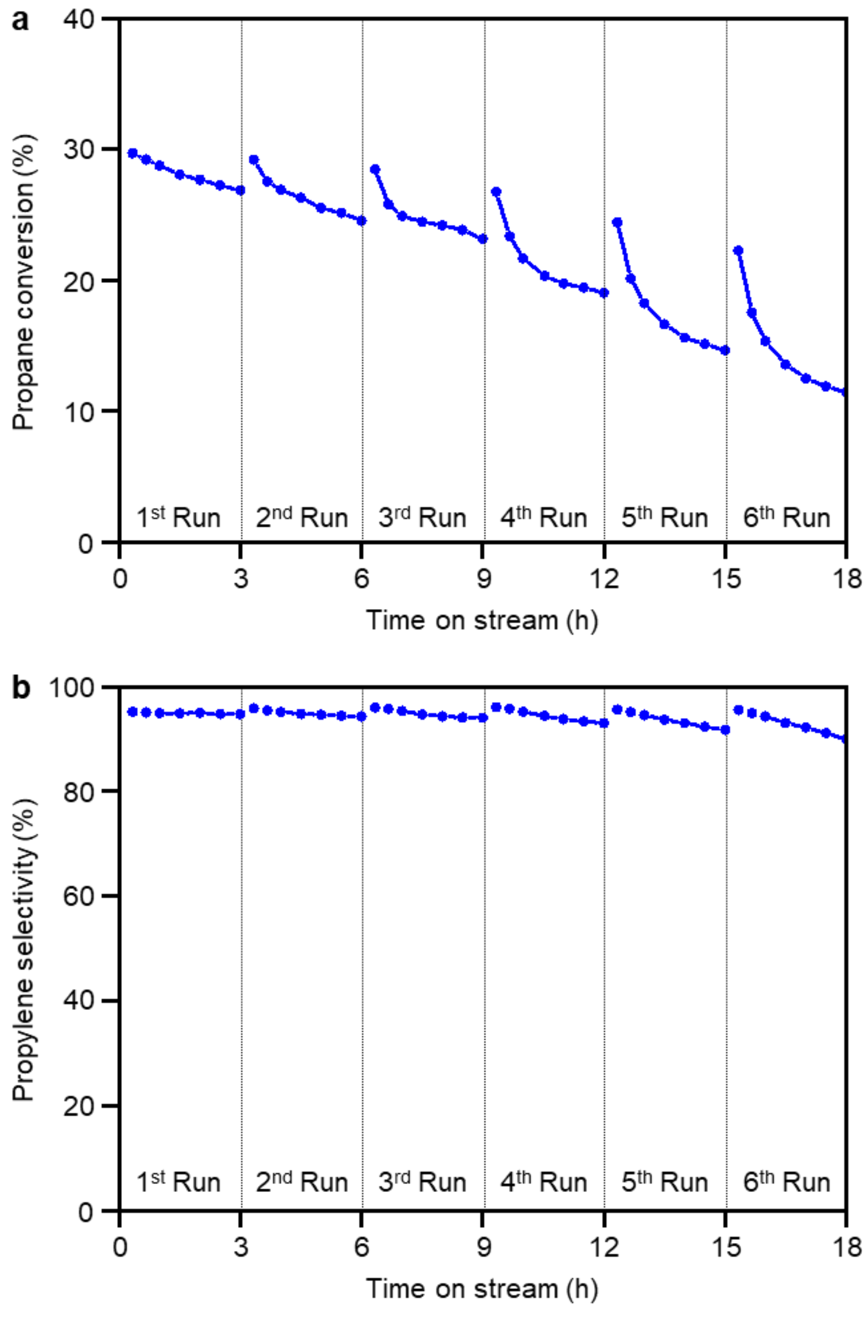

Figure S11. a) Propane conversion and b) propylene selectivity measured from 1Pt1Zn/MZ after five regeneration cycles ($WHSV_{total}$ = 130 h^{-1}, $WHSV_{Pt}$ = 13000 h^{-1}, pure propane flow, temperature = 580 °C). The regeneration treatment was performed by 350 °C air calcination for 4h followed by 580 °C H_2 reduction for 2h.

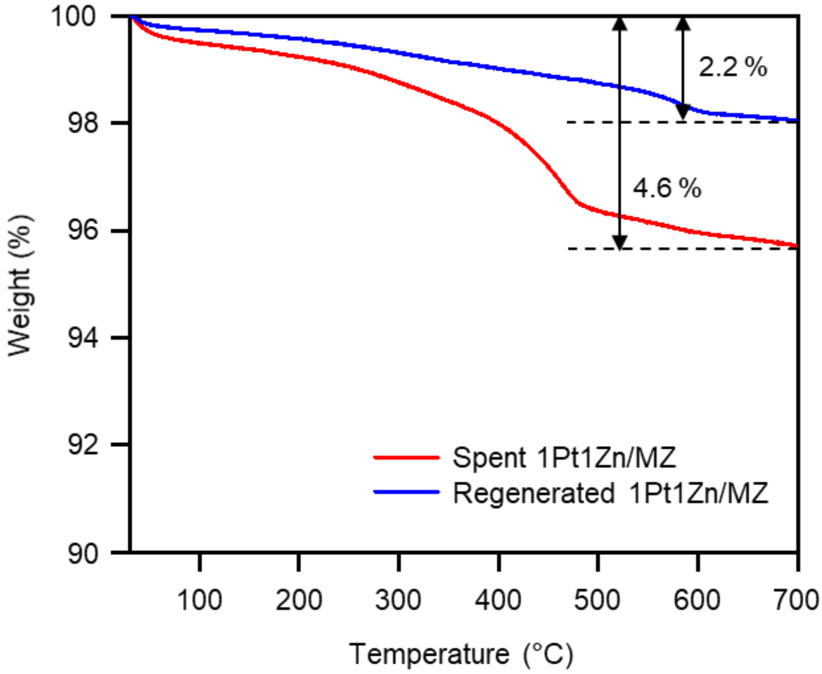

Figure S12. TGA results of the 1Pt1Zn/MZ catalysts after the 1st run and after the following regeneration treatment with air at 350°C, indicating that 52% of coke (probably near metal catalyst surfaces) was removed by air at 350 °C

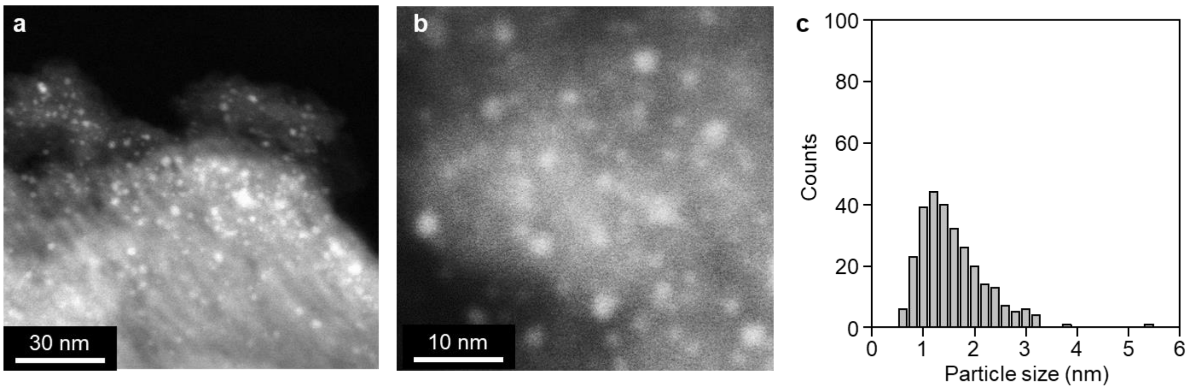

Figure S13. a) Low-magnification and b) high-magnification HAADF-STEM images of 1Pt1Zn/MZ after five regeneration cycles. c) particle size distribution plot obtained from 1Pt1Zn/MZ after five regeneration cycles

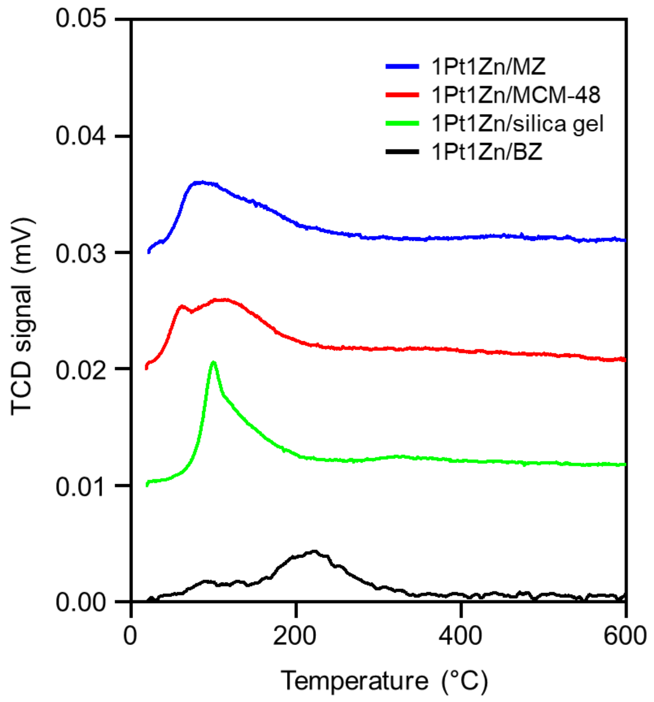

Figure S14. TPR profile of 1 wt% Pt and 1 wt% Zn supported on MZ, MCM-48 mesoporous silica, silica gel, and alumina prepared by incipient-wetness impregnation of metal precursors and heat treatment under O_2 flow at 350 °C (offset = 0.01 mV)

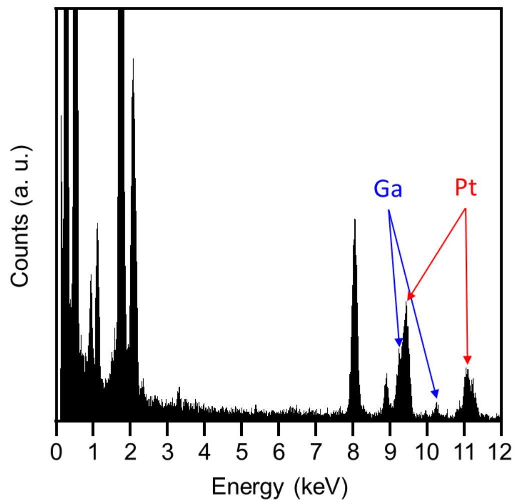

Figure S15. EDS spectrum of 1Pt1Ga/MZ obtained from a metal nanoparticle

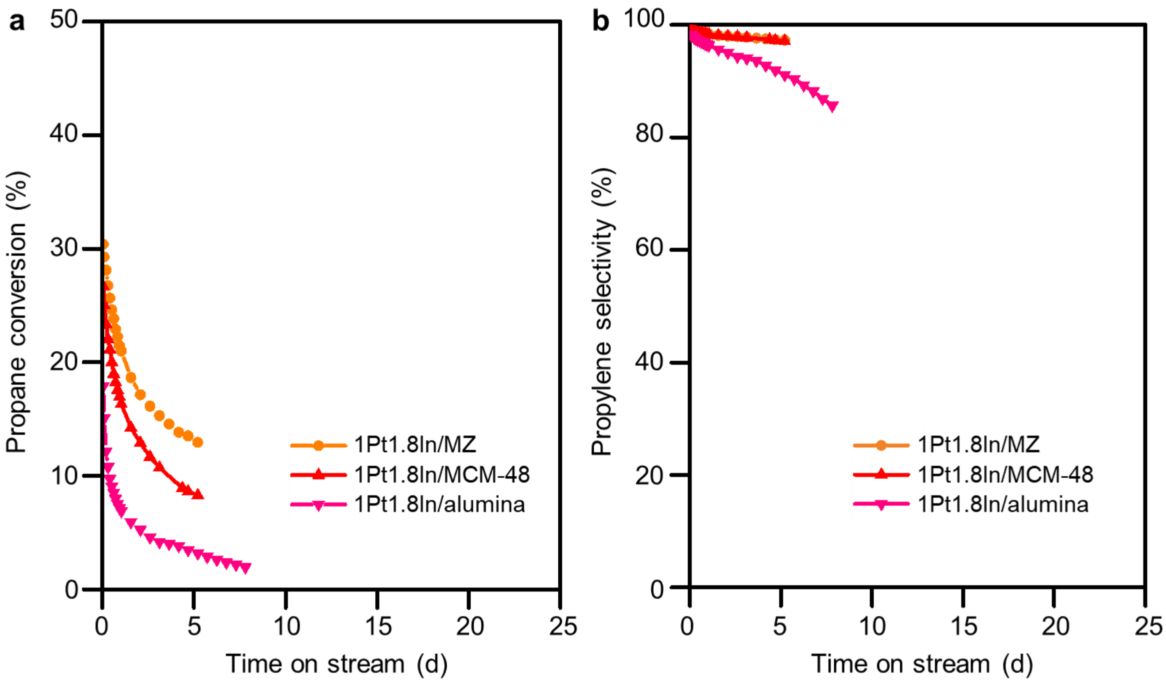

Figure S16. a) Propane conversion and b) propylene selectivity measured from 1Pt1.8In/MZ, 1Pt1.8In/MCM-48, 1Pt1.8In/alumina (WHSV = 1300 $h^{-1}g_{Pt}^{-1}$ with pure propane flow, temperature = 580 °C)