

Supplementary Information

Alkali metal modified Pt/EG-TiO₂ catalysts for CO oxidation with efficient resistance to SO₂ and H₂O

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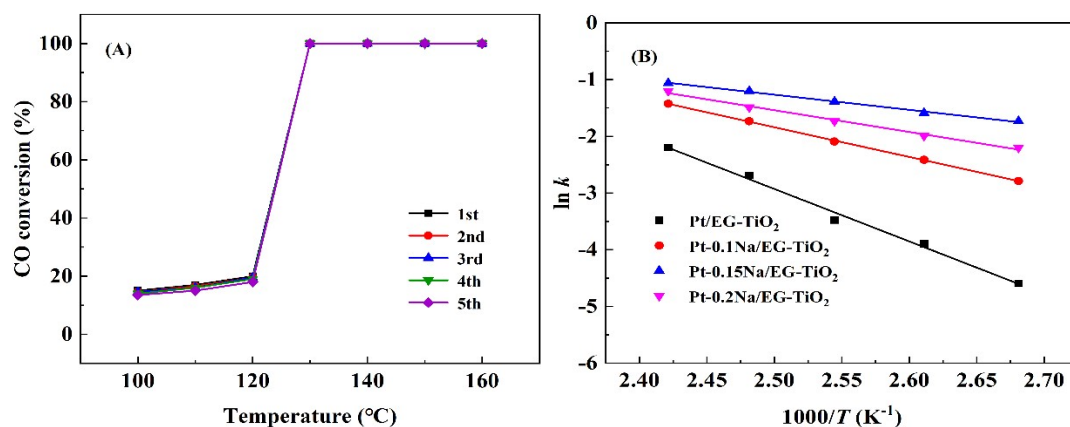


Fig. S1 (A) Cycling of CO conversion over the Pt-0.15Na/EG-TiO₂ catalysts and (B) Arrhenius plots for CO oxidation over the catalysts. Reaction condition: 1 vol% CO, 6 vol% O₂, He (balance); GHSV = 400,000 hr⁻¹.

Table S1 Pt and Na contents in the samples determined by the ICP-AES technique, the dispersion of Pt in the samples determined by CO chemisorption and apparent activation energies (E_a) for CO oxidation over the samples.

Samples	Pt content (%)	Na content (%)	Pt dispersion (%)	E_a (kJ·mol ⁻¹)
Pt/EG-TiO ₂	0.92	-	29.7	62.3
Pt-0.1Na/EG-TiO ₂	0.91	0.09	49.3	43.6
Pt-0.15Na/EG-TiO ₂	0.90	0.13	60.1	22.2
Pt-0.2Na/EG-TiO ₂	0.91	0.18	58.2	31.9

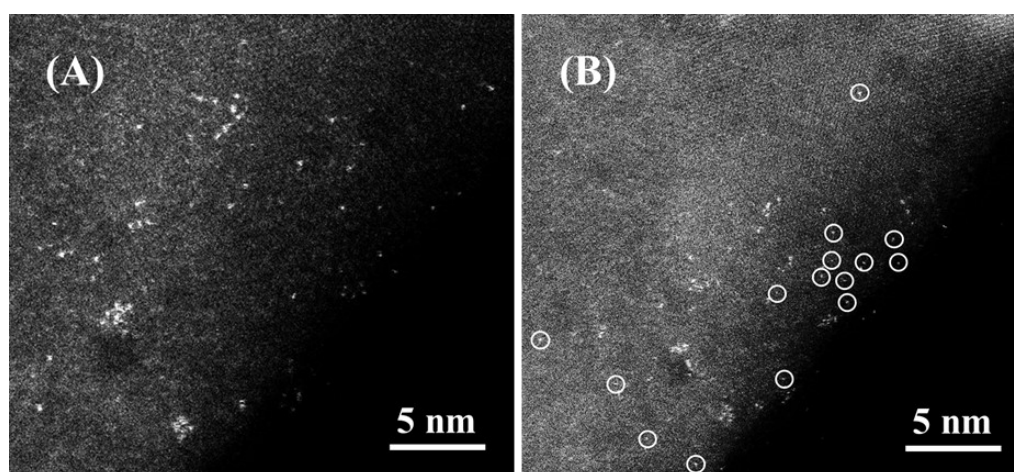


Fig. S2 (A) and (B) AC-TEM images of Pt-0.15Na/EG-TiO₂ catalysts.

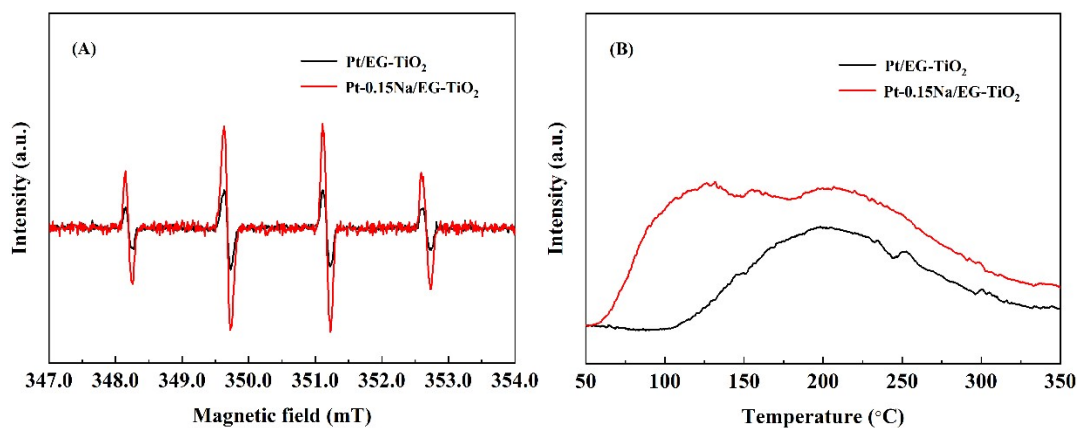


Fig. S3 (A) ESR and (B) O₂-TPD spectra of catalysts.

Table S2 EXAFS fitting parameters for the Pt L₃ sides of the samples.

Samples	Shell	N^a	R (Å) ^b	σ^2 (Å ²) ^c	ΔE_0 (eV) ^d	R factor
Pt foil	Pt-Pt	12*	2.766 ± 0.001	0.0045 ± 0.0002	10.7 ± 0.3	0.0032
	Pt-O	5.5 ± 0.3	2.012 ± 0.001	0.0028 ± 0.0005	14.0 ± 0.3	
PtO ₂	Pt-Pt	4.2 ± 1.0	3.084 ± 0.001	0.0041 ± 0.0013	10.7 ± 0.9	0.0045
	Pt-O	11.4 ± 1.6	4.018 ± 0.001	0.0036 ± 0.0001	1.5 ± 0.1	
	Pt-O	5.6 ± 0.4	2.010 ± 0.001	0.0012 ± 0.0008	12.0 ± 0.4	
Pt/EG-TiO ₂	Pt-Pt	6.1 ± 0.1	3.092 ± 0.001	0.0032 ± 0.0006	9.7 ± 1.0	0.0096
	Pt-O	22.6 ± 0.1	4.036 ± 0.001	0.0081 ± 0.0023	0.6 ± 0.8	
	Pt-O	5.7 ± 0.3	1.984 ± 0.001	0.0017 ± 0.0007	12.0 ± 0.6	
Pt-0.15Na/EG-TiO ₂	Pt-Pt	1.9 ± 0.1	3.185 ± 0.001	0.0044 ± 0.0019	13.1 ± 1.1	0.0077
	Pt-O	9.6 ± 0.1	3.656 ± 0.001			

^a N : Coordination numbers; ^b R : Bond distance; ^c σ^2 : Debye-Waller factors; ^d ΔE_0 : The inner potential correction; *: According to the experimental EXAFS fit of Pt foil reference as the known crystallographic value.

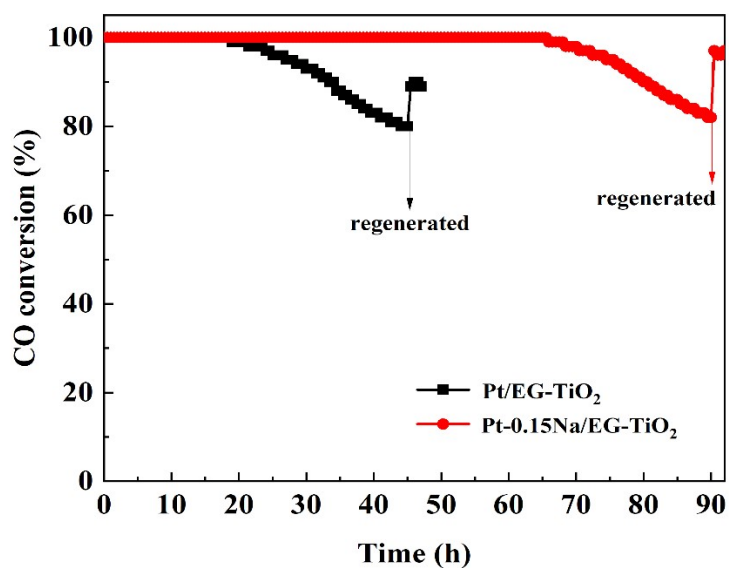


Fig. S4 SO₂ and H₂O resistance of the regenerated catalysts. Reaction condition: 1 vol% CO, 6 vol% O₂, 100 ppm SO₂, 10 vol% H₂O, He (balance); GHSV = 400,000 h⁻¹; temperature = 220 °C. Regeneration condition: 1 vol% CO, 6 vol% O₂, He (balance); GHSV = 400,000 h⁻¹; temperature = 350 °C constant for 3 h.

Table S3 SO₂ and H₂O resistance of the catalysts on reported literatures.

Catalysts	Reaction condition	Time (h)	CO conversion (%)	Reference
Pt-1P&M/TiO ₂	0.8 vol% CO, 15 vol% O ₂ , 50 ppm SO ₂ , 15 vol% H ₂ O, N ₂ (balance); GHSV = 30,000 h ⁻¹ ; temperature = 170 °C.	72	99	30
Pt/Keg-CeTi	1 vol% CO, 6 vol% O ₂ , 100 ppm SO ₂ , 10 vol% H ₂ O, He (balance); GHSV = 400,000 h ⁻¹ ; temperature = 200 °C.	30	93	64
0.1Pt-5W/Ti-A	1 vol% CO, 16 vol% O ₂ , 50 ppm SO ₂ , 10 vol% H ₂ O, N ₂ (balance); GHSV = 90,000 mL·g ⁻¹ ·h ⁻¹ ; temperature = 220 °C.	26	85	69
Pt-0.15Na/EG-TiO ₂	1 vol% CO, 6 vol% O ₂ , 100 ppm SO ₂ , 10 vol% H ₂ O, He (balance); GHSV = 400,000 h ⁻¹ ; temperature = 220 °C.	66	100	This work

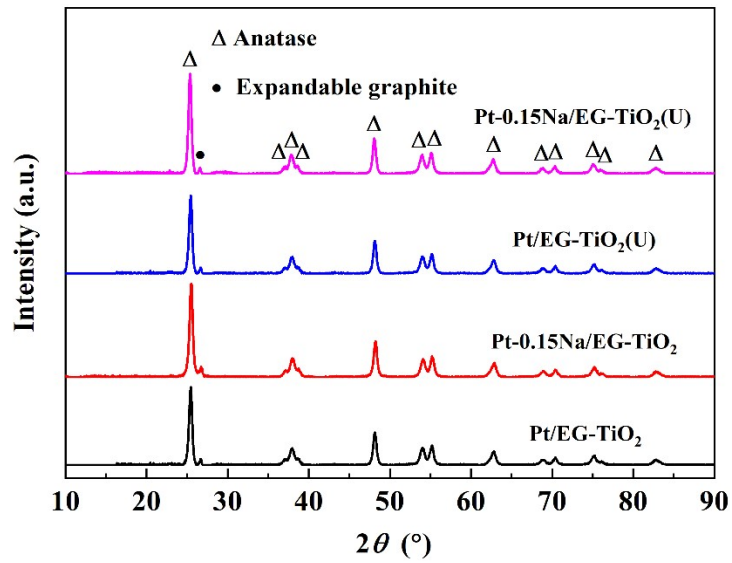


Fig. S5 XRD patterns of the as-obtained catalysts.

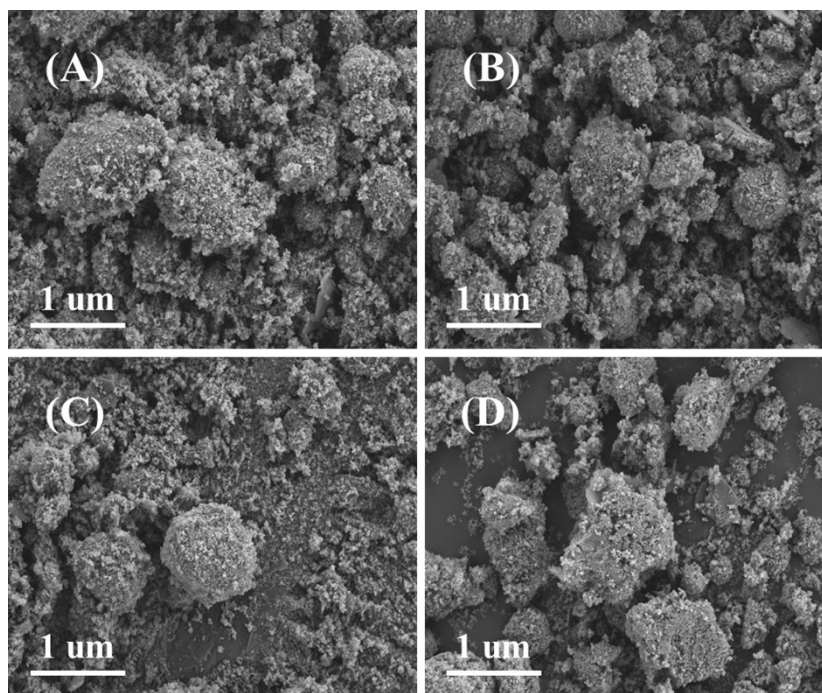


Fig. S6 SEM images of (A) Pt/EG-TiO₂, (B) Pt-0.15Na/EG-TiO₂, (C) Pt/EG-TiO₂(U), and (D) Pt-0.15Na/EG-TiO₂(U).

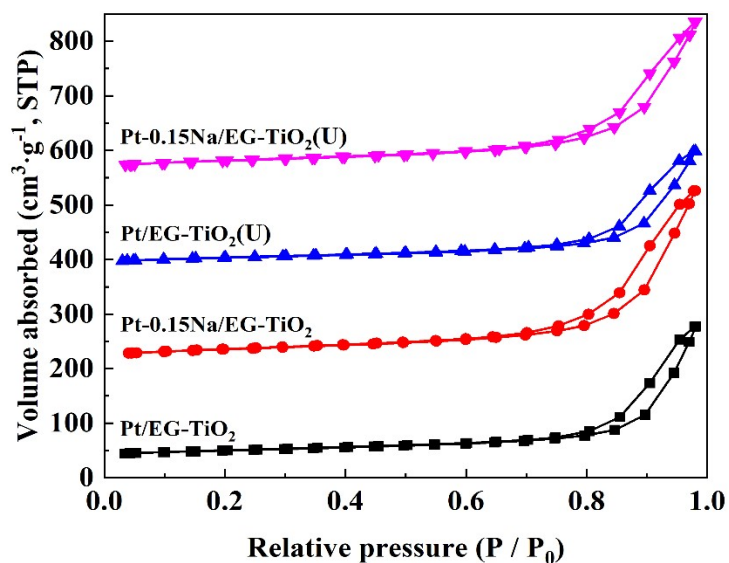


Fig. S7 N₂ adsorption-desorption isotherms of the samples.

Table S4 BET surface areas, pore volumes, and pore sizes of the samples.

Samples	BET surface area (m ² ·g ⁻¹)	Pore volume (cm ³ ·g ⁻¹)	Pore size (nm)
Pt/EG-TiO ₂	97	0.5	18.1
Pt-0.15Na/EG-TiO ₂	98	0.5	18.1
Pt/EG-TiO ₂ (U)	92	0.4	17.5
Pt-0.15Na/EG-TiO ₂ (U)	95	0.4	17.9

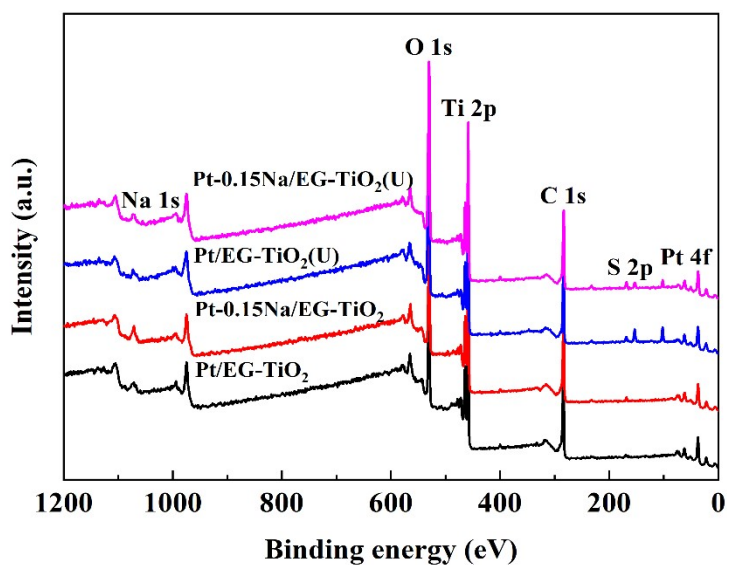


Fig. S8 XPS survey spectrum of the samples.

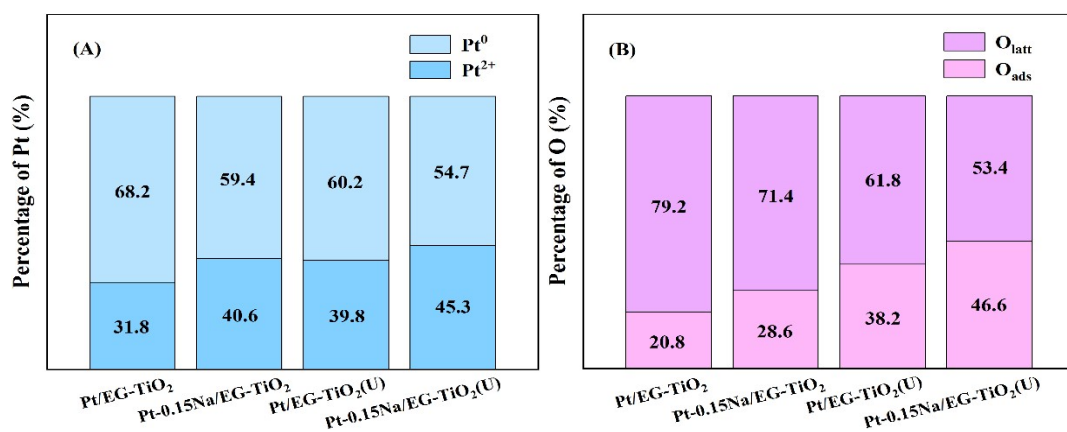


Fig. S9 Surface element compositions of (A) Pt and (B) O on the samples.

Table S5 XPS binding energies (BEs) of the samples.

Samples	Pt ²⁺ 4f		Pt ⁰ 4f		O _{ads} 1s		O _{latt} 1s	
	BE	Area	BE	Area	BE	Area	BE	Area
Pt/EG-TiO ₂	72.5	14.4	71.4	33.5				
					531.4	20.8	529.4	79.2
	75.9	17.4	74.4	34.7				
Pt-0.15Na/EG-TiO ₂	72.4	21.1	71.1	27.7				
					531.3	28.6	529.3	71.4
	75.9	19.5	74.3	31.7				
Pt/EG-TiO ₂ (U)	72.1	21.9	71.3	20.9				
					531.3	38.2	529.2	61.8
	75.8	17.9	74.2	39.3				
Pt-0.15Na/EG-TiO ₂ (U)	72.3	15.5	71.1	22.3				
					531.0	46.6	529.2	53.4
	75.7	29.8	74.3	32.4				

The unit of BE is (eV) and Area is percentage content (%).

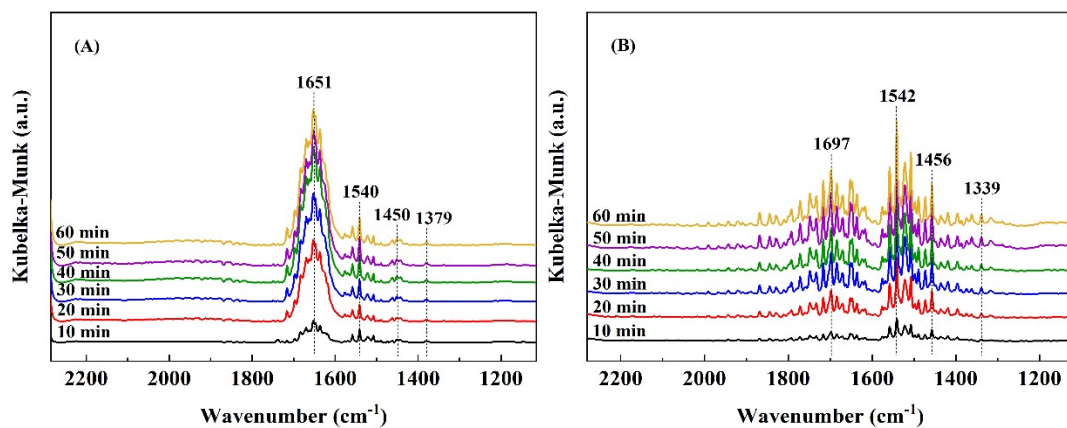


Fig. S10 At 220 °C, CO + O₂ + SO₂ DRIFTS spectra of (A) the Pt/EG-TiO₂ catalysts with time, and (B) the Pt-0.15Na/EG-TiO₂ catalysts with time. Reaction conditions: 1 vol% CO, 16 vol% O₂, 100 ppm SO₂.

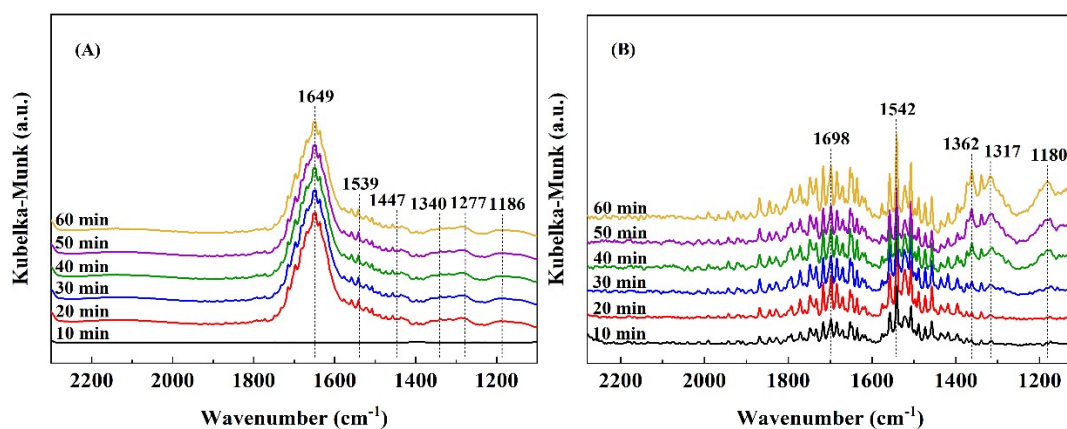


Fig. S11 At 220 °C, CO + O₂ + SO₂ + H₂O DRIFTS spectra of (A) the Pt/EG-TiO₂ catalysts with time, and (B) the Pt-0.15Na/EG-TiO₂ catalysts with time. Reaction conditions: 1 vol% CO, 16 vol% O₂, 100 ppm SO₂, 3 vol% H₂O, He (balance).