

Influences of doping and thermal stability on the catalytic performance of CuO/Ce₂₀M₁O_x (M = Zr, Cr, Mn, Fe, Co, Sn) catalysts for NO reduction by CO

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Supplementary data

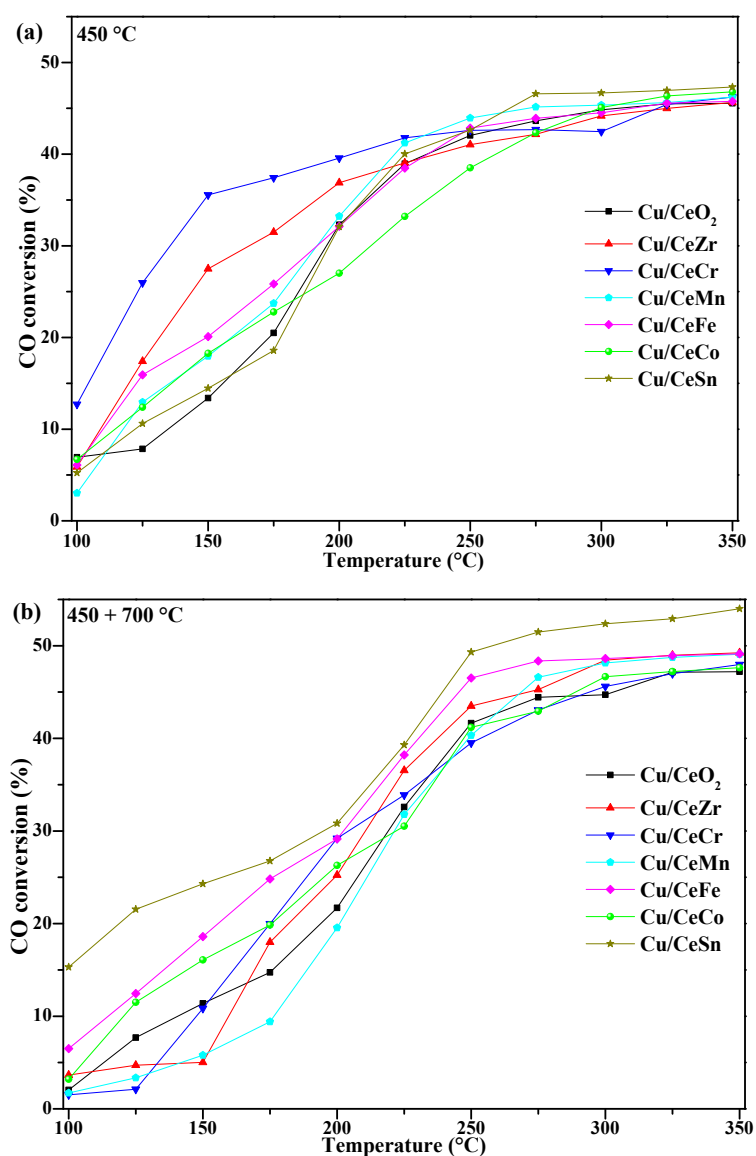


Fig. S1. The results of CO conversion (%) over these fresh (a) and aged (b) samples as a function of reaction temperatures. Reaction conditions: 5% NO, 10% CO, and balanced He; SV = 24,000 mL/g·h.

Table S1. The data of NO and CO conversions, N₂ selectivity, and N₂ yield of fresh catalysts.

Temp./°C	%	Cu/CeO ₂	Cu/CeZr	Cu/CeCr	Cu/CeMn	Cu/CeFe	Cu/CeCo	Cu/CeSn
100	NO con.	28.04	15.89	18.26	17.33	19.05	22.39	19.24
	CO con.	6.93	5.89	12.71	3.03	6.09	6.71	5.24
	N ₂ sel.	20.91	23.36	23.84	23.32	21.03	22.83	24.44
	N ₂ yie.	5.86	3.71	4.35	4.02	4.01	5.11	4.70
125	NO con.	43.95	81.10	74.25	54.42	72.21	51.13	42.63
	CO con.	7.84	17.40	25.97	12.94	15.93	12.38	10.61
	N ₂ sel.	16.53	18.83	18.14	13.21	11.22	13.46	15.80
	N ₂ yie.	7.26	15.27	13.47	7.19	8.10	6.88	6.74
150	NO con.	65.35	93.43	93.02	81.95	89.15	84.38	64.87
	CO con.	13.39	27.50	35.56	17.97	20.10	18.27	14.45
	N ₂ sel.	18.92	44.47	41.54	15.92	15.04	13.16	15.56
	N ₂ yie.	12.37	41.55	38.64	13.05	13.40	11.10	10.10
175	NO con.	73.15	94.40	95.37	84.66	94.47	92.30	73.25
	CO con.	20.50	31.50	37.42	23.72	25.84	22.78	18.58
	N ₂ sel.	38.85	49.34	56.54	37.52	27.62	20.18	35.00
	N ₂ yie.	28.42	46.57	53.92	31.76	25.15	18.63	25.64
200	NO con.	87.88	96.05	96.20	90.80	95.39	95.97	87.42
	CO con.	32.29	36.89	39.57	33.23	32.12	27.01	32.08
	N ₂ sel.	71.46	67.27	73.26	68.33	48.27	31.87	79.84
	N ₂ yie.	62.80	64.61	70.48	62.04	46.04	30.58	69.80
225	NO con.	92.73	96.79	96.95	95.85	97.16	96.06	94.54
	CO con.	38.95	39.04	41.78	41.22	38.47	33.20	40.02
	N ₂ sel.	81.49	75.44	78.46	85.49	72.13	52.32	90.67
	N ₂ yie.	75.57	73.02	76.07	81.94	70.09	50.26	85.72
250	NO con.	95.30	97.19	97.37	97.58	99.65	99.52	97.45
	CO con.	42.04	41.03	42.59	43.94	42.85	38.50	42.63
	N ₂ sel.	86.22	79.86	82.41	91.96	86.85	70.95	94.87
	N ₂ yie.	82.17	77.61	80.25	89.74	86.54	70.61	92.46
275	NO con.	99.31	99.52	99.56	100	100	100	97.45
	CO con.	43.64	42.16	42.68	45.14	43.91	42.33	46.59
	N ₂ sel.	90.58	84.23	85.97	96.22	92.88	82.70	95.81
	N ₂ yie.	89.96	83.83	85.60	96.22	92.88	82.70	93.63
300	NO con.	100	100	100	100	100	100	98.16
	CO con.	44.84	44.18	42.46	45.34	44.51	45.09	46.68
	N ₂ sel.	93.02	89.17	90.28	96.57	95.41	90.19	100
	N ₂ yie.	93.02	89.17	90.28	96.57	95.41	90.19	98.16
325	NO con.	100	100	100	100	100	100	100
	CO con.	45.48	44.99	45.43	45.63	45.56	46.35	46.96
	N ₂ sel.	95.75	92.63	94.22	100	100	93.31	100
	N ₂ yie.	95.75	92.36	94.22	100	100	93.31	100
350	NO con.	100	100	100	100	100	100	100
	CO con.	45.55	45.64	46.23	46.22	45.76	46.80	47.32
	N ₂ sel.	97.28	100	100	100	100	100	100
	N ₂ yie.	97.28	100	100	100	100	100	100

Table S2. The data of NO and CO conversions, N₂ selectivity, and N₂ yield of aged catalysts.

Temp./°C		Cu/CeO ₂	Cu/CeZr	Cu/CeCr	Cu/CeMn	Cu/CeFe	Cu/CeCo	Cu/CeSn
100	NO con.	11.58	8.15	3.85	8.39	22.56	10.01	12.86
	CO con.	2.04	3.64	1.52	1.72	6.50	3.19	15.31
	N ₂ sel.	33.95	44.48	44.23	44.90	20.06	31.20	29.77
	N ₂ yie.	3.93	3.62	1.70	3.77	5.88	3.12	3.83
125	NO con.	32.12	39.06	10.25	35.13	44.74	38.14	39.26
	CO con.	7.69	4.71	2.12	3.35	12.45	11.50	21.55
	N ₂ sel.	20.49	16.91	37.07	18.61	16.49	14.83	17.28
	N ₂ yie.	6.58	6.60	3.80	6.54	7.38	5.66	6.98
150	NO con.	45.81	54.05	36.01	48.28	81.26	63.25	53.80
	CO con.	11.38	5.02	10.58	5.79	18.59	16.08	24.30
	N ₂ sel.	19.47	20.47	21.13	16.91	14.38	11.77	18.66
	N ₂ yie.	8.92	11.07	7.61	8.16	11.73	7.45	10.04
175	NO con.	57.52	61.89	60.30	57.56	91.77	79.03	58.86
	CO con.	14.74	17.99	19.99	9.4	24.82	19.84	26.77
	N ₂ sel.	25.06	30.14	32.41	18.58	21.44	17.72	29.61
	N ₂ yie.	14.41	18.65	19.54	10.69	19.68	14.01	17.43
200	NO con.	70.65	77.19	79.47	67.01	92.60	84.34	67.90
	CO con.	21.70	25.24	29.21	19.55	29.14	26.28	30.83
	N ₂ sel.	56.85	52.38	57.27	30.23	37.87	35.38	58.02
	N ₂ yie.	40.16	40.43	45.51	20.26	35.07	29.84	39.40
225	NO con.	88.52	86.76	86.53	85.17	97.84	88.72	83.07
	CO con.	32.59	36.54	33.88	31.78	38.21	30.52	39.30
	N ₂ sel.	81.18	81.26	70.49	65.52	67.23	59.11	85.16
	N ₂ yie.	71.86	70.50	61.00	55.80	65.78	52.44	70.74
250	NO con.	93.61	93.33	89.53	93.71	98.99	93.63	92.96
	CO con.	41.64	43.50	39.51	40.32	46.52	41.19	49.31
	N ₂ sel.	89.24	90.49	77.57	85.50	91.81	79.34	93.26
	N ₂ yie.	83.53	84.45	69.45	80.12	90.88	74.28	86.69
275	NO con.	96.70	98.65	93.28	98.95	99.47	96.84	97.20
	CO con.	44.44	45.27	43.06	46.60	48.36	42.94	51.48
	N ₂ sel.	91.92	91.13	86.02	91.36	93.56	88.70	97.07
	N ₂ yie.	88.88	89.90	80.24	90.40	93.06	85.90	94.36
300	NO con.	98.01	99.16	95.25	99.62	99.67	97.87	99.26
	CO con.	44.72	48.45	45.61	48.14	48.62	46.66	52.37
	N ₂ sel.	94.99	95.60	91.74	94.52	100	93.01	99.49
	N ₂ yie.	93.10	94.80	87.38	94.16	99.67	91.03	98.75
325	NO con.	98.30	99.55	100	100	100	100	99.60
	CO con.	47.14	48.91	46.98	48.75	48.93	47.22	52.92
	N ₂ sel.	97.24	97.13	95.92	98.09	100	96.27	99.83
	N ₂ yie.	95.58	96.70	95.92	98.09	100	96.27	99.43
350	NO con.	99.65	99.71	100	100	100	100	100
	CO con.	47.20	49.24	47.98	49.08	49.13	47.63	54.00
	N ₂ sel.	99.45	98.97	94.22	100	100	99.61	100
	N ₂ yie.	99.10	98.68	94.22	100	100	99.61	100

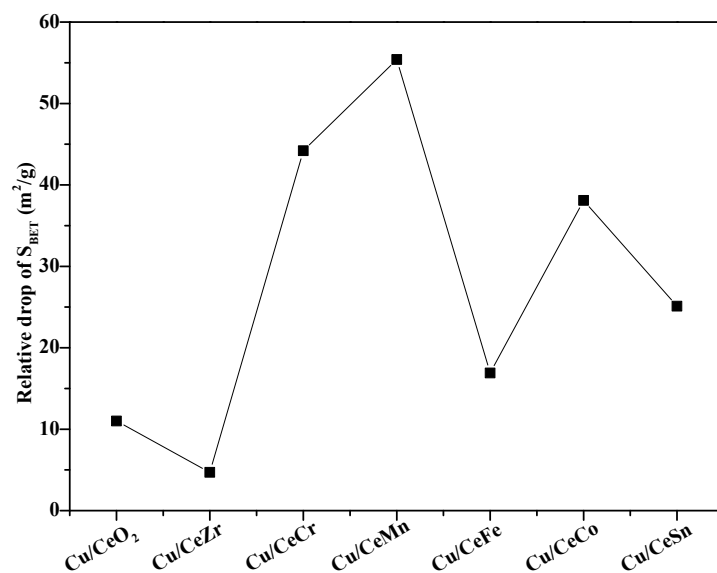


Fig. S2. The relative drop of S_{BET} from fresh to aged catalysts.

Table S3. The data information of A_I , A_{II} , and A_{III} .

Samples	A_I	A_{II}	A_{III}	$(A_I + A_{III})/A_{II}$	
450 °C	Cu/CeO ₂	353.67	32738.18	3417.77	0.1152
	Cu/CeZr	160.15	15916.96	2015.70	0.1367
	Cu/CeCr	235.83	13712.86	1438.51	0.1221
	Cu/CeMn	175.13	2455.29	697.48	0.3554
	Cu/CeFe	345.50	49968.85	5770.69	0.1224
	Cu/CeCo	295.59	27800.90	3001.60	0.1186
	Cu/CeSn	258.38	6700.79	1306.25	0.2335
450 °C + 700 °C	Cu/CeO ₂	211.64	20796.50	1520.71	0.0833
	Cu/CeZr	248.14	4866.68	164.07	0.0847
	Cu/CeCr	223.72	19278.89	1436.19	0.0861
	Cu/CeMn	307.54	23238.04	2427.58	0.1177
	Cu/CeFe	309.32	35958.08	3232.55	0.0985
	Cu/CeCo	327.60	34648.37	2860.05	0.0920
	Cu/CeSn	278.35	12440.31	2092.77	0.1906

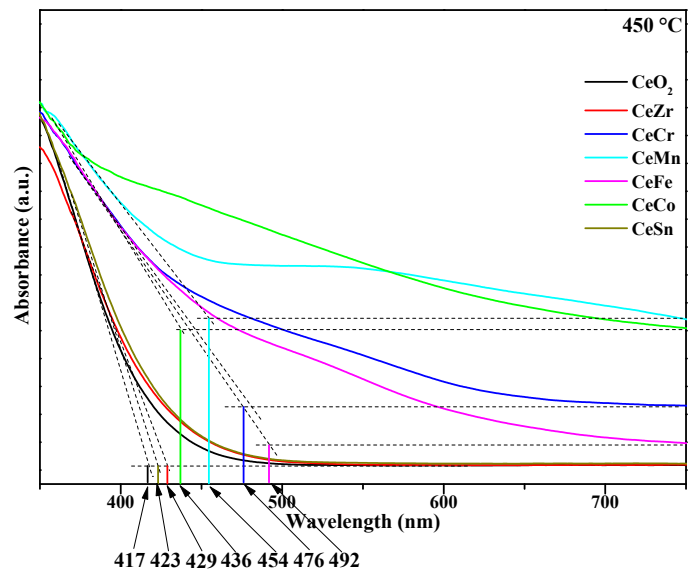


Fig. S3. The positions of absorption edges of these supports.