Supplementary Information:

Procedure for CO chemisorption:

Chemisorption experiments of carbon monoxide were conducted at 40°C utilising AutoChem 2950 Micromeritics apparatus. A 100 mg catalyst sample was introduced into a reactor and reduced with pure hydrogen for 30 minutes at 750 °C. The sample was subsequently cooled to 40°C in a helium flow.

The adsorption of CO was conducted via the pulse chemisorption method with a 10% CO/He gas mixture. The results were computed based on the assumption that the adsorption stoichiometry of CO/Ni is 1:1.

Table S1: TableS1: Textural properties of spent catalysts

Catalyst (spent)	Surface Area ($m^2 g^{-1}$)	Pore volume ($cm^3 g^{-1}$)	Pore size (nm)
Ni/SA	247	0.57	5.68
Ba-Ni/SA	221	0.53	5.68
La-Ni/SA	165	0.44	7.12
Ce-Ni/SA	212	0.52	6.22

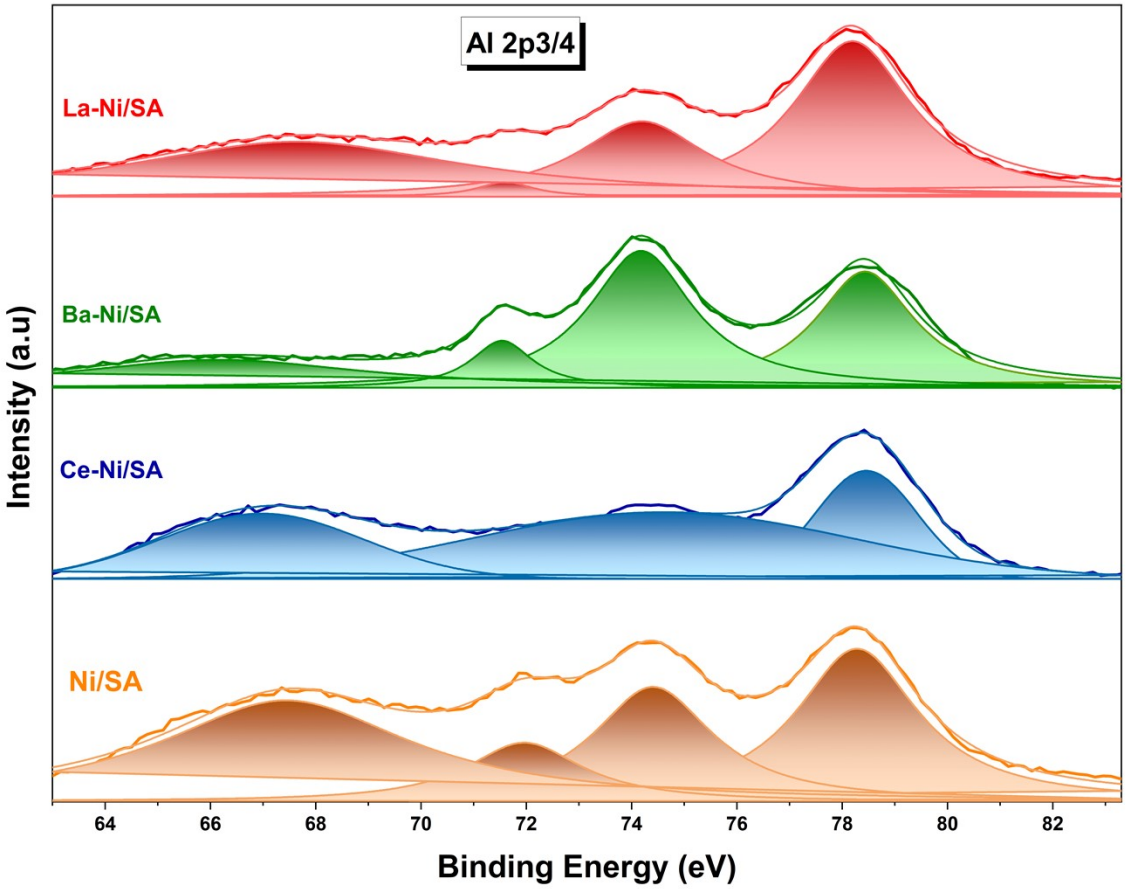


Figure S1: Al 2p XPS spectra of calcined X-Ni/SA catalysts

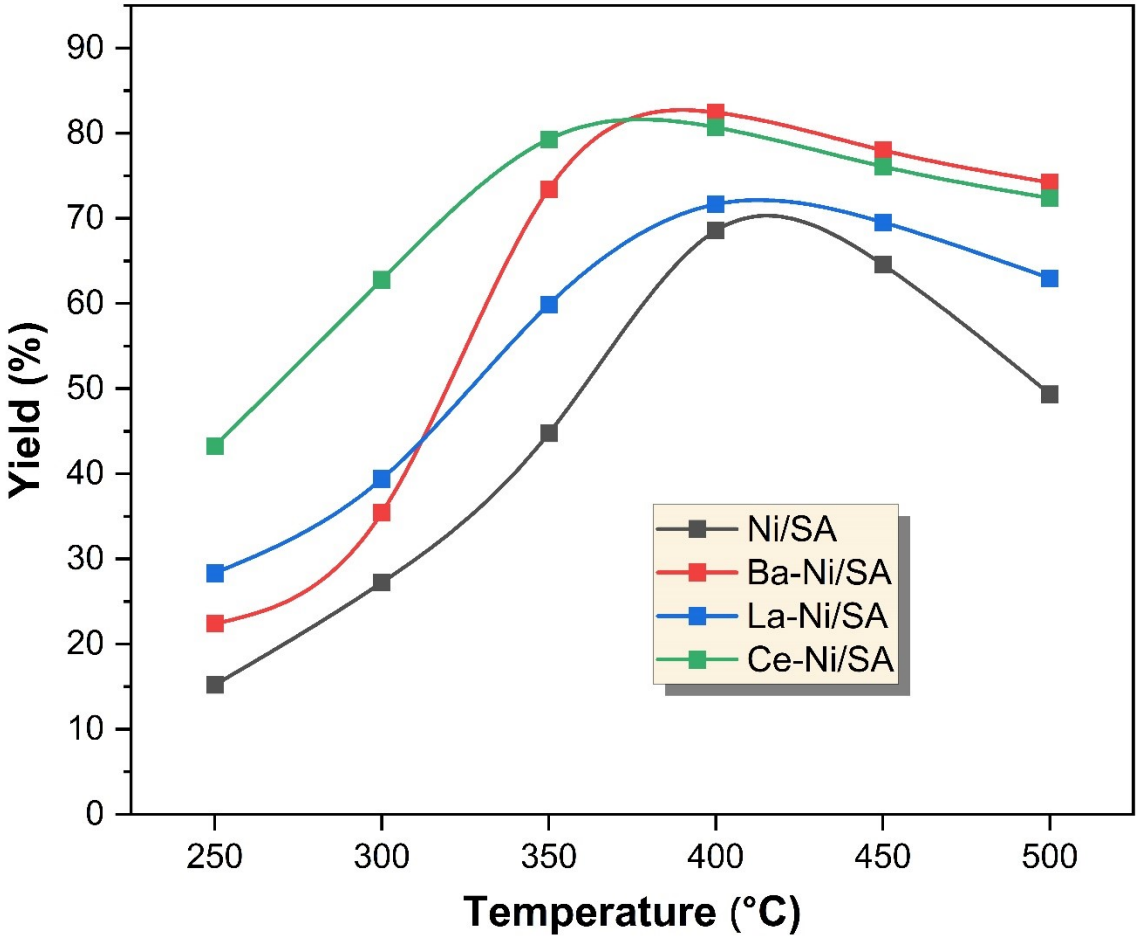


Figure S2: Product yield of X-Ni/SA catalysts; 1 atm, 250-500 °C, 12000 ml/g.h, H_2:CO_2=4/1

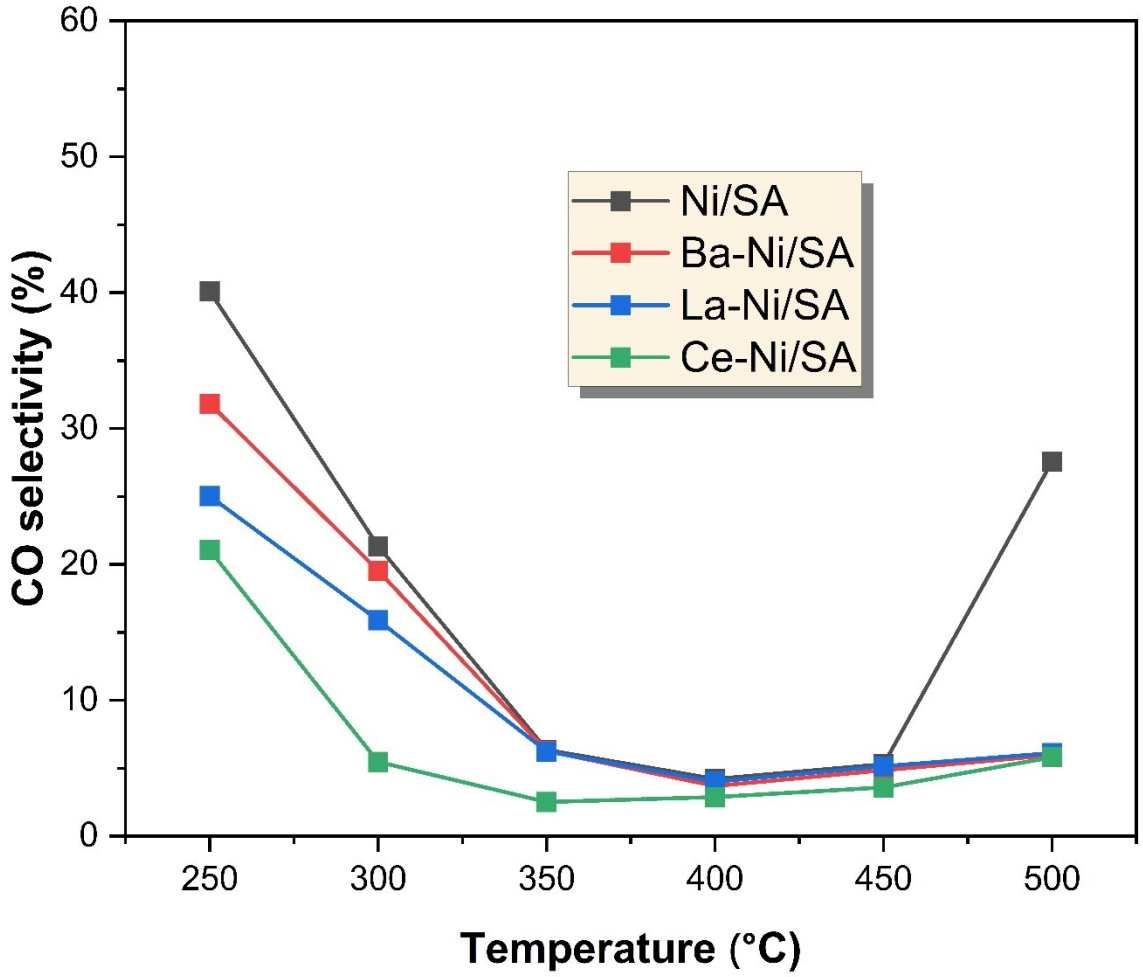
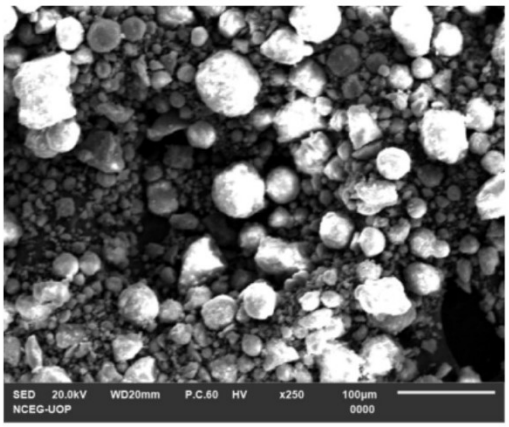


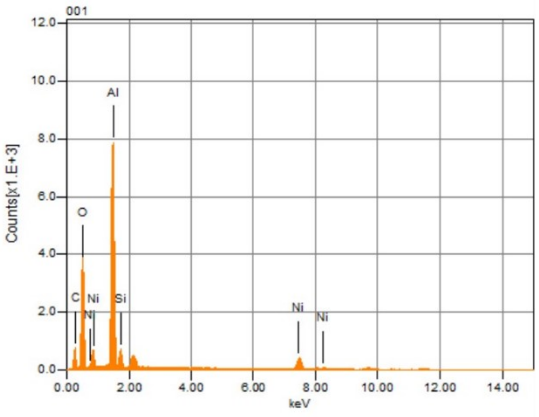
Figure S3: CO selectivity of X-Ni/SA catalysts; 1 atm, 250-500 °C, 12000 ml/g.h, H_2:CO_2=4/1

Table S2: FWMH data for calcined sample to calculate crystal size using Scherrer equation

Sample	**FWHM (rad)**
Ni/SA	2.30
Ba-Ni/SA	1.98
La-Ni/SA	2.95
Ce-Ni/SA	2.87

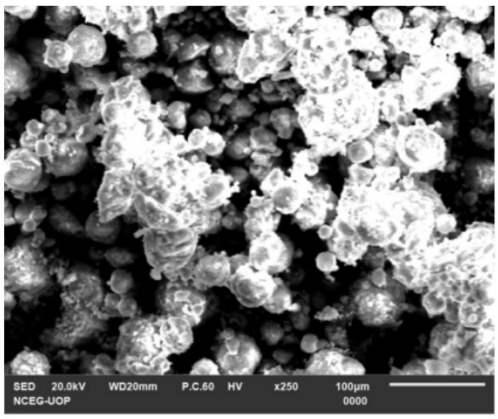
(a)

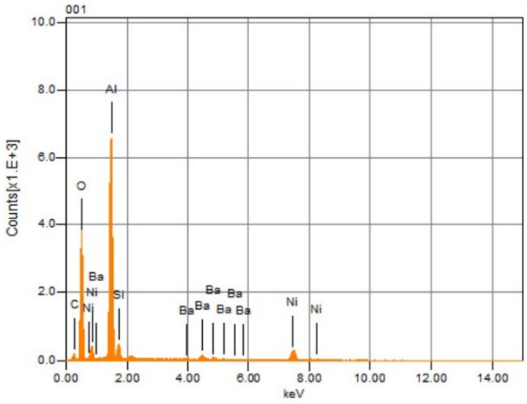




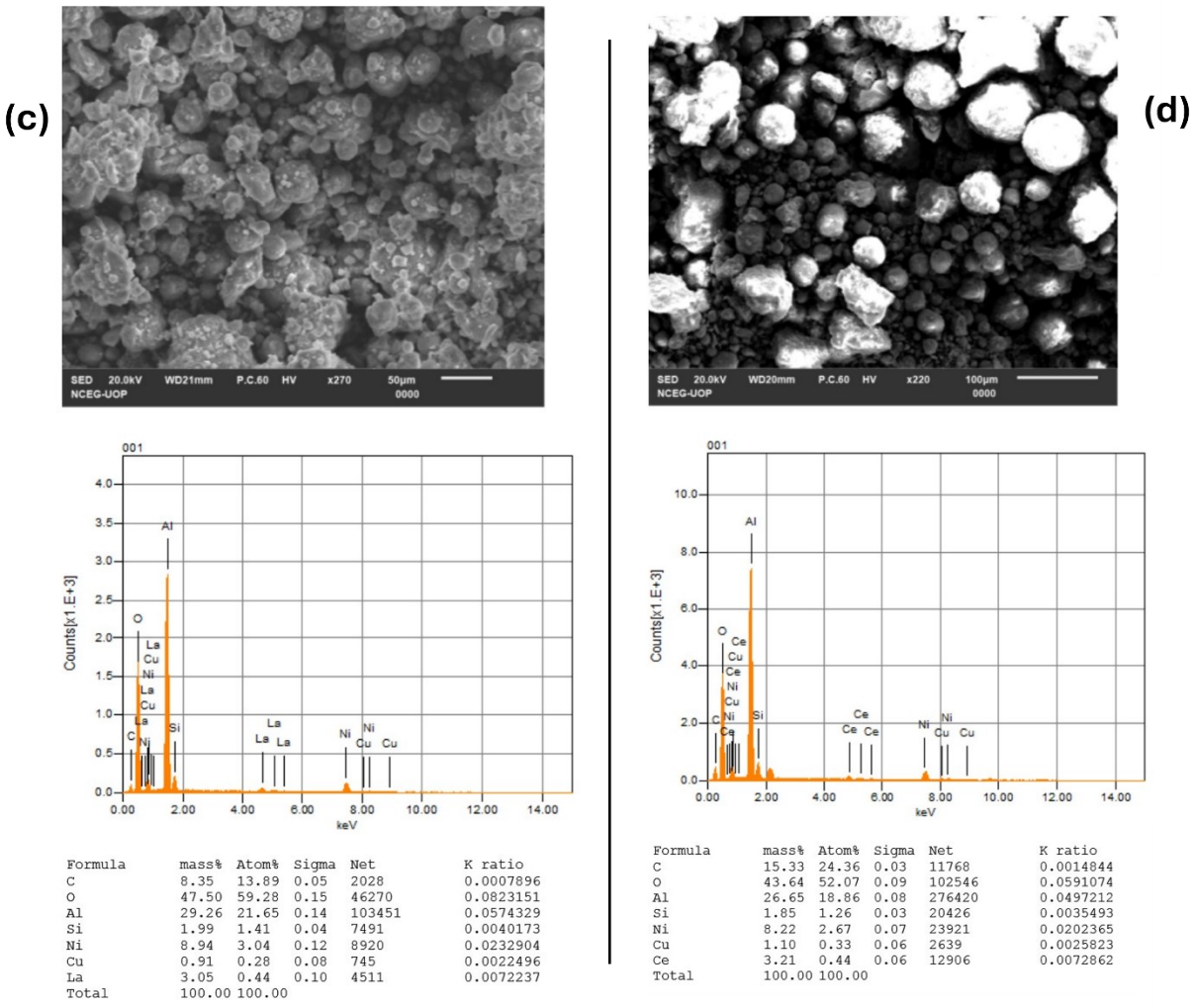
Formula	mass%	Atom%	Sigma	Net	K ratio
C	19.59	29.28	0.03	17581	0.0022175
O	45.03	50.52	0.09	106947	0.0616437
Al	24.50	16.30	0.07	291248	0.0523885
Si	1.73	1.10	0.02	21789	0.0037861
Ni	9.15	2.80	0.07	29661	0.0250920
Total	100.00	100.00			

(b)





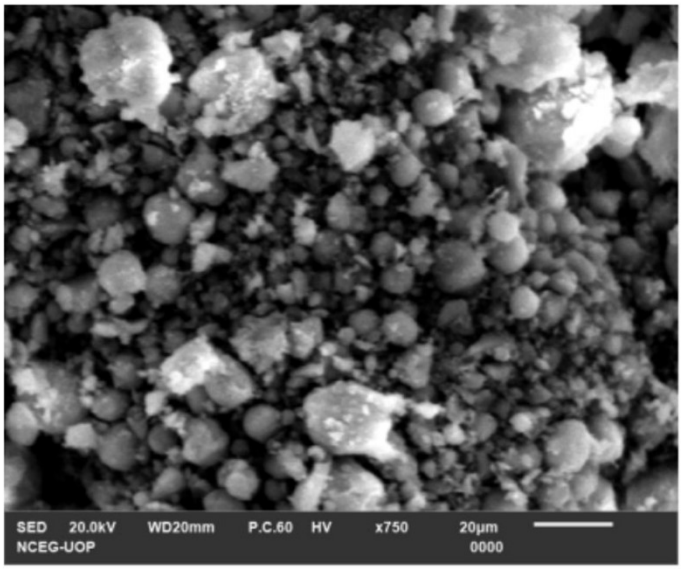
Formula	mass%	Atom%	Sigma	Net	K ratio
C	9.17	15.23	0.03	5169	0.0007707
O	46.29	57.76	0.10	101651	0.0692569
Al	29.52	21.84	0.09	243233	0.0517161
Si	1.98	1.41	0.03	17380	0.0035697
Ni	9.60	3.27	0.09	22182	0.0221811
Ba	3.44	0.50	0.07	12063	0.0072436
Total	100.00	100.00			

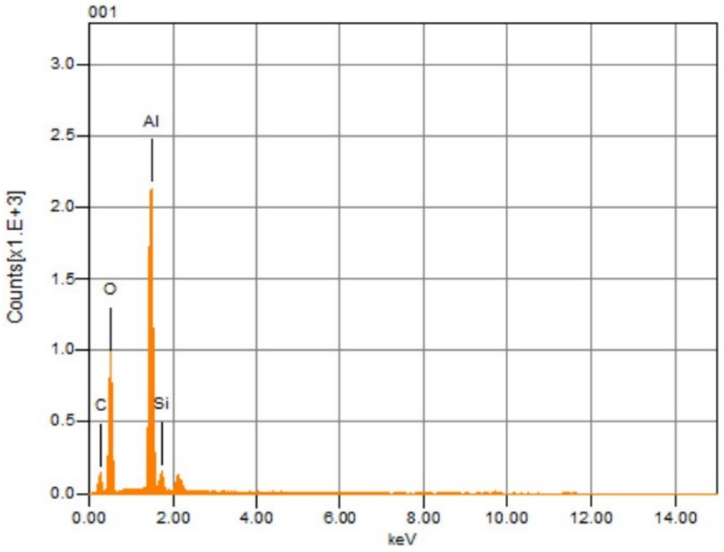


Formula	mass%	Atom%	Sigma	Net	K ratio
C	8.35	13.89	0.05	2028	0.0007896
O	47.50	59.28	0.15	46270	0.0823151
Al	29.26	21.65	0.14	103451	0.0574329
Si	1.99	1.41	0.04	7491	0.0040173
Ni	8.94	3.04	0.12	8920	0.0232904
Cu	0.91	0.28	0.08	745	0.0022496
La	3.05	0.44	0.10	4511	0.0072237
Total	100.00	100.00			

Formula	mass%	Atom%	Sigma	Net	K ratio
C	15.33	24.36	0.03	11768	0.0014844
O	43.64	52.07	0.09	102546	0.0591074
Al	26.65	18.86	0.08	276420	0.0497212
Si	1.85	1.26	0.03	20426	0.0035493
Ni	8.22	2.67	0.07	23921	0.0202365
Cu	1.10	0.33	0.06	2639	0.0025823
Ce	3.21	0.44	0.06	12906	0.0072862
Total	100.00	100.00			

Figure S4: SEM & EDS of calcined samples (a) Ni/SA (b) Ba-Ni/SA (c) La-Ni/SA (d) Ce-Ni/SA





Formula	mass%	Atom%	Sigma	Net	K ratio
C	20.52	28.79	0.07	3838	0.0022657
O	50.42	53.10	0.21	25709	0.0693543
Al	27.36	17.09	0.15	78331	0.0659434
Si	1.71	1.02	0.05	5075	0.0041272
Total	100.00	100.00			

Figure S5: SEM & EDS of puree SA support

Table S3: CO-pulse chemisorption results

Catalyst	Metal particle Size (nm) [a]	Active metal area (m^2/g) [a]
Ni/SA	5.7	3.55
Ba-Ni/SA	7.3	2.77
La-Ni/SA	5.4	3.74
Ce-Ni/SA	5.1	3.98

[a] Calculated from CO chemisorption analysis