Supporting information

Hydrodeoxygenation of sulfoxides into sulfides under mild conditions over a heterogeneous cobalt catalyst

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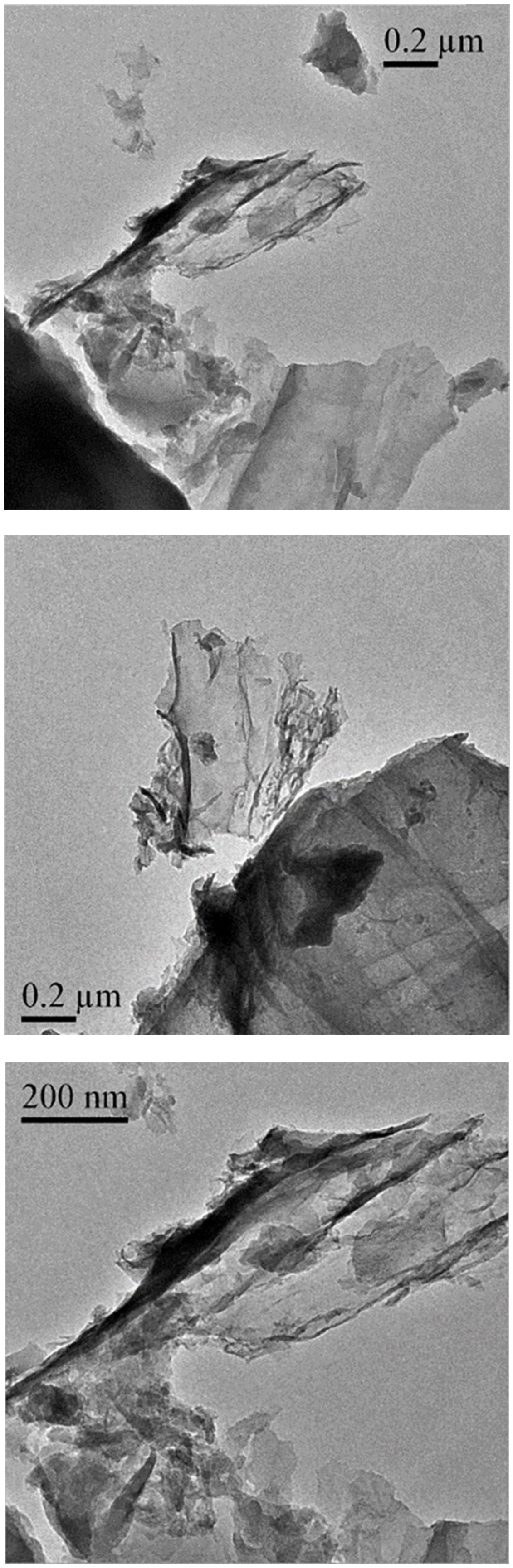


Figure S1. TEM images of the Co-NC/Al_2O_3-400 catalyst.

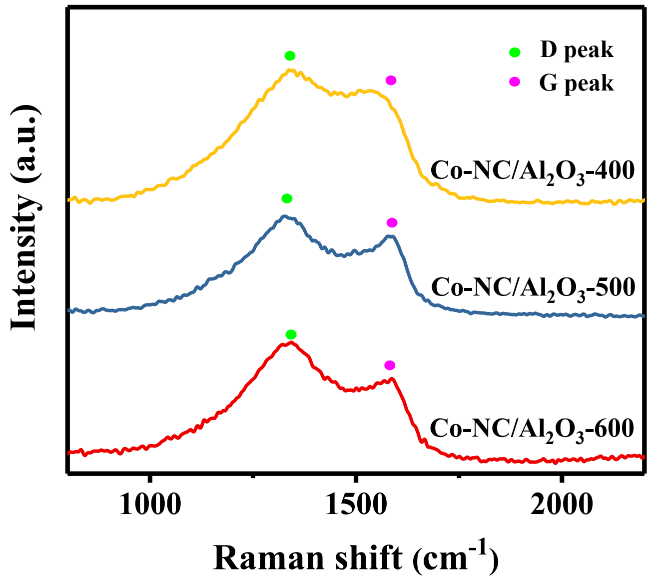
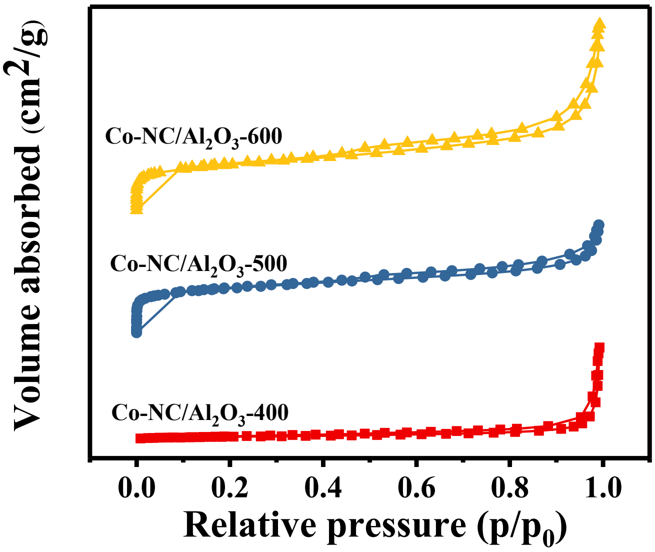


Figure S2. Raman spectra of the Co-NC/Al_2O_3-400, Co-NC/Al_2O_3-500 and Co-NC/Al_2O_3-600 catalysts.

(a)



(b)

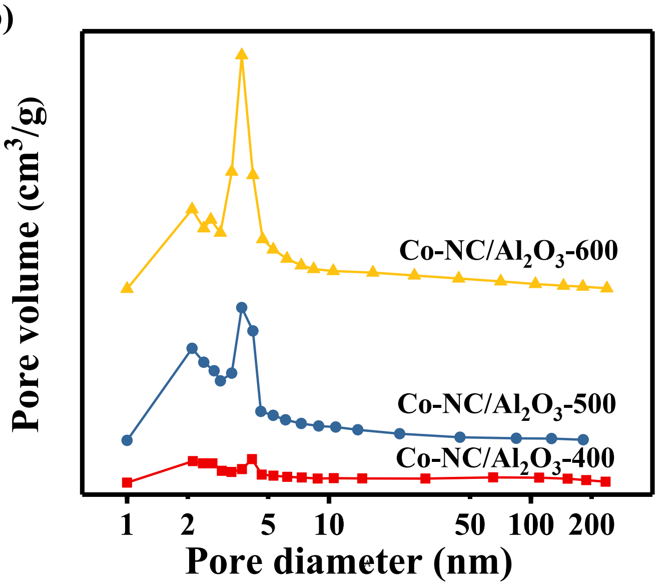


Figure S3. N_2-Sorption isotherm curves (a) and pore size distributions (b) of the Co-NC/Al_2O_3-T catalysts.

Table S1. The texture properties of the as-prepared catalysts.

Catalyst	Surface area (m^2 g^{-1})	Pore size (nm)	Pore volume (cm^3 g^{-1})
Co-NC/Al_2O_3-400	23.03	2.04	0.20
Co-NC/Al_2O_3-500	274.11	2.06	0.16
Co-NC/Al_2O_3-600	280.37	2.05	0.34

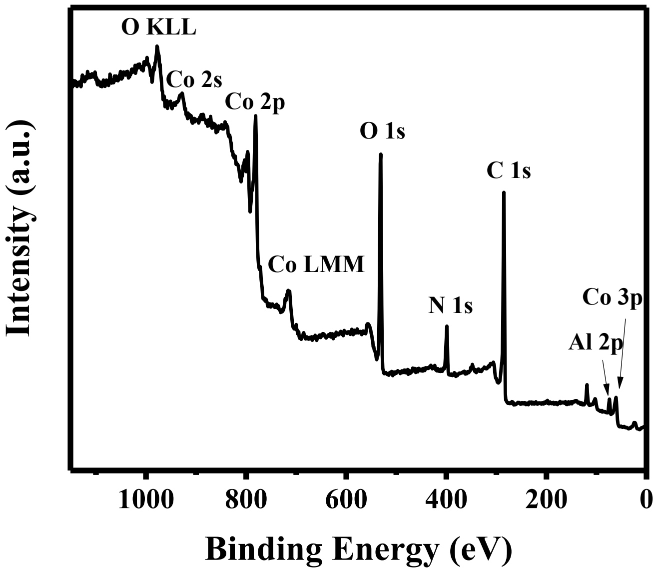
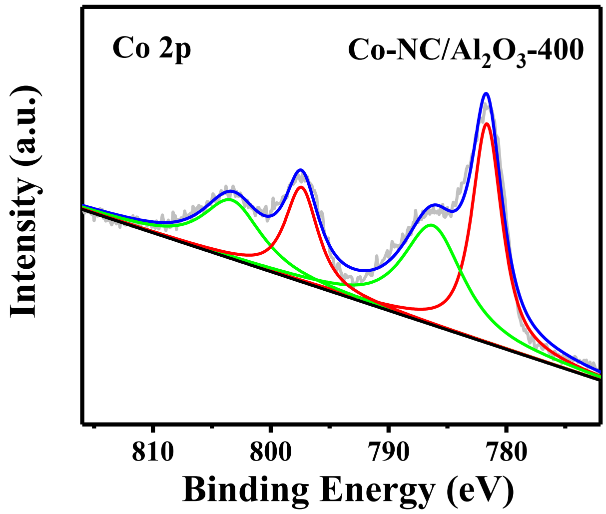


Figure S4. XPS survey scan of the Co-NC/Al_2O_3-500 catalyst.



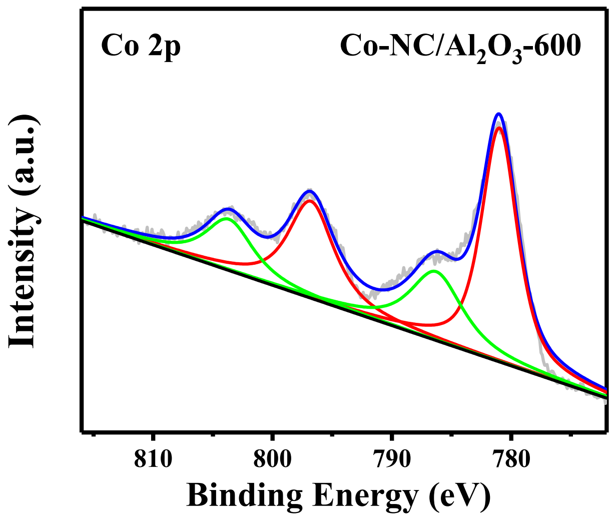


Figure S5. XPS spectra of Co 2p in the Co-NC/Al_2O_3-400 and Co-NC/Al_2O_3-600 catalysts.

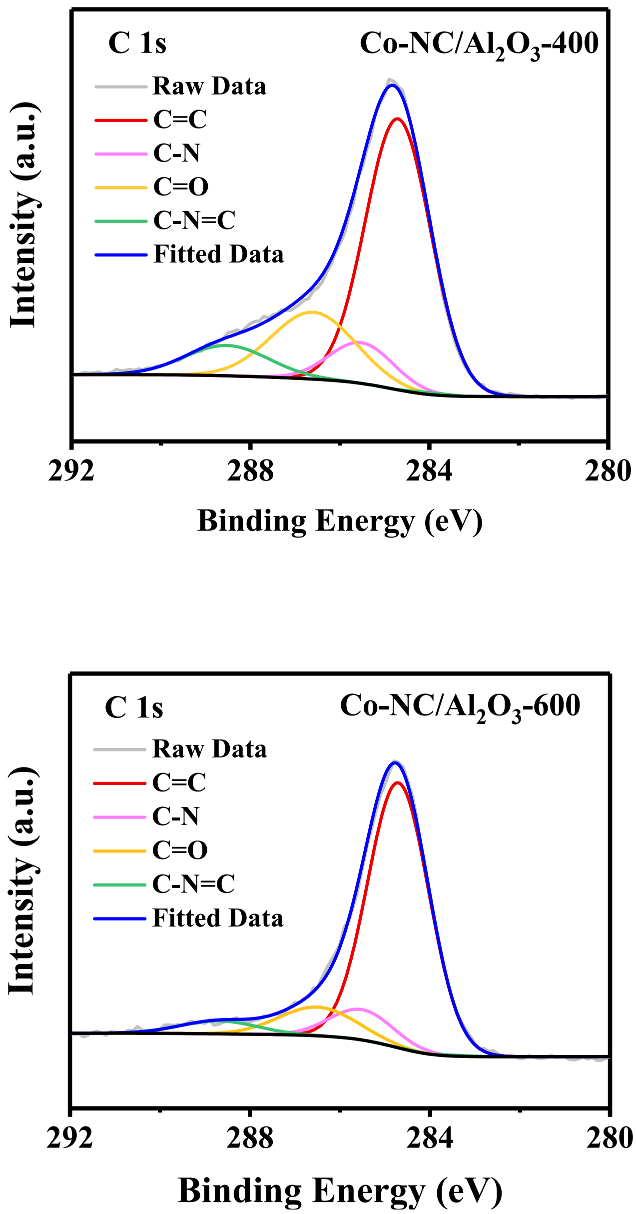
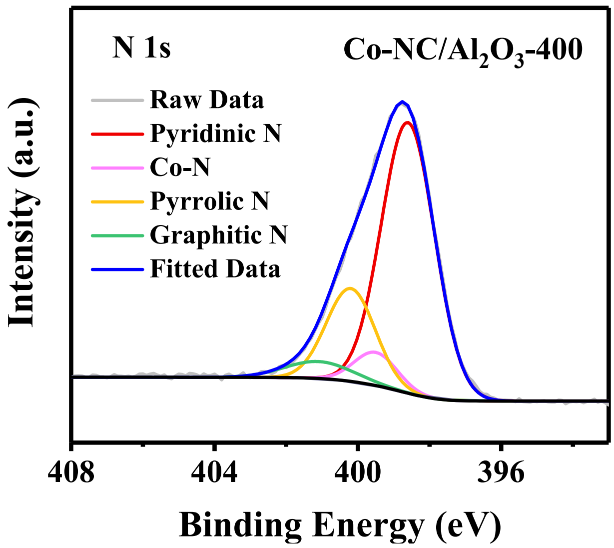


Figure S6. XPS spectra of C 1s in the Co-NC/Al_2O_3-400 and Co-NC/Al_2O_3-600 catalysts.

Table S2. The percentage of the different carbon in C 1s spectra.

Catalyst	C=C	C-N	C=O	C-N=C
Co-NC/Al_2O_3-400	62.2%	9.2%	19.7%	8.9%
Co-NC/Al_2O_3-500	70.2%	11.4%	11.7%	6.7%
Co-NC/Al_2O_3-600	76.1%	9.0%	10.3%	4.6%



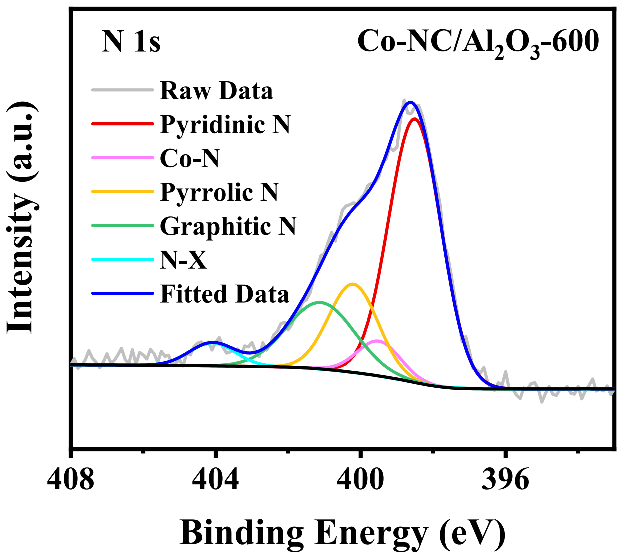


Figure S7. XPS spectra of N 1s in the Co-NC/Al_2O_3-400 and Co-NC/Al_2O_3-600 catalysts.

Table S3. The percentage of the different nitrogen in N 1s spectra and N content in the catalysts.

Catalyst	Pyridinic N	Co-N	Pyrrolic N	Graphitic N	N-X	N (at. %)
Co-NC/Al_2O_3-400	67.1%	6.5%	21.1%	5.3%	0	17.4%
Co-NC/Al_2O_3-500	58.4%	6.6%	17.5%	15.1%	2.4%	8.24%
Co-NC/Al_2O_3-600	54.8%	5.9%	17.3%	17.9%	4.1%	5.43%

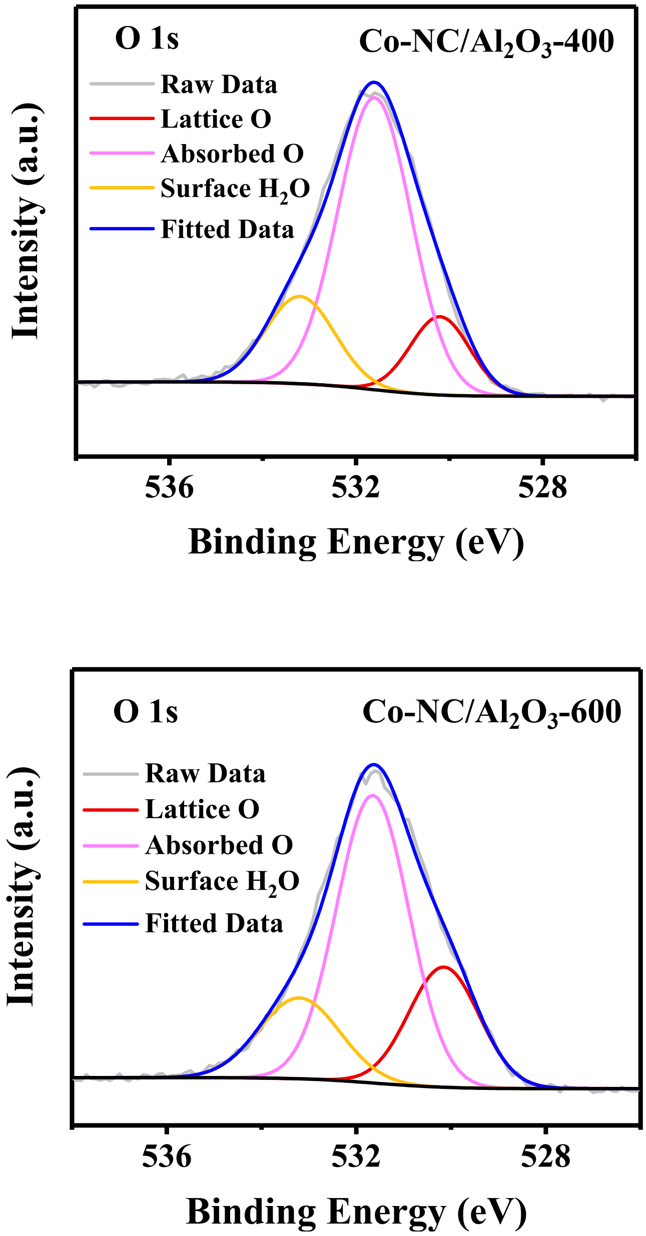


Figure S8. XPS spectra of O 1s in the Co-NC/Al_2O_3-400 and Co-NC/Al_2O_3-600 catalysts.

Table S4. The percentage of the different nitrogen in O 1s spectra in the catalysts.

Catalyst	Lattice O	Absorbed O	Surface H_2O
Co-NC/Al_2O_3-400	14.5%	66.7%	18.8%
Co-NC/Al_2O_3-500	27.8%	58.2%	13.9%
Co-NC/Al_2O_3-600	23.6%	58.2%	18.2%

Table S5. The comparison between other non-noble metal catalysts and Co-NC/Al_2O_3-500 catalyst.

Entry	Catalyst	Condition	Comparison	Ref.
1	$Fe_2(CO)_9$	Silane, 100 ^oC, 24 h	Use of high-cost reduction agent, long reaction time, hard to separate production and catalyst.	*ChemCatChem*, 2011, **3**, 666-670.
2	$Zn(OTf)_2$	Silane, 100 ^oC, 24 h	Use of high-cost reduction agent, long reaction time, hard to separate production and catalyst.	*Catal. Sci. Technol.*, 2011, **1**, 104-110.
3	Mo@C	Alcohol as hydrogen source, 120 ^oC, 3 h	Complex synthesis procedure.	*ChemCatChem,* 2019, **11**, 4139-4146.
4	Fe powder	H_2O and CO_2, 80 ^oC, 10 h	Fe was consumed during the reaction and large amount of catalyst was required.	*Green Chem.*, 2013, **15**, 1274-1279.
5	Co-Mo/NC	10 bar H_2, 80 ^oC	Green and accessible molecular H_2 was used but complex synthesis	*Green Chem.*, 2020, **22**, 39-43.

			procedure.	
6	TiO_2	>300 nm photocatalyzed, 120 min	$(COOH)_2$ was added as hole scavengers.	*Catal. Commun.*, 2014, **54**, 100-103.
7	$Cu(acac)_2$	Ph_2SiH_2, 100 °C, 12 h	Use of high-cost reduction agent, long reaction time	*Catal. Lett*, 2011, **141**, 833-838.
8	$NbCl_5$&Zn	THF/PhH, 23 °C, 1-24 h	Use of toxic benzene but mild condition.	*Tetrahedron*, 2009, **65**, 2966-2974.
9	Co-NC/Al_2O_3-500	10 bar H_2, 80 °C, 2 h	Green and accessible molecular H_2 was used, facile preparation method.	This work