Supporting information

Co embedded within biomass-derived mesoporous N-doped carbon as an acid-resistant and chemoselective catalyst for transfer hydrodeoxygenation of biomass with formic acid

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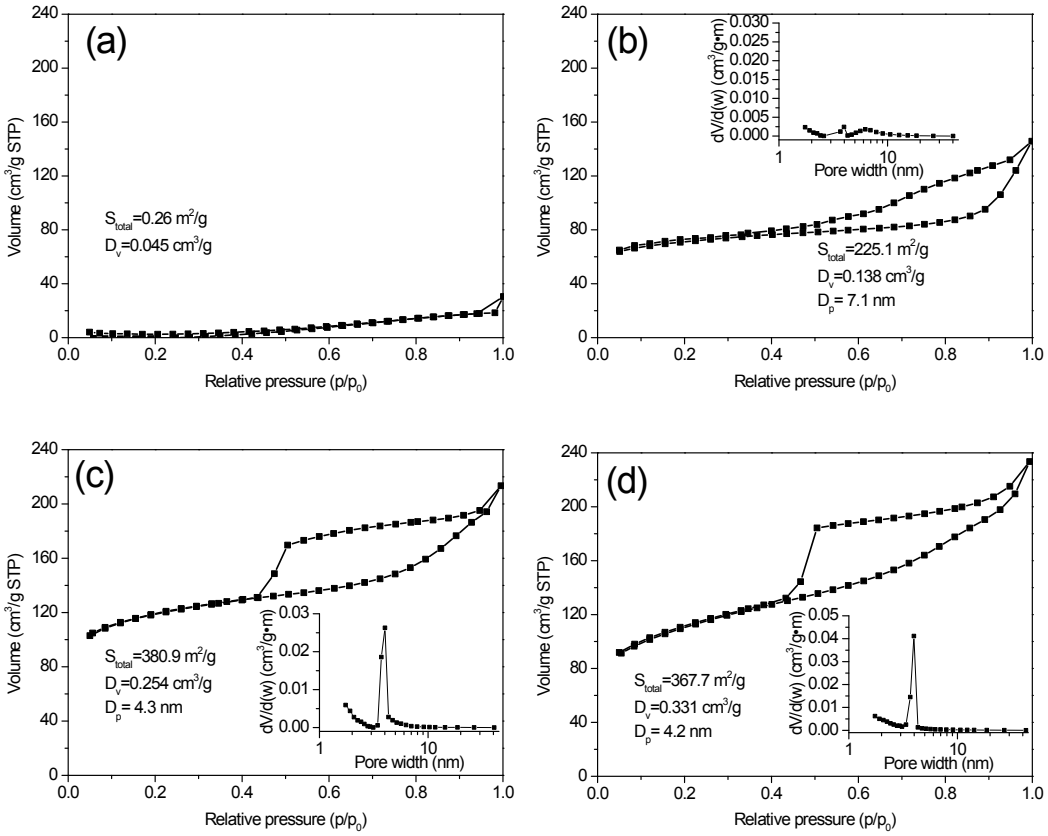

Fig. S1 Nitrogen sorption isotherms of (a) Co@NC-500, (b) Co@NC-600, (c) Co@NC-700 and (d) Co@NC-800.

Table S1 Pore structure of the Co@NC-x.

Samples	S_{total} (m^2/g)	Pore volume (cm^3/g)	Average pore diameter (nm)
Co@NC-500	0.26	0.045	-
Co@NC-600	225.1	0.138	7.1
Co@NC-700	380.9	0.254	4.3
Co@NC-800	367.7	0.331	4.2

Table S2 Chemical compositions of Co@NC-x catalysts.[a]

Catalysts	I_D/I_G	Atomic concentration (%)				Co loading (wt. %) [b]
		C	N	O	Co	
Co@NC-500	1.05	72.02	10.01	17.50	0.47	6.13
Co@NC-600	1.08	78.01	5.60	15.84	0.55	5.71
Co@NC-700	1.35	84.45	4.92	10.11	0.52	4.66
Co@NC-800	1.12	85.64	2.65	11.22	0.49	3.04

[a] Atomic concentrations were detected in XPS analysis.

[b] Detected by TG analysis.

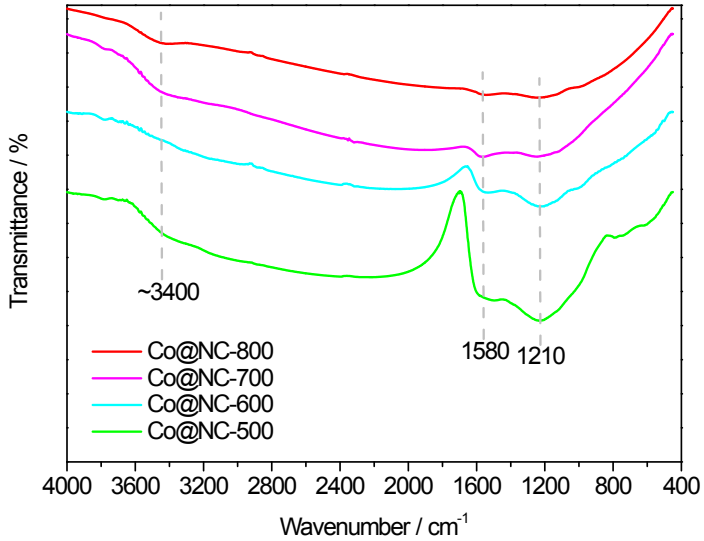

Fig. S2 FT-IR spectra of (a) Co@NC-500, (b) Co@NC-600, (c) Co@NC-700 and (d) Co@NC-800.

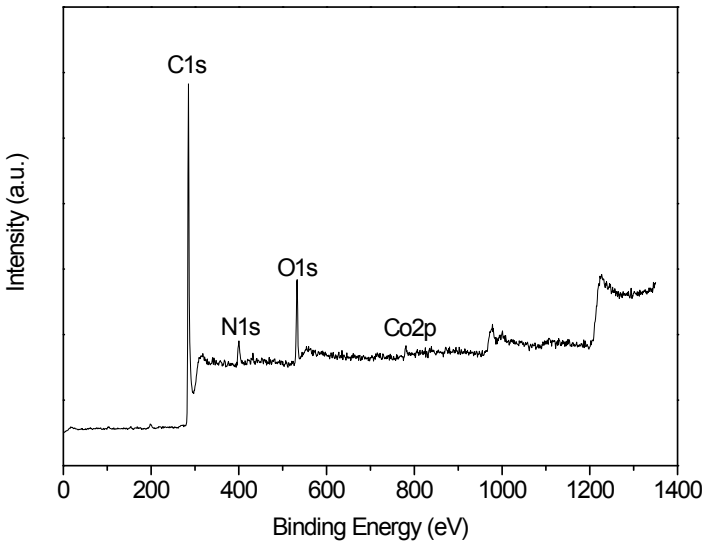

Fig. S3 XPS wide-scan spectrum of Co@NC-700.

Table S3 Structural properties of Co@NC-x.

Catalysts	Relative atomic percentage (%)				Relative atomic percentage (%)		
	N (398.5 eV)	N (400.1 eV)	N (401.1 eV)	N (403.3 eV)	Co^0	Co-O	Co-N
Co@NC-500	51.58	48.15	-	-	12.37	72.03	15.6
Co@NC-600	49.11	38.96	7.92	4.01	16.21	65.94	17.86
Co@NC-700	47.35	17.45	26.58	8.63	19.94	58.83	21.24
Co@NC-800	45.21	12.54	42.24	0	26.02	59.12	14.86

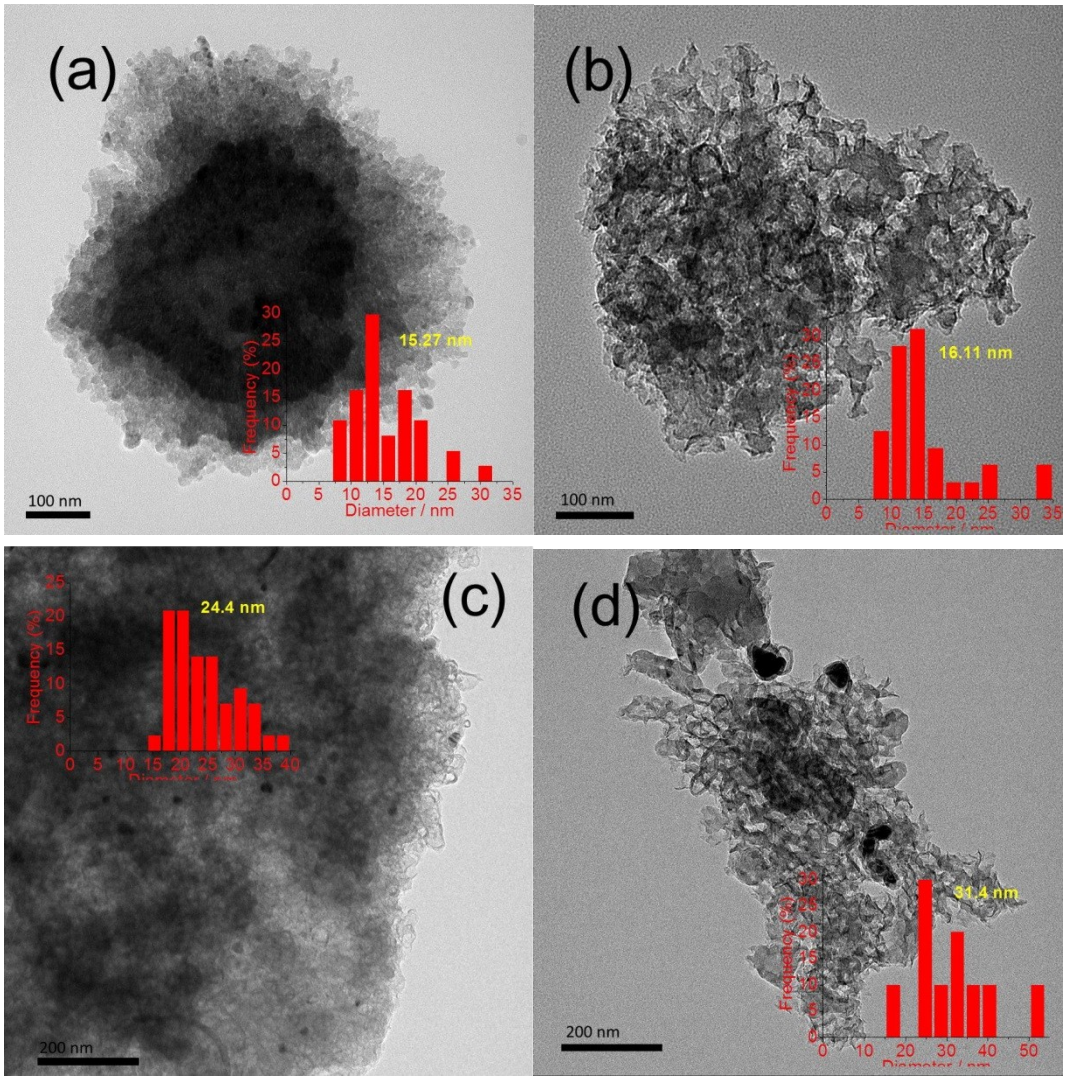

Fig. S4 TEM images of (a) Ni/NCB-600, (b) Ni/NCB-900, (c) Ni/CB and (d) Ni/AC. The insets in images (a-d) are corresponding histograms of Co particle size distribution.

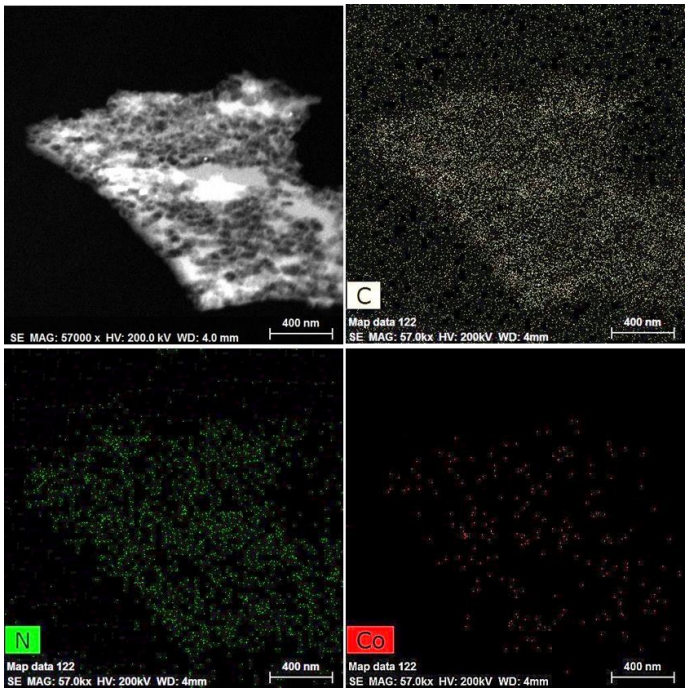

Fig. S5 Elemental mapping of Co@NC-700.

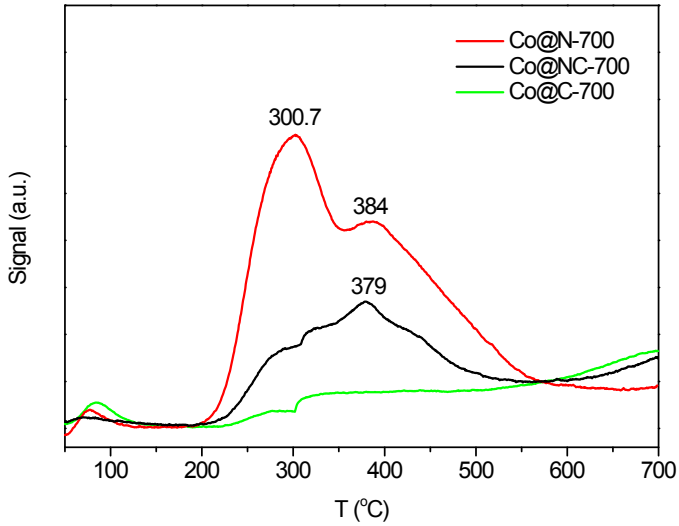

Fig. S6 CO_2-TPD analysis of Co@N-700, Co@NC-700 and Co@C-700.

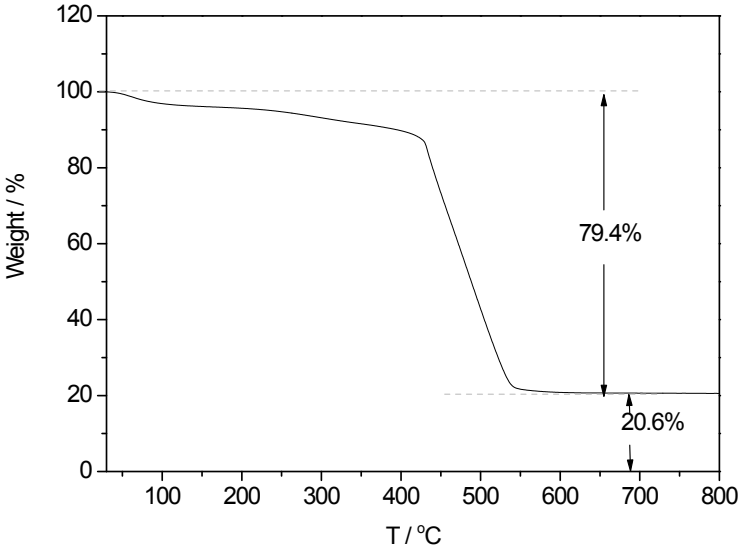

Fig. S7 TG result of Co@N-700 in air atmosphere.

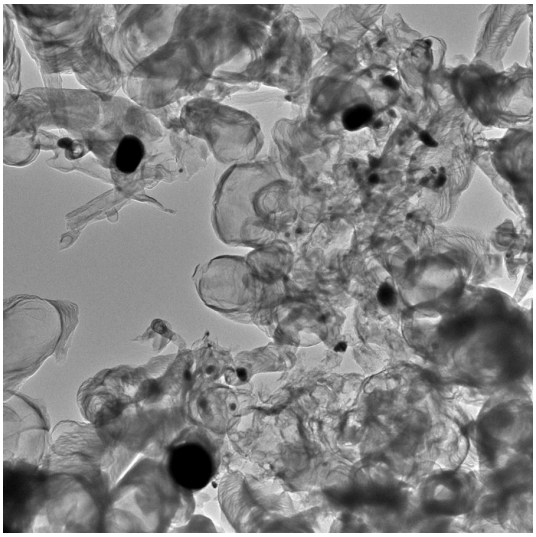

Fig. S8 TEM image of Co@N-700.

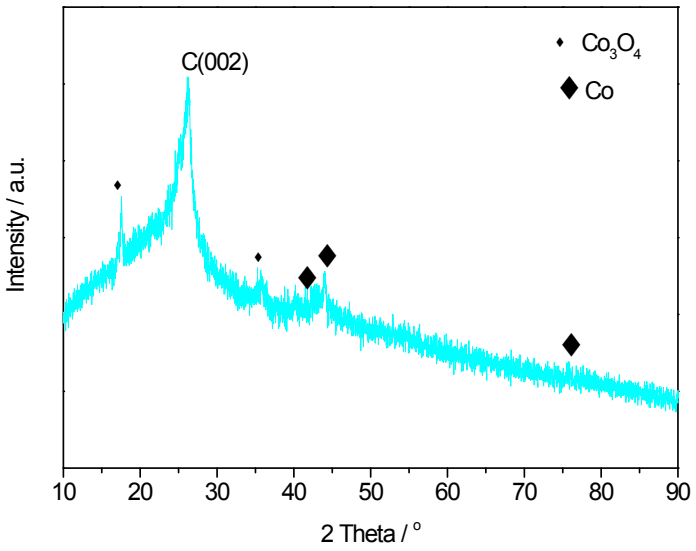

Fig. S9 XRD patterns of Co@N-700.

Table S4 Effect of amount of Co@NC-700 on transfer HDO of vanillin.

Entry	Catalyst amount/ mol%	Conversion/%	MMP selectivity/%
1	0	1.1	-
2	1.6	14.1	100
3	4.7	25.3	100
4	7.9	95.6	100

[a] Reaction conditions: vanillin (0.5 mmol), FA (200 mg), H_2O (10 mL), 0.5 MPa N_2, 180 °C, 4h.

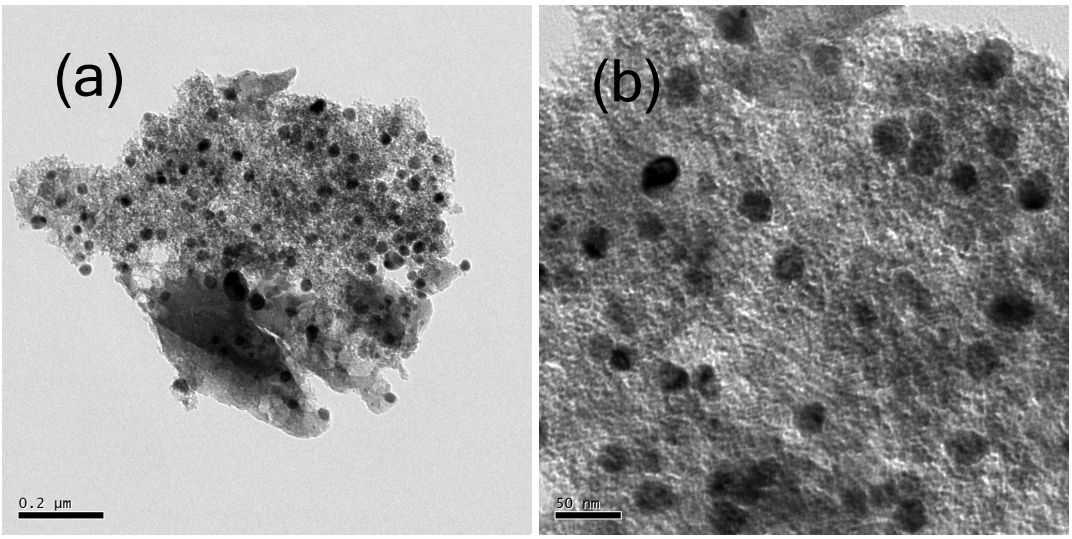

Fig. S10 TEM images of (a, b) Co/AC.

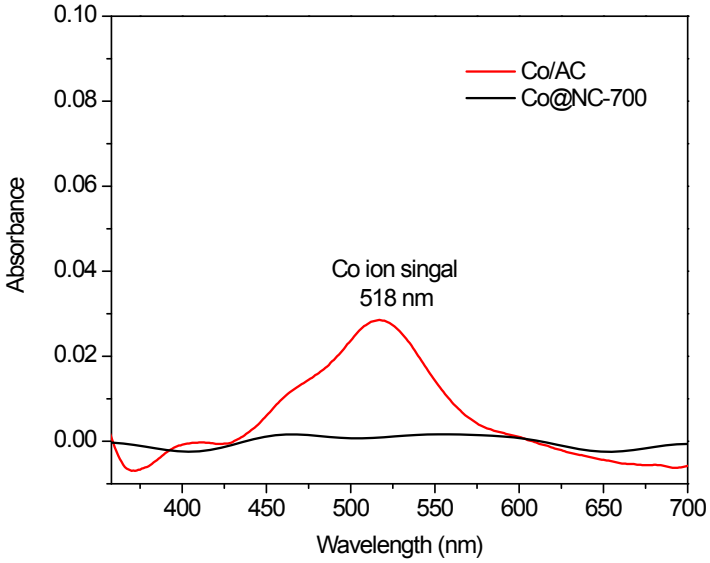

Fig. S11 UV-vis spectra of filtrate of Co@NC-700 and Co/AC.

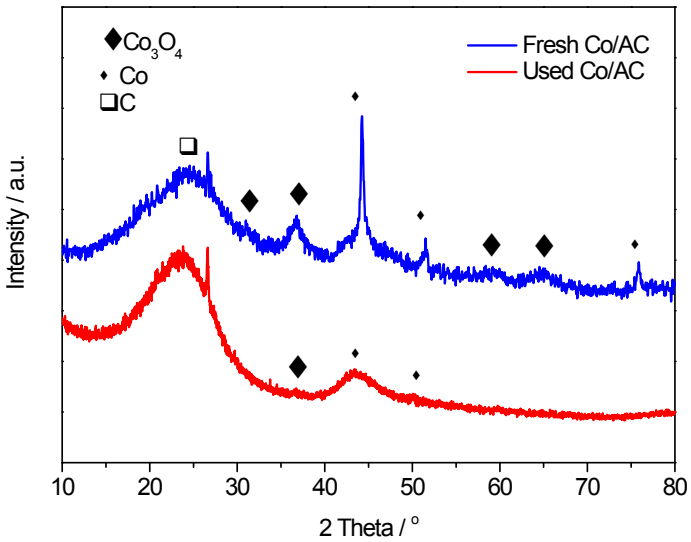

Fig. S12. XRD patterns of (a) fresh and (b) used Co/AC.

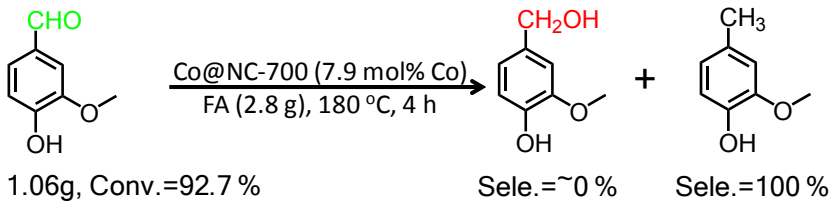

Fig. S13 Gram-scale transfer HDO of vanillin over Co@NC-700 with FA as hydrogen source.
Reaction conditions: vanillin (1.06 g, 7 mmol), FA (2.8 g), catalyst (7.9 mol% Co), H_2O (100 mL), 0.5 MPa N_2, 180 °C, 4h.

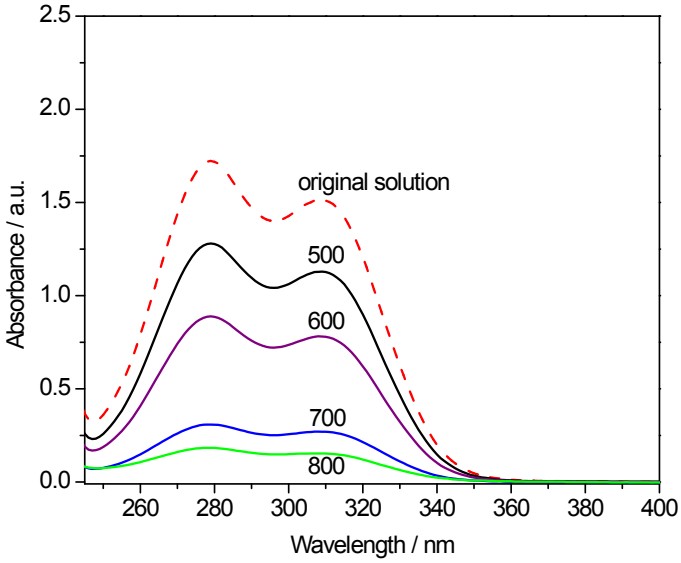

Fig. S14 The UV-vis spectra of vanillin adsorption on Co@NC-x.