Electronic Supplementary Information (ESI)

$Co_{0.85}Se$ bundle-like nanostructures catalysts for hydrogenation of 4-nitrophenol to 4-aminophenol†

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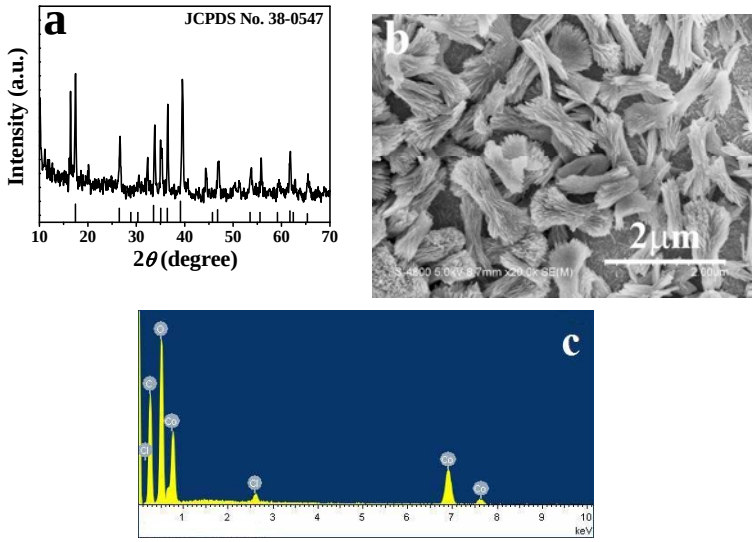

Fig. S1 (a) XRD pattern, (b) SEM image, and (c) EDX spectrum of bundle-like $Co(CO_3)_{0.35}Cl_{0.20}(OH)_{1.10}$ precursor.

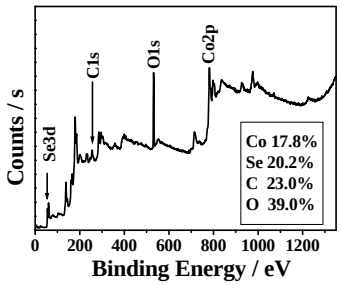

Fig. S2 XPS survey spectrum of $Co_{0.85}Se$ BNs.

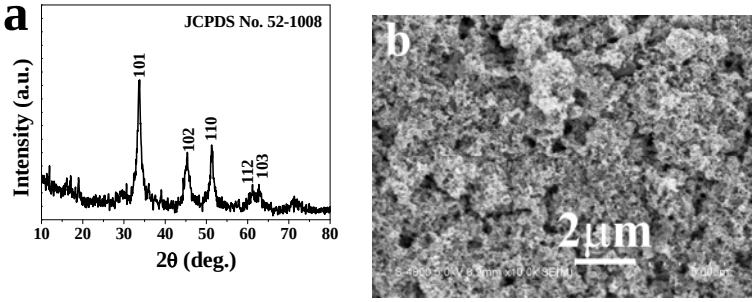

Fig. S3 (a) XRD pattern and (b) SEM image of $Co_{0.85}Se$ NPs.

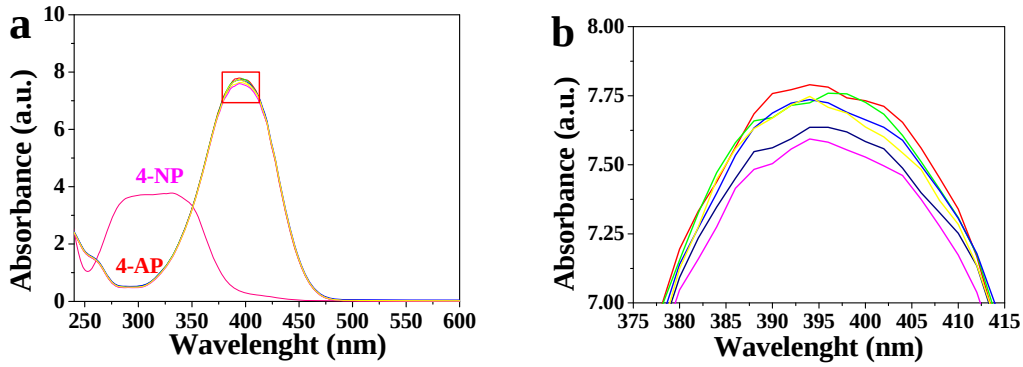

Fig. S4 Time-dependent UV–vis absorption spectrum (a) and magnified view (375 nm to 415 nm) spectrum (b) changes for reducing of 4-nitrophenol into 4-aminophenol without catalyst.

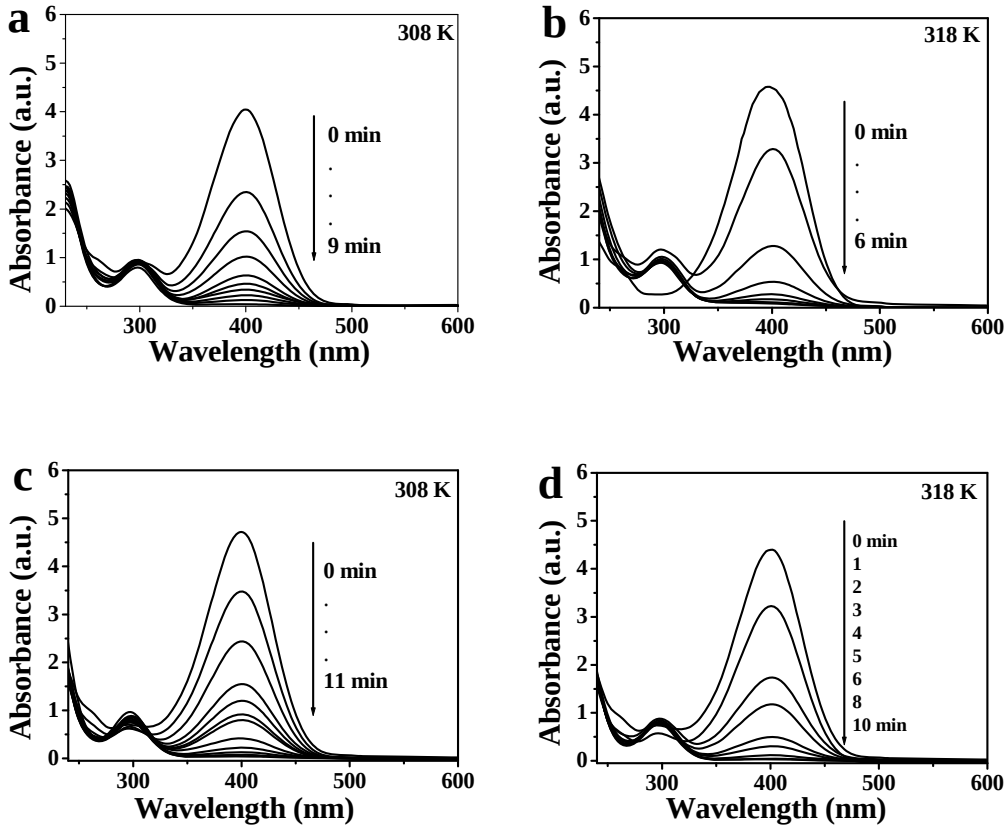

Fig. S5 Time-dependent UV–vis absorption spectrum changes for reducing of 4-nitrophenol into 4-aminophenol by $Co_{0.85}Se$ BNs (a, b) and NPs (c, d) at the temperatures of 308 K and 318 K, respectively.

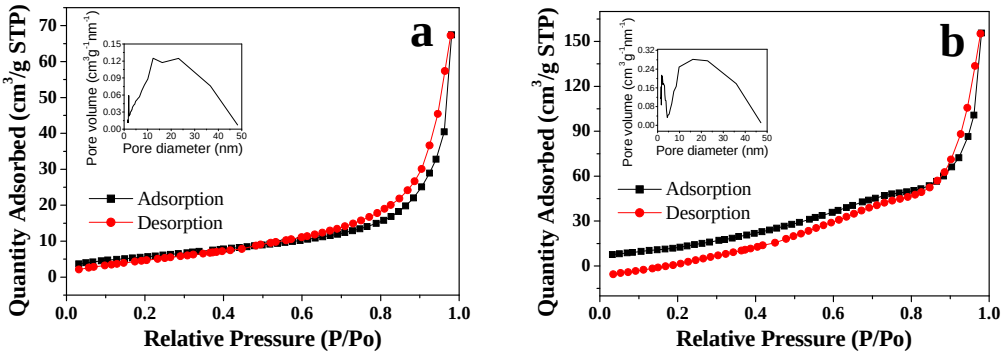

Fig. S6 Nitrogen adsorption and desorption isotherms of (a) $Co_{0.85}Se$ BNs and (b) $Co_{0.85}Se$ NPs with corresponding pore-size distribution (inset) calculated by the BJH method from the desorption branch.

Table S1 The linear correlation coefficients in the fitting process for the $Co_{0.85}Se$ catalysts at three different temperatures.

Catalysts	Kinetic equation			Arrhenius equation	Eyring equation
	298 K	308 K	318 K		
$Co_{0.85}Se$ BNs	y= –0.457x+0.274 R=0.9789	y= –0.513x+0.0644 R=0.9984	y= –0.673x+0.0789 R=0.9942	y= –1.763x+5.114 R=0.9984	y= –1.991x–0.1077 R=0.9984
$Co_{0.85}Se$ NPs	y= –0.311x+0.6225 R=0.9561	y= –0.434x+0.2839 R=0.9831	y= –0.530x+0.0567 R=0.9927	y= –2.139x+6.093 R=0.9984	y= –1.461x–1.598 R=0.9984

Table S2 The change in the percent recovery, reaction time, and conversion with repetitive use of $Co_{0.85}Se$ BNs catalyst system in sequential reactions (Conditions: 4-nitrophenol, 10 mL, 0.5 mM; $Co_{0.85}Se$ catalyst, 10 mL, 0.1 g/L; $NaBH_4$, 10 mL, 0.02 M; temperature, 298 K).

Cycle numbers	Percent recovery of catalyst (%)	Reaction time (min)	Conversion (%)
1	~94	10	100
2	~85		~98
3	~70		~94
4	~35		~66
5	~20		~45