

Supporting Information

Excellent catalytic performance of ISOBAM stabilized Co/Fe colloidal catalysts toward KBH₄ hydrolysis

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Table S1 Batch compositions and processing conditions for the preparation of ISOBAM-104 stabilized Co/Fe colloidal catalysts.

molar ratio of ISOBAM-104 to ion concentration	molar concentration of ISOBAM-104 (mM)	metal ion concentration (mM)	chemical composition (atom ratio)
10	9		
30	27		
50	45	0.9	
80	72		
	30	0.6	Co ₅₀ Fe ₅₀
	45	0.9	
	60	1.2	
	75	1.5	
			Fe
50			Co ₁₀ Fe ₉₀
			Co ₃₀ Fe ₇₀
	60	1.2	Co ₅₀ Fe ₅₀
			Co ₇₀ Fe ₃₀
			Co ₉₀ Fe ₁₀
			Co

Table S2 Lattice spacing and indexed reflection planes of Co and Fe.

Element	Faces		
	(200)	(220)	(222)
Co: ICDD 00-015-0806 (nm)	0.1772	0.1253	0.1023
Fe: ICDD 00-006-0696 (nm)	0.1433	0.1013	0.0828

Table S3 Lattice spacing and indexed reflection planes of Co/Fe colloidal catalysts determined by HRTEM.

Co/Fe nanoparticle	Lattice spacing (nm)	Comparison	Indexed reflection planes
1	0.168	Between Co(200) and Fe(200) $0.1772 > 0.168 > 0.1433$	(200)
2	0.172	Between Co(200) and Fe(200) $0.1772 > 0.172 > 0.1433$	(200)
3	0.174	Between Co(200) and Fe(200) $0.1772 > 0.174 > 0.1433$	(200)
4	0.169	Between Co(200) and Fe(200) $0.1772 > 0.169 > 0.1433$	(200)

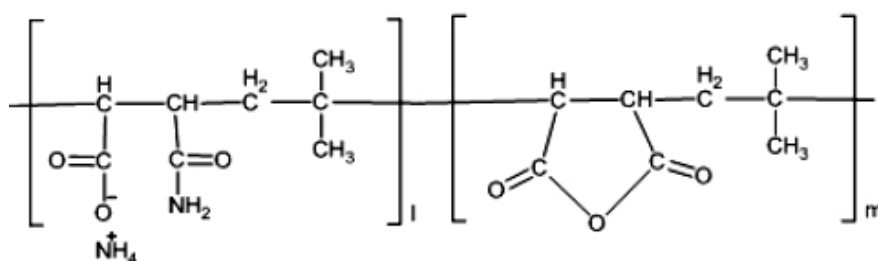


Figure S1 The chemical structure of ISOBAM-104.

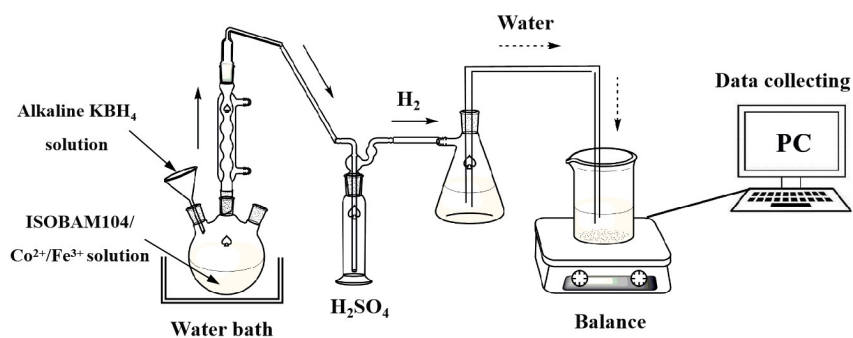


Figure S2 The schematic diagram of experimental device for KBH₄ hydrolysis reaction.

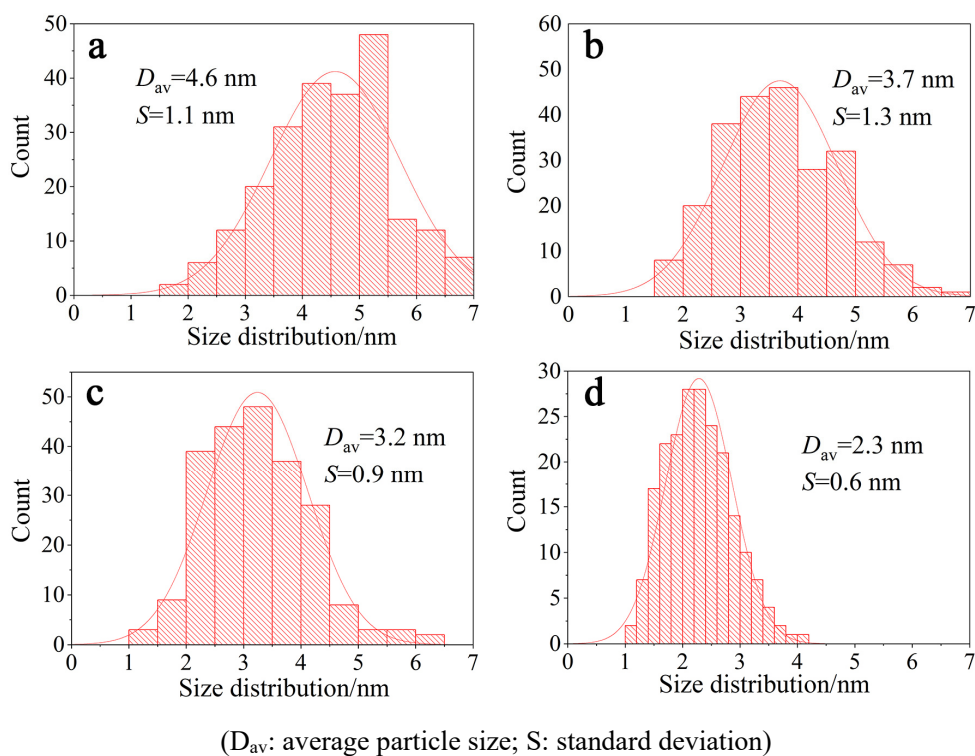


Figure S3 Particles size distribution histograms of $\text{Co}_{50}\text{Fe}_{50}$ colloidal catalysts with various R_{ISO} ($[\text{Co}^{2+} + \text{Fe}^{3+}] = 0.9 \text{ mM}$; $R_{ISO} = 10$ (a), 30 (b), 50 (c), and 80 (d)).

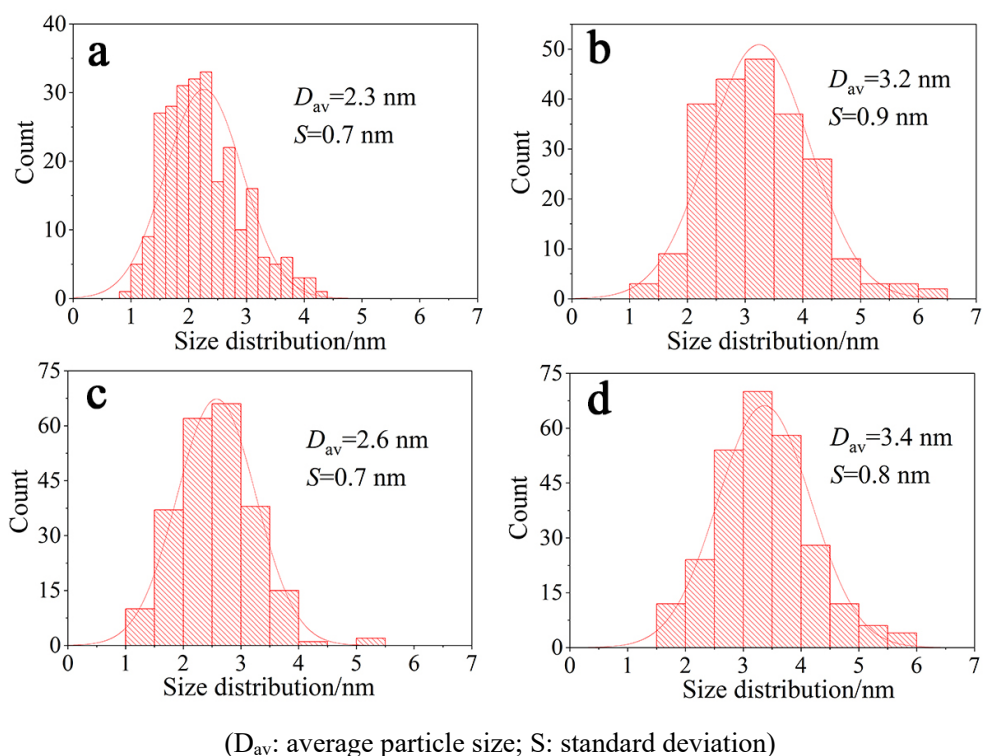


Figure S4 Particles size distribution histograms of $\text{Co}_{50}\text{Fe}_{50}$ colloidal catalysts synthesized with various ion concentrations ($R_{ISO} = 50$; $[\text{Co}^{2+} + \text{Fe}^{3+}] = 0.6$ (a), 0.9 (b), 1.2 (c), and 1.5 (d) mM).

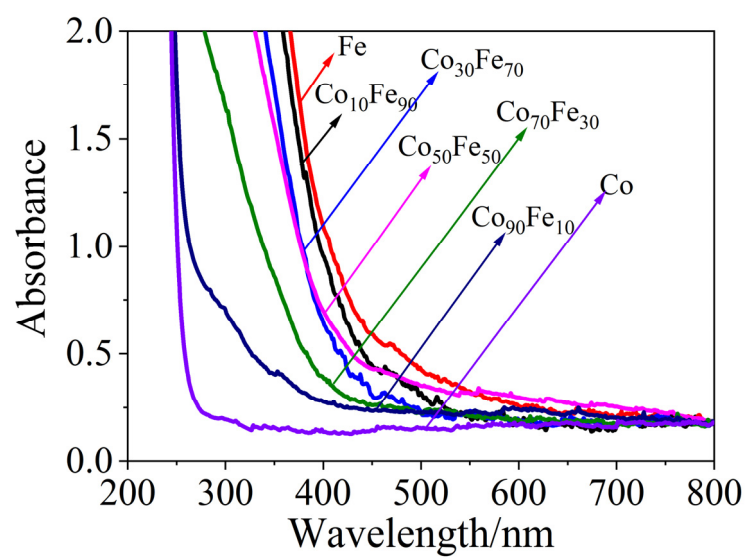
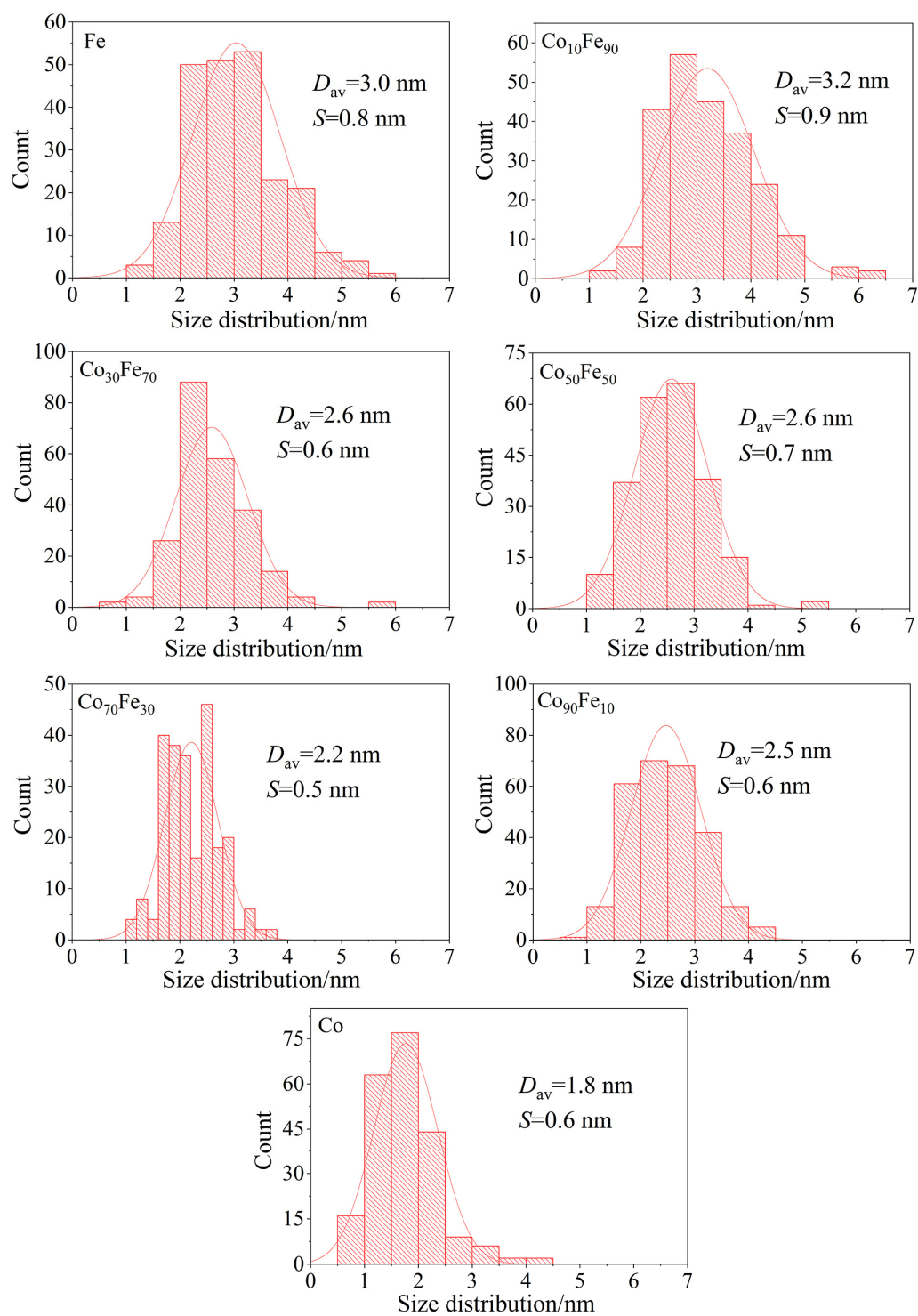


Figure S5 UV-*vis* spectra of Co/Fe BNPs, Co and Fe nanoparticles.



(D_{av} : average particle size; S : standard deviation)

Figure S6 Particles size distribution histograms of Co/Fe colloidal catalysts synthesized with various chemical compositions ($R_{ISO} = 50$, $[Co^{2+}+Fe^{3+}] = 1.2$ mM).

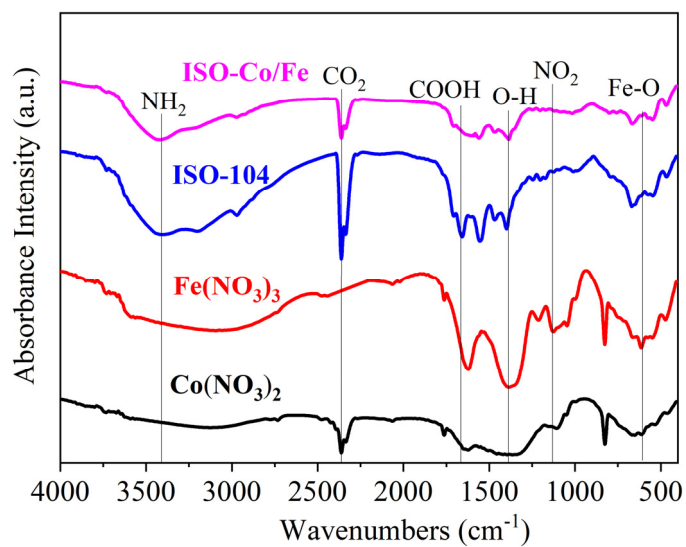


Figure S7 FTIR spectra of ISOBAM-104, $\text{Co}(\text{NO}_3)_2$, $\text{Fe}(\text{NO}_3)_3$, and $\text{Co}_{10}\text{Fe}_{90}$ colloidal catalysts.

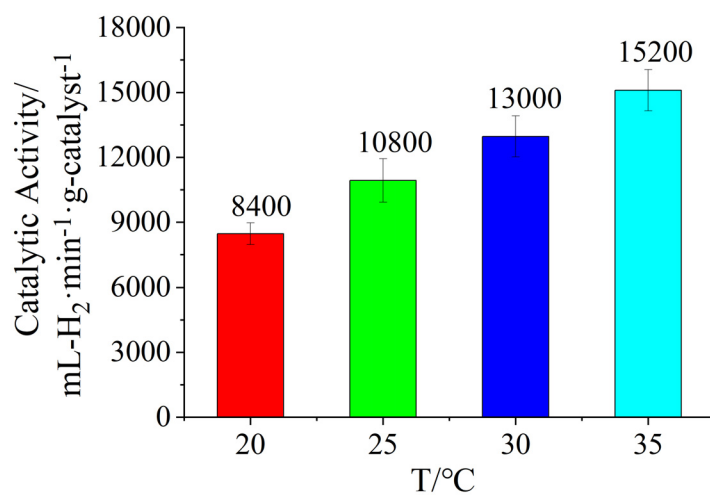


Figure S8 Effect of temperature on the catalytic performance of $\text{Co}_{10}\text{Fe}_{90}$ colloidal catalysts.

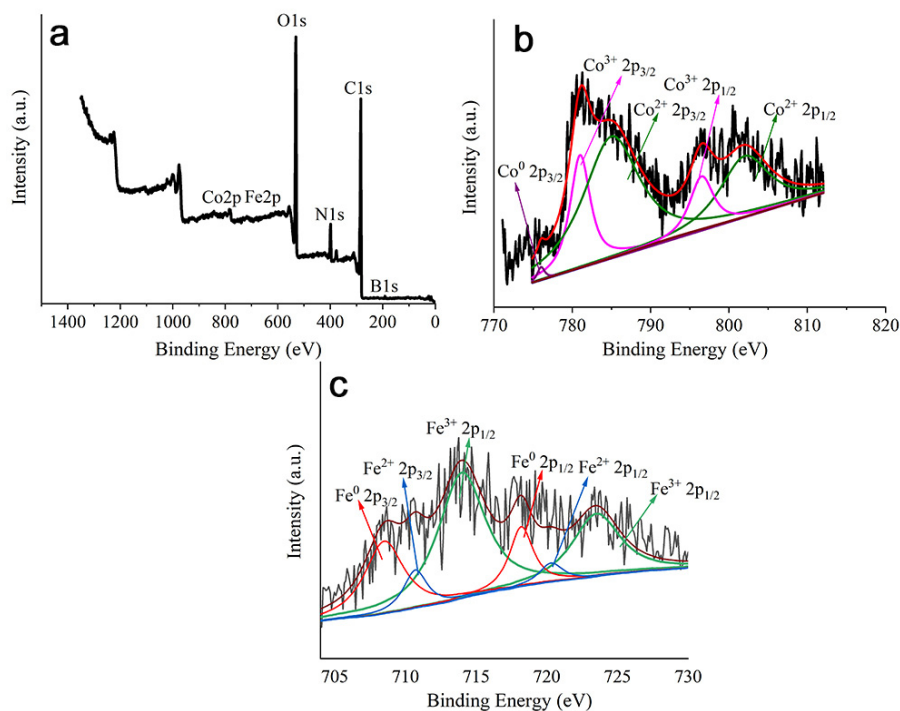


Figure S9 XPS spectra of Co₃₀/Fe₇₀ colloidal catalysts: (a) total spectra, (b) Co 2p, and (c) Fe 2p.

Calculation of catalytic activity

The catalytic activity (a , mL-H₂·min⁻¹·g-catalyst⁻¹) of the obtained Co/Fe colloidal catalysts can be calculated by the ratio of the hydrogen generation rate (k) to the mass of catalyst (m), as the following Equation (1):

$$a = \frac{k}{m_{cat.}} \quad (1)$$

where a represents the catalytic activity of catalysts, k is the hydrogen generation rate (mL-H₂·min⁻¹), $m_{cat.}$ represents the mass of catalysts. It should be noted that the ISOBAM-104 used in this work contains NH₄⁺ group, which also possesses a catalytic effect for KBH₄ hydrolysis. Therefore, under the same condition, the catalytic activities of ISOBAM-104 stabilized Co/Fe colloidal catalysts and ISOBAM-104 (NH₄⁺ group) were respectively measured. The intrinsic catalytic activity value of Co/Fe colloidal catalysts were obtained by subtracting the value of ISOBAM-104 from that of ISOBAM-104 stabilized Co/Fe, as the following Equation

(2):

$$a_{(NPs)} = a_{(NPs/ISOBAM)} - a_{(ISOBAM)} \quad (2)$$

where $a_{(NPs)}$ represents the catalytic activity of Co/Fe catalysts, $a_{(NPs/ISOBAM)}$ is the catalytic activity of ISOBAM-104 stabilized Co/Fe colloidal catalysts, $a_{(ISOBAM)}$ represents the catalytic activity of ISOBAM-104. All the catalytic experiments were repeated no less three times under the identical condition, and the average values of the measured data were used to determine the catalytic activity. Finally, the activity values were normalized to $\text{mL-H}_2 \text{ min}^{-1} \text{ g-Co}^{-1}$.based on the following Equation (3):

$$a_{Co} = \frac{a_{(Co/Fe)} - a_{Fe} * x}{1 - x} \quad (3)$$

where a_{Co} represents the catalytic activity of Co atoms in Co/Fe catalysts, $a_{(Co/Fe)}$ is the catalytic activity of Co/Fe colloidal catalysts, a_{Fe} represents the catalytic activity of Co atoms in Co/Fe catalysts, x is the content of Fe in Co/Fe colloidal catalysts, and $1 - x$ represents the content of Co in Co/Fe colloidal catalysts.