

Supporting Information

3D Porous Fe/N/C Spherical Nanostructures As High-Performance Electrocatalysts for Oxygen Reduction in Both Alkaline and Acidic Media

Qiliang Wei,[†] Gaixia Zhang,^{*,†} Xiaohua Yang,[†] Régis Chenitz,[†] Dustin Banham,[‡] Lijun Yang,[‡]
Siyu Ye,[‡] Shanna Knights,[‡] Shuhui Sun^{*,†}

[†]*Institut National de la Recherche Scientifique-Énergie Matériaux et Télécommunications, Varennes,
Quebec, J3X 1S2, Canada.*

[‡]*Ballard Power Systems Inc., Burnaby, British Columbia, V5J 5J8, Canada*

Figures:

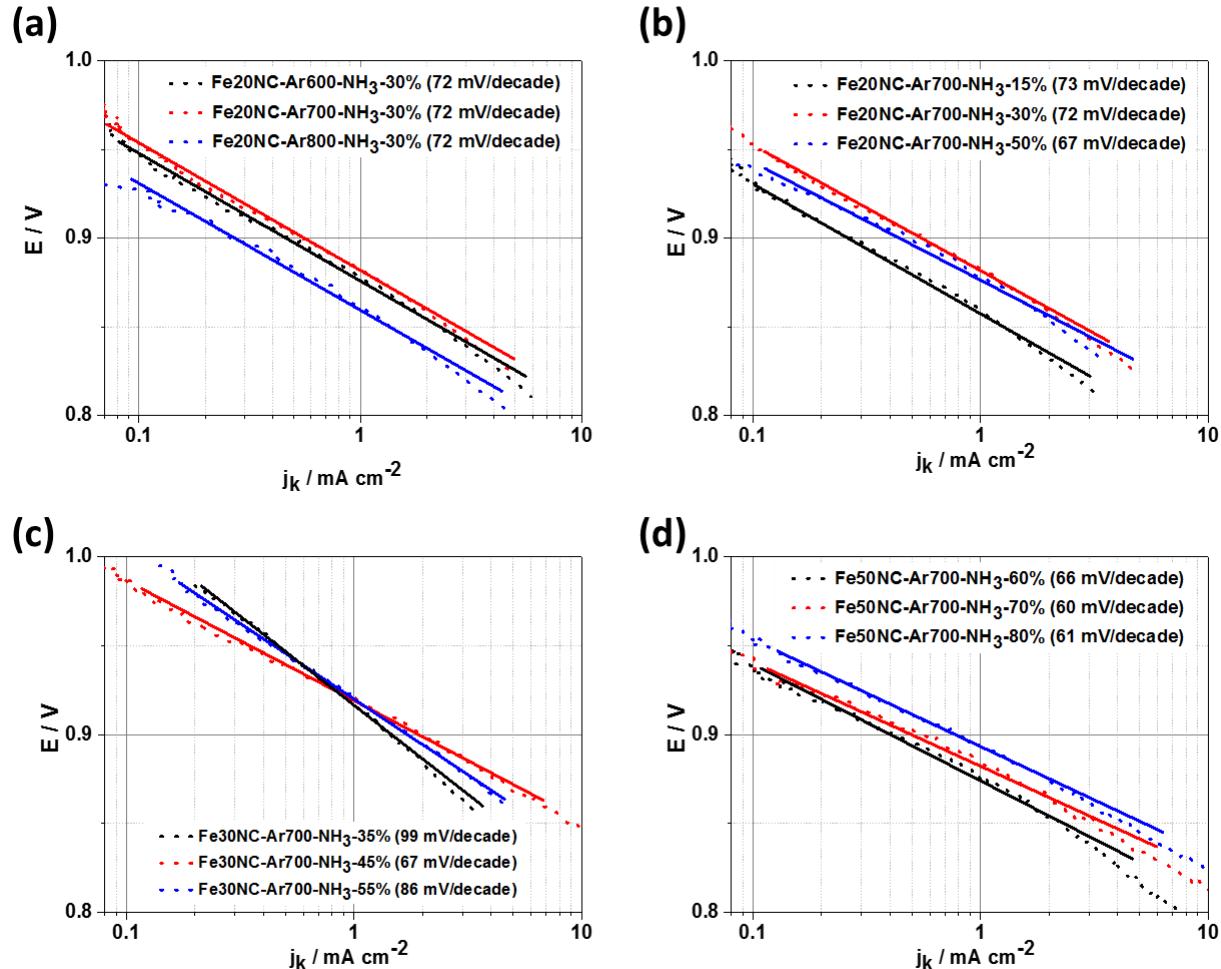


Figure S1. Tafel plots in O₂-saturated 0.1 M KOH of (a) Fe20NC-ArT-NH₃-30%, (b) Fe20NC-Ar700-NH₃-y%, (c) Fe30NC-Ar700-NH₃-y%, (d) Fe50NC-Ar700-NH₃-y% (scan rate = 10 mV s⁻¹, rotation rate = 1600 rpm).

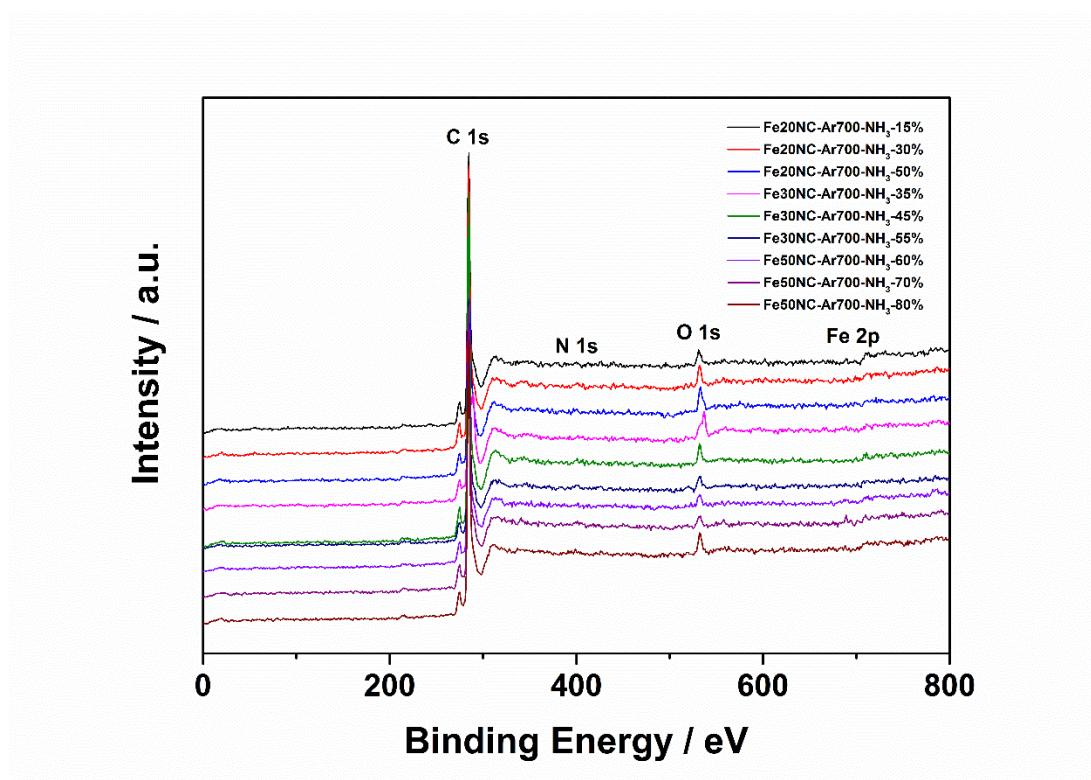


Figure S2. XPS spectrums of $\text{Fe}_x\text{NC}-\text{Ar}700-\text{NH}_3-y\%$ samples.

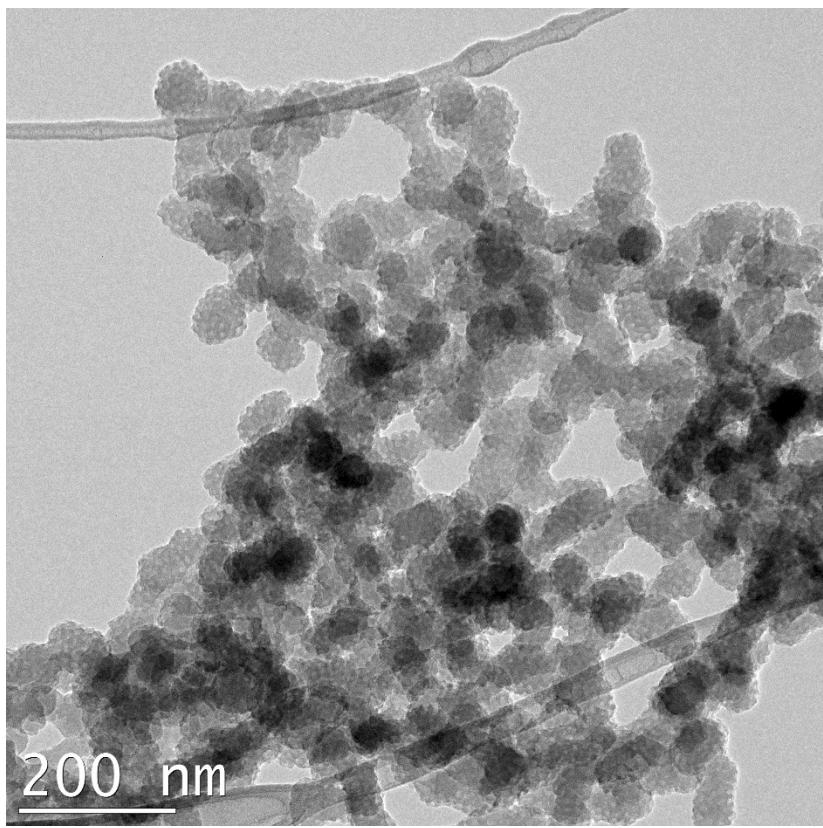


Figure S3. TEM images of spherical phenolic resol-F127 monomicelles.

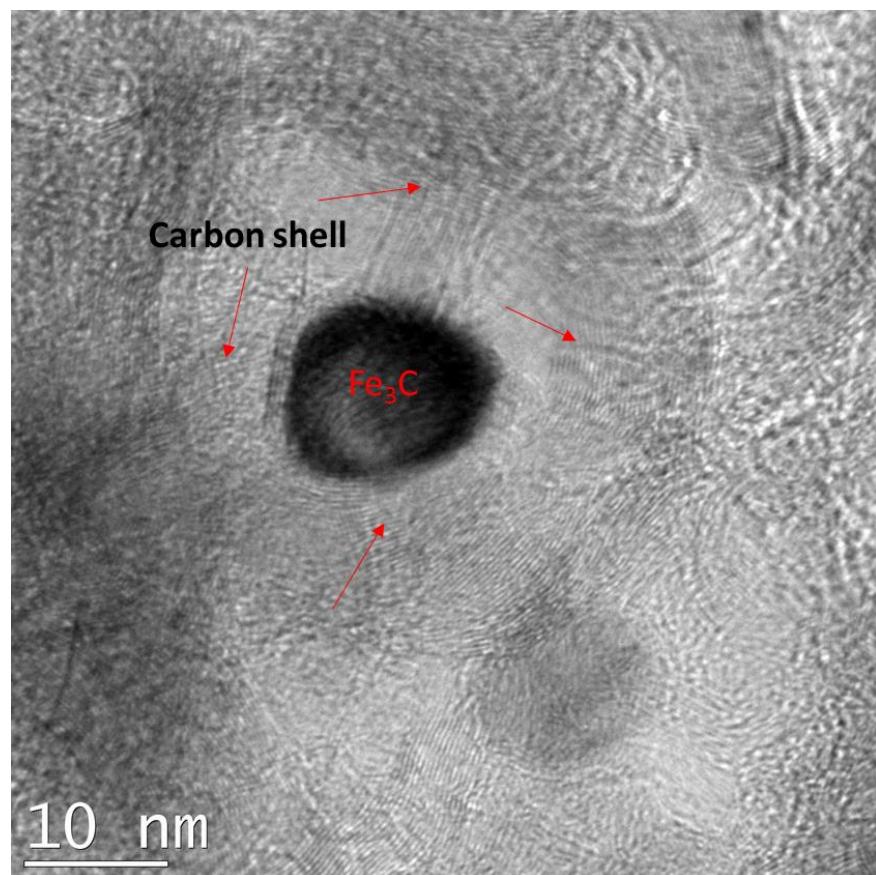


Figure S4. HRTEM images of black spot part of Fe30NC-Ar700-NH₃-45%.

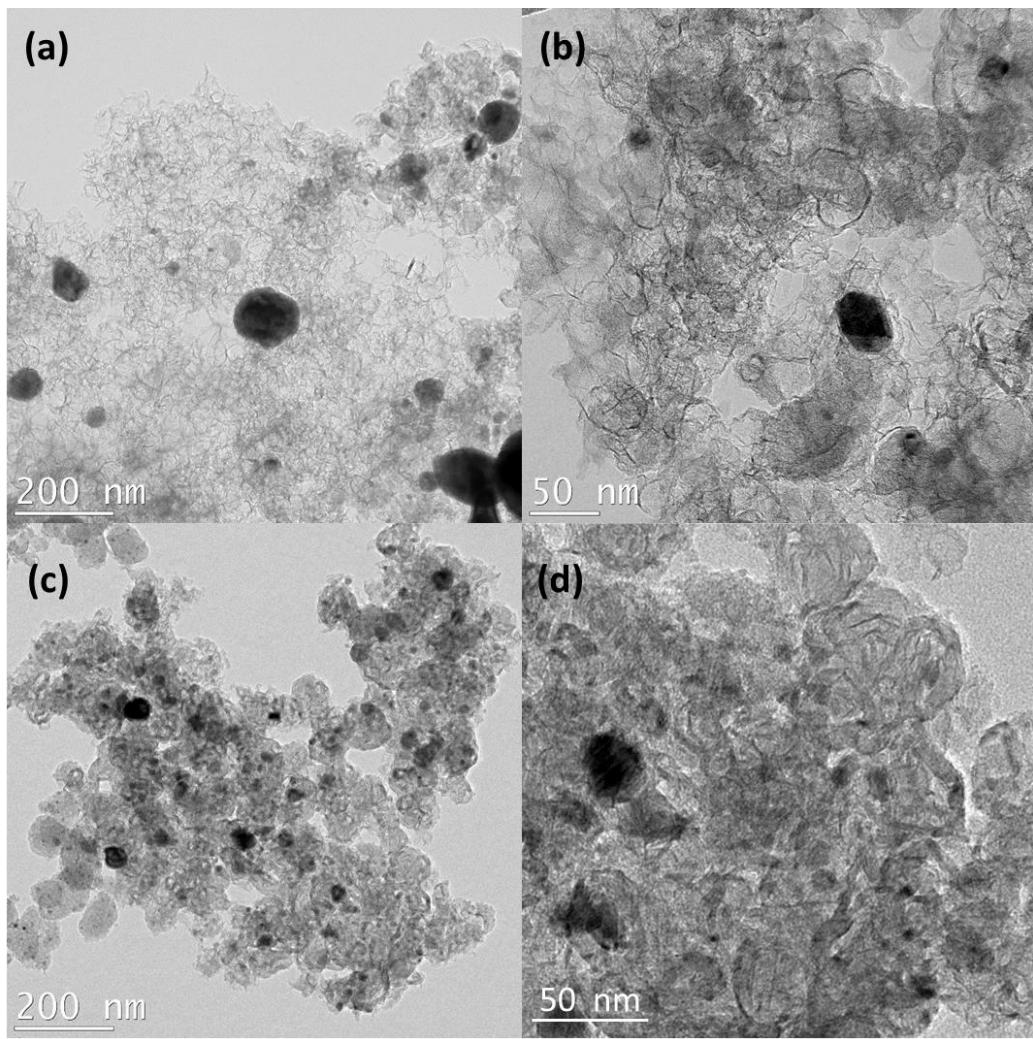


Figure S5. TEM images of (a-b) Fe₂₀NC-Ar700-NH₃-30% and (c-d) Fe₅₀NC-Ar700-NH₃-80%.

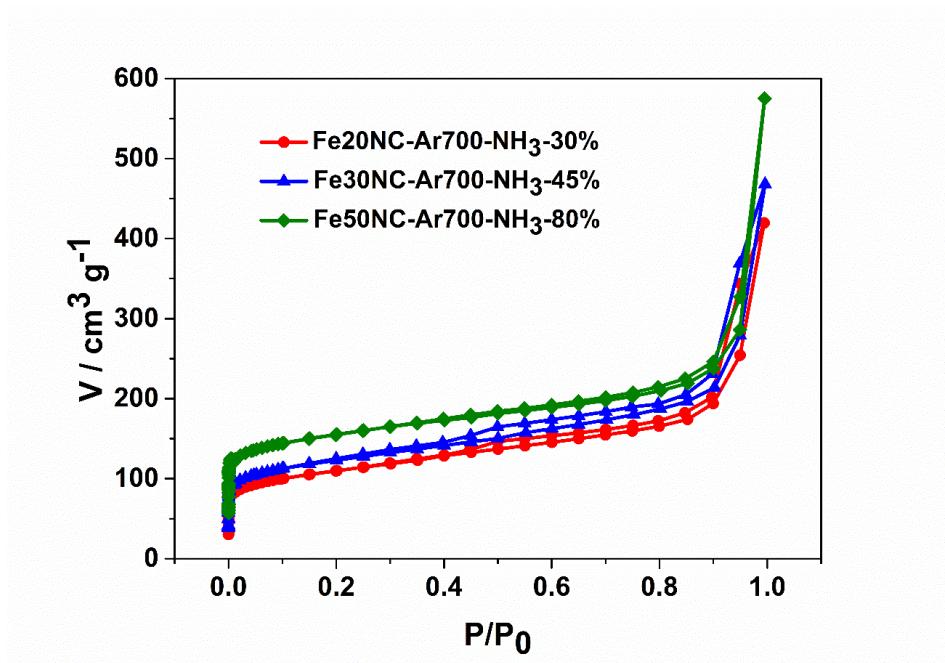


Figure S6. N_2 isothermal adsorption/desorption curves of Fe20NC-Ar700-NH₃-30%, Fe30NC-Ar700-NH₃-45%, Fe50NC-Ar700-NH₃-80%.

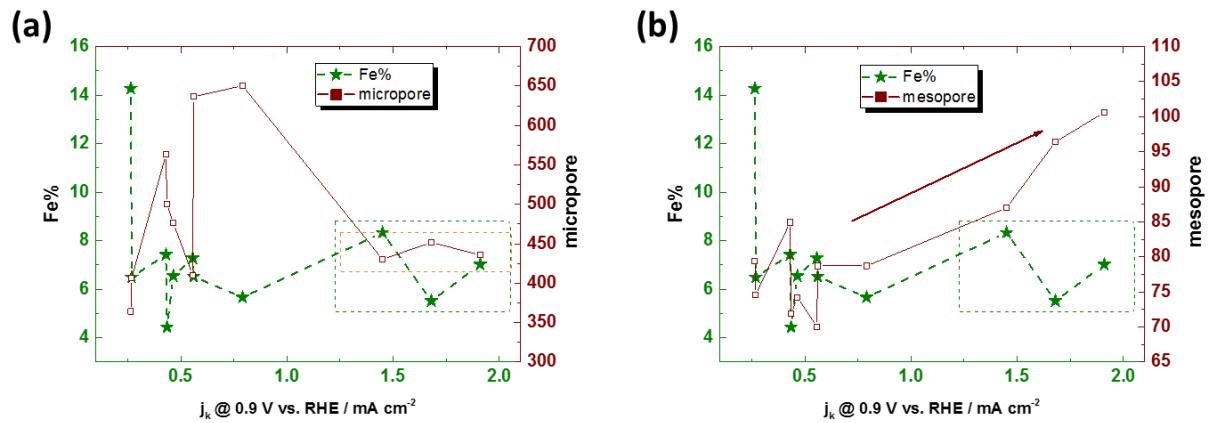


Figure S7. The relationship of micro-pore (a), mesopore (b) and Fe content with the current density $j_k @ 0.9 \text{ V}$.

Table S1 Experimental parameters

Samples	Precursors			Ar pyrolysis			NH ₃ pyrolysis	
	SPRMs (mg)	1,10-Phen (mg)	FeAc (mg)	T (°C)	Time (h)	Weight remaining	T (°C)	Weight remaining
Fe20NC-Ar600-NH ₃ -30%	700	136	20	450 + 600	2 + 1	32.7%	950	33.3%
Fe20NC-Ar700-NH ₃ -30%	700	136	20	450 + 700	2 + 1	31.8%	950	30.8%
Fe20NC-Ar800-NH ₃ -30%	700	136	20	450 + 800	2 + 1	30.5%	950	36%
Fe20NC-Ar700-NH ₃ -15%	700	136	20	450 + 700	2 + 1	31.8%	950	15.7%
Fe20NC-Ar700-NH ₃ -50%	700	136	20	450 + 700	2 + 1		950	50.6%
Fe30NC-Ar700-NH ₃ -35%	700	136	30	450 + 700	2 + 1	33.3%	950	38.1%
Fe30NC-Ar700-NH ₃ -45%	700	136	30	450 + 700	2 + 1		950	45.2%
Fe30NC-Ar700-NH ₃ -55%	700	136	30	450 + 700	2 + 1	36.5%	950	57.6%
Fe50NC-Ar700-NH ₃ -60%	700	136	50	450 + 700	2 + 1		950	63.6%
Fe50NC-Ar700-NH ₃ -70%	700	136	50	450 + 700	2 + 1	36.5%	950	72.3%
Fe50NC-Ar700-NH ₃ -80%	700	136	50	450 + 700	2 + 1		950	83.3%

Table S2. The relationship of the catalytic activity and the Fe, N content (wt.%):

	Samples	Half-wave potential	$J_k @ 0.9 V$ vs. RHE (mA cm^{-2})	Fe content (Fe_{cal} , calculated from the weight loss during pyrolysis)	Fe content (Fe_{xps} , calculated from XPS)
Group 1 (Fe20)	Fe20NC-Ar600-NH ₃ -30%	0.81 V	0.465	6.54%	1.32%
	Fe20NC-Ar700-NH ₃ -30%	0.82 V	0.556	7.28%	2.13%
	Fe20NC-Ar800-NH ₃ -30%	0.80 V	0.268	6.49%	1.05%
	Fe20NC-Ar700-NH ₃ -15%	0.79 V	0.264	14.27%	2.57%
	Fe20NC-Ar700-NH ₃ -50%	0.81 V	0.435	4.43%	1.22%
Group 2 (Fe30)	Fe30NC-Ar700-NH ₃ -35%	0.835 V	1.45	8.33%	1.41%
	Fe30NC-Ar700-NH ₃ -45%	0.87 V	1.91	7.02%	1.35%
	Fe30NC-Ar700-NH ₃ -55%	0.855 V	1.68	5.51%	1.23%
Group 3 (Fe50)	Fe50NC-Ar700-NH ₃ -60%	0.82 V	0.431	7.42%	2.13%
	Fe50NC-Ar700-NH ₃ -70%	0.84 V	0.560	6.52%	1.94%
	Fe50NC-Ar700-NH ₃ -80%	0.85 V	0.789	5.66%	1.78%

Table S3. N₂ adsorption/desorption analysis of selected samples

	Samples	N ₂ adsorption/desorption				Half-wave potential (V)
		Surface area (m ² /g)	surface area of micropores (m ² /g)	surface area of mesopores (m ² /g)	Fe content (Fe _{cal}) (%)	
Group 1 (Fe20)	Fe20NC-Ar600-NH ₃ -30%	550.3	476.1	74.2	6.54	0.81
	Fe20NC-Ar700-NH ₃ -15%	443.4	364.0	79.4	14.27	0.79
	Fe20NC-Ar700-NH ₃ -30%	480.0	410.0	70.0	7.28	0.82
	Fe20NC-Ar700-NH ₃ -50%	572.2	500.3	71.9	4.43	0.81
	Fe20NC-Ar800-NH ₃ -30%	480.6	406.0	74.6	14.27	0.80
Group 2 (Fe30)	Fe30NC-Ar700-NH ₃ -35%	517.2	430.2	87	8.33	0.835
	Fe30NC-Ar700-NH ₃ -45%	536.3	435.7	100.6	7.02	0.87
	Fe30NC-Ar700-NH ₃ -55%	547.9	451.5	96.4	5.51	0.855
Group 3 (Fe50)	Fe50NC-Ar-700-NH ₃ -60%	648.1	563.2	84.9	7.42	0.82
	Fe50NC-Ar-700-NH ₃ -70%	715.1	636.4	78.7	6.52	0.84
	Fe50NC-Ar-700-NH ₃ -80%	729.1	650.4	78.7	5.66	0.85