“Cost-effective solutions to energy storage system development”

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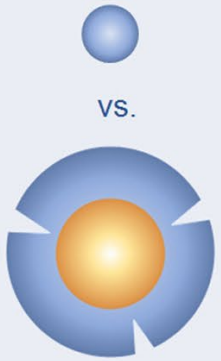
Presentation by **Tenzin Ingsel** (tingsel@gus.pittstate.edu)

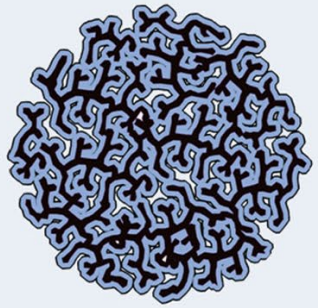
(a) Dimension Reduction

- Faster ion & electron transport
- Higher surface reactivity
- Relief of stress(s) & improved mechanical stability



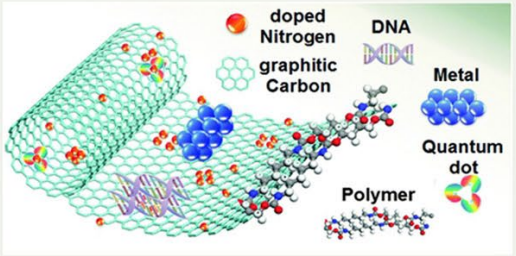
(b) Composite Formation

- Conductive media
- Mechanical (structural) support



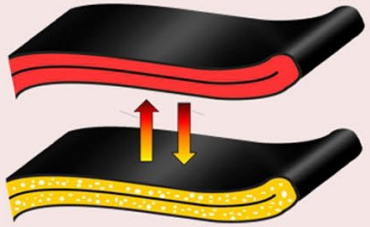
(c) Doping & Functionalization

- Faster ion & electron transport
- Improved chemical & thermal stability



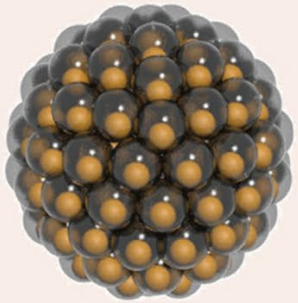
(d) Morphology Control

- Improved structural stability
- Faster ion, electron, & phonon transport
- Modified reactivity



(e) Coating & Encapsulation

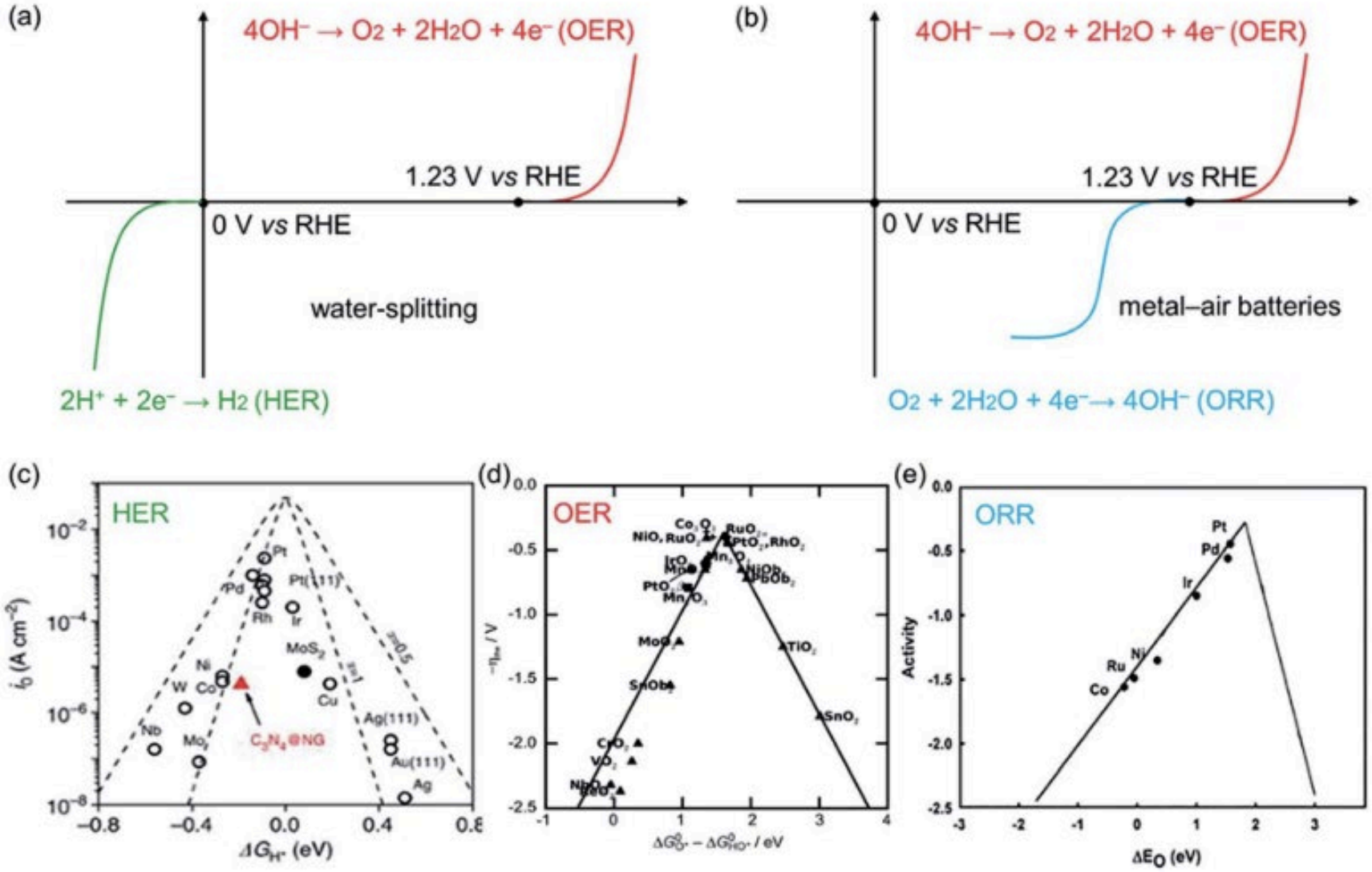
- Protection from electrolyte
- Prevention of electrolyte decomposition
- Stabilization of surface reactions
- Conductive media



(f) Electrolyte Modification

- Formation of passivation layer(s) on the surface of electrode(s)
- Controlled solubility of active material(s) & decomposition product(s)

Nitta N, Wu F, Lee JT, Yushin G (2015) Li-ion battery materials: Present and future. Mater Today 18:252–264



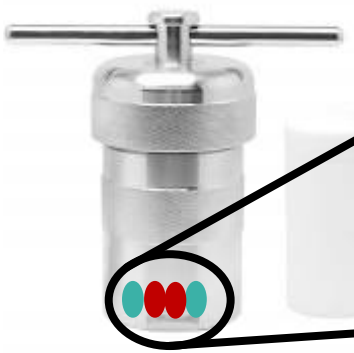
Fu G, Lee JM (2019) Ternary metal sulfides for electrocatalytic energy conversion. J. Mater. Chem. A 7:9386–9405

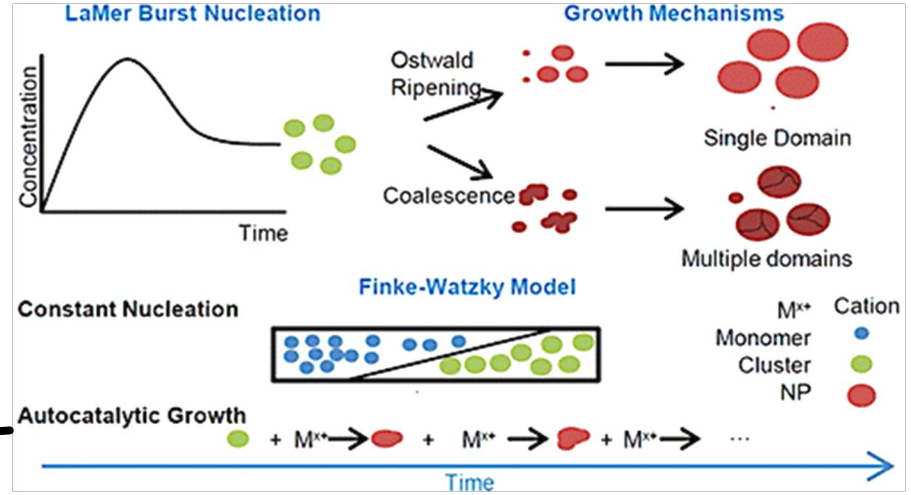
Synthesis

$Co(NO_3)_2.6H_2O$

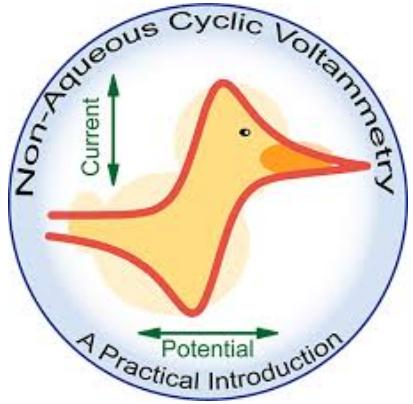
$FeSO_4.7H_2O$

140 °C 12h





$(Fe_xCo_{(1-x)})_3O_4$@Ni foam



Elgrishi N, Rountree KJ, McCarthy BD, Rountree ES, Eisenhart TT, Dempsey JL (2018) A Practical Beginner's Guide to Cyclic Voltammetry. J Chem Educ 95:197–206

Thanh NTK, Maclean N, Mahiddine S (2014) Mechanisms of nucleation and growth of nanoparticles in solution. Chem Rev 114:7610–7630

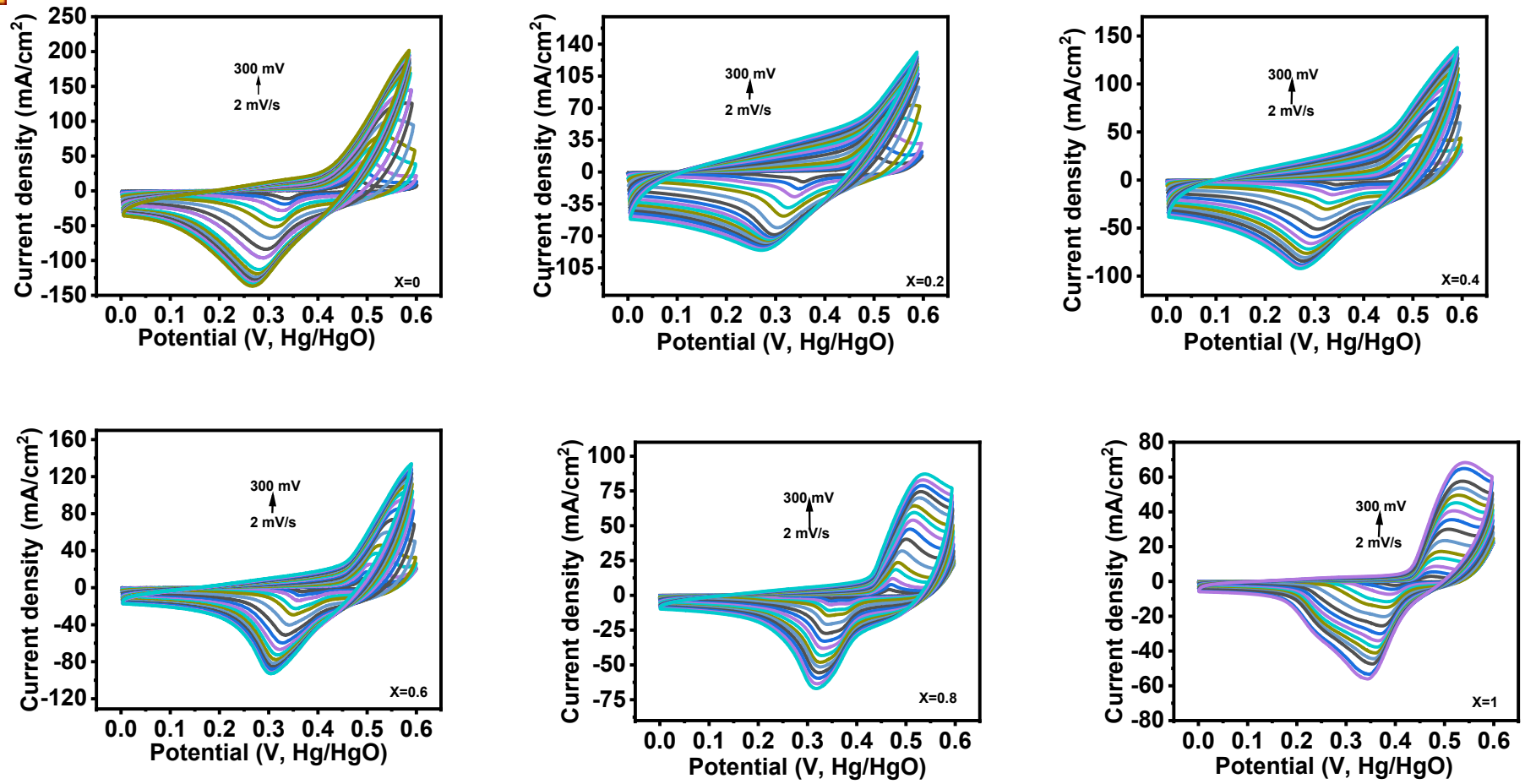
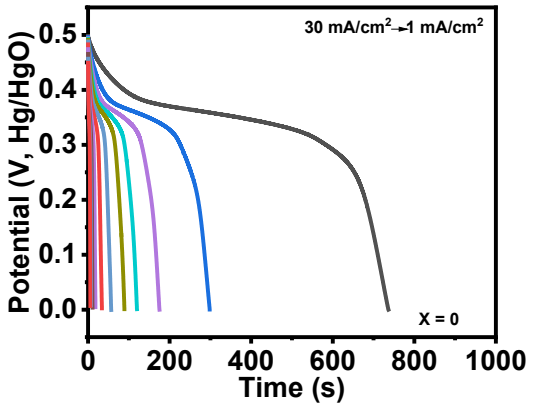
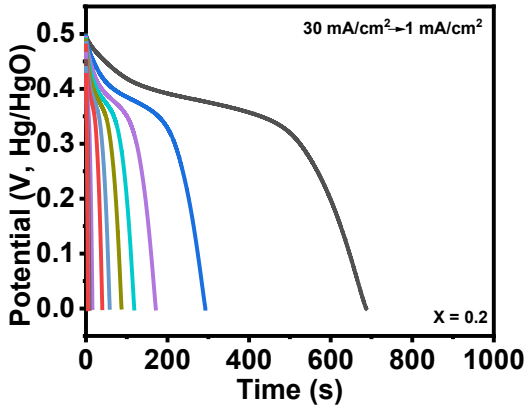
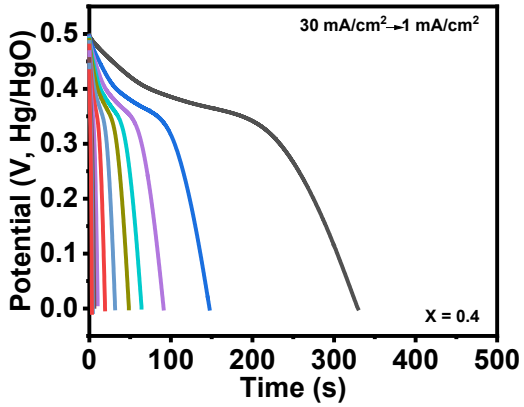


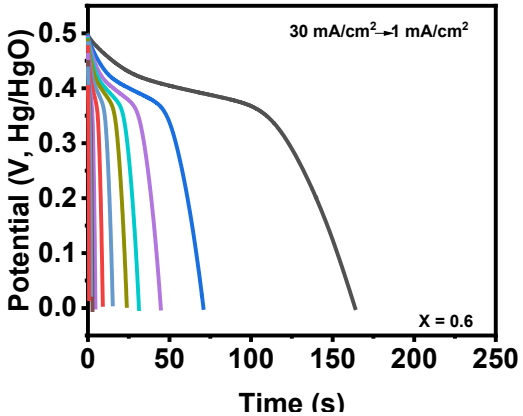
Figure 1: Cyclic Voltammetry curves of the six samples with scan rate range of 2 mV/s to 300 mV/s

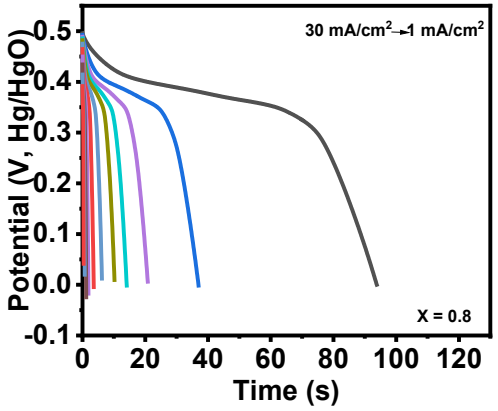






$$\text{Specific capacitance (F/cm}^2) = \frac{I.\triangle t}{cm^2.\triangle v}$$





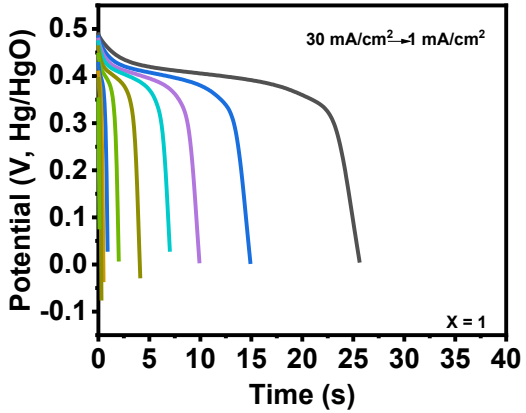


Figure 2: GCD curves of the six samples at the current density ranging from from 1 to 30 mA/cm^2.

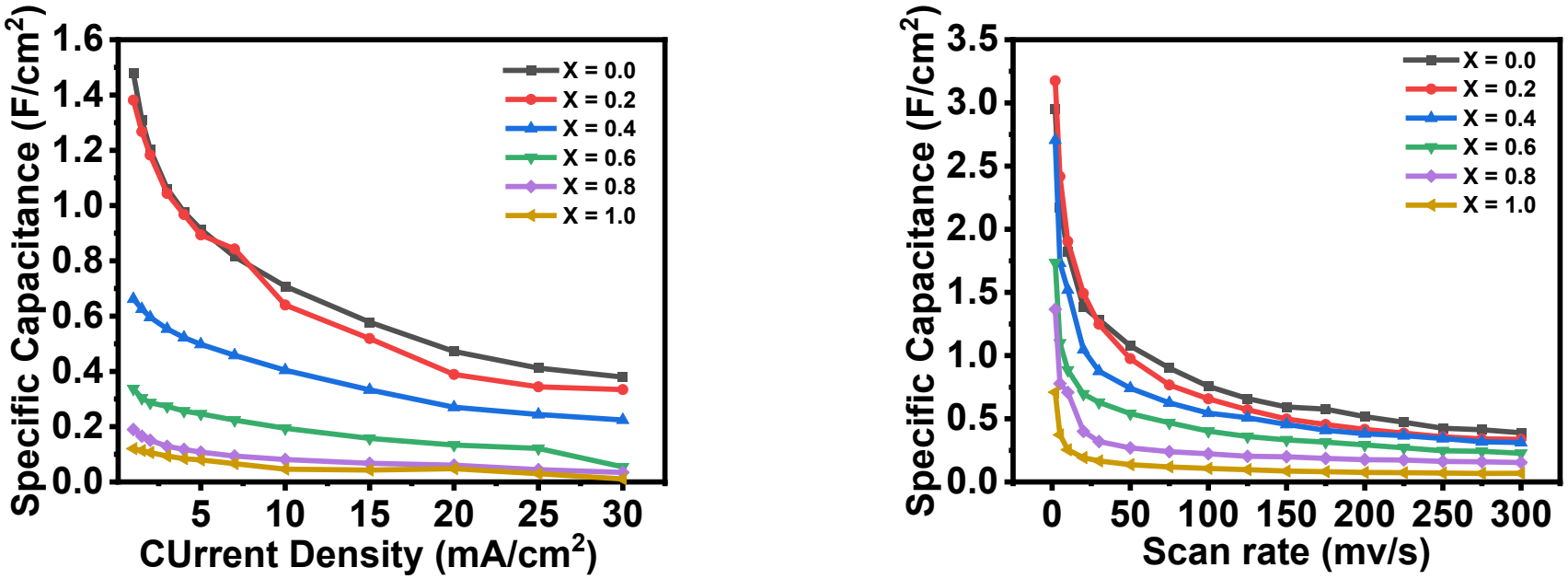


Figure 3: Specific capacitance versus applied current density and scan rates

Conclusions

~Previous reports have mentioned the synergistic effect of Co and Fe in various electrochemical applications.

~This work studied samples obtained by changing the elemental compositions of iron-cobalt $(Fe_xCo_{(1-x)})_3O_4$ with x = 0, 0.2, 0.4, 0.6, 0.8, and 1. It was observed that $Fe_{0.2}Co_{2.8}O_4$ showed the best performance in the capacitive test by delivering 3.17 F/cm^2 at a 2 mV/s scan rate.

~We speculate that a mild trend can be seen in iron dopant amount and the sample's electrochemical properties. Such techniques can be applied to optimize materials for cost-effective energy solutions.