



HIGH ENTROPY ALLOYS AS BIFUNCTIONAL CATALYSTS FOR METAL AIR BATTERIES

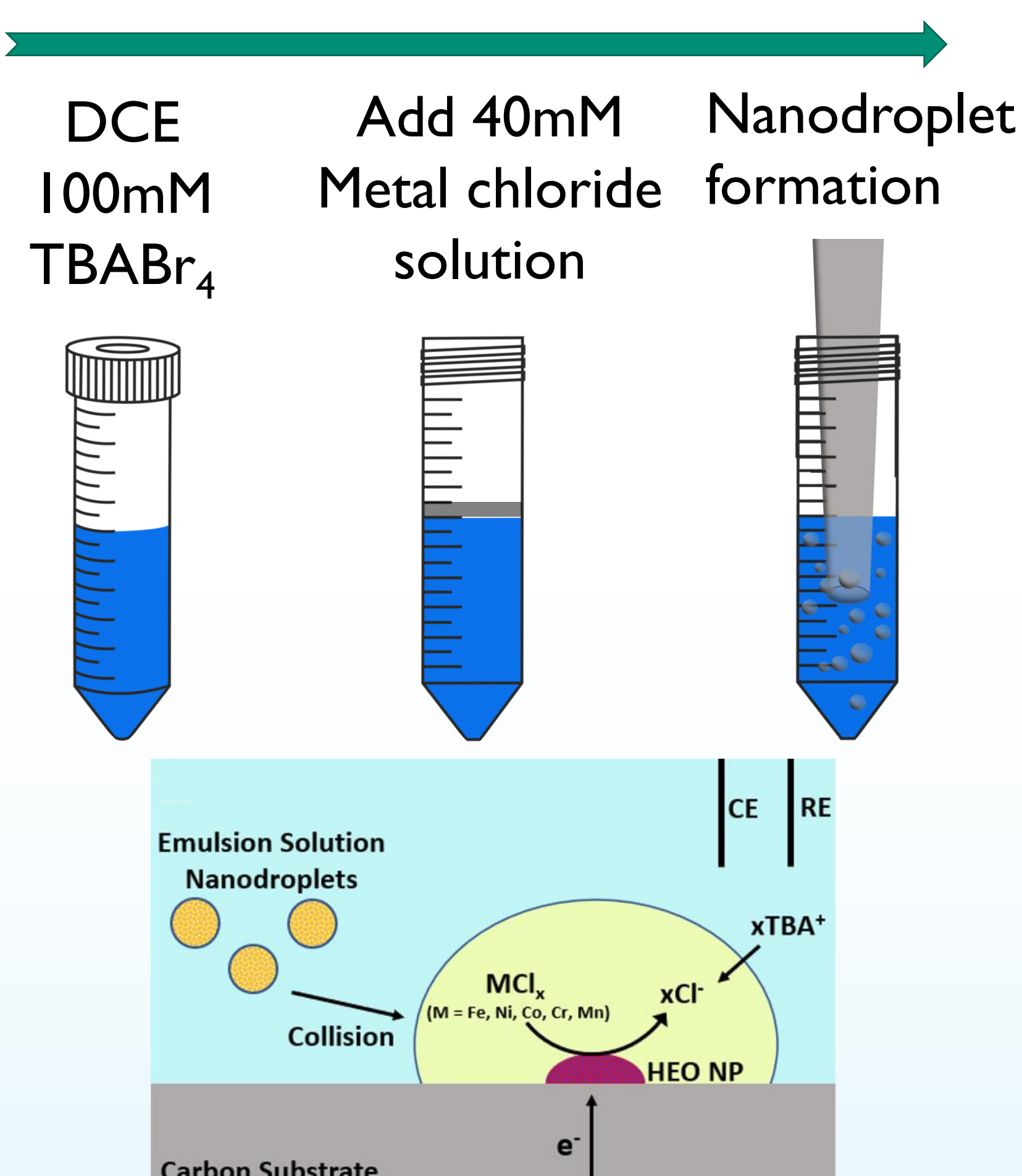
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Motivation

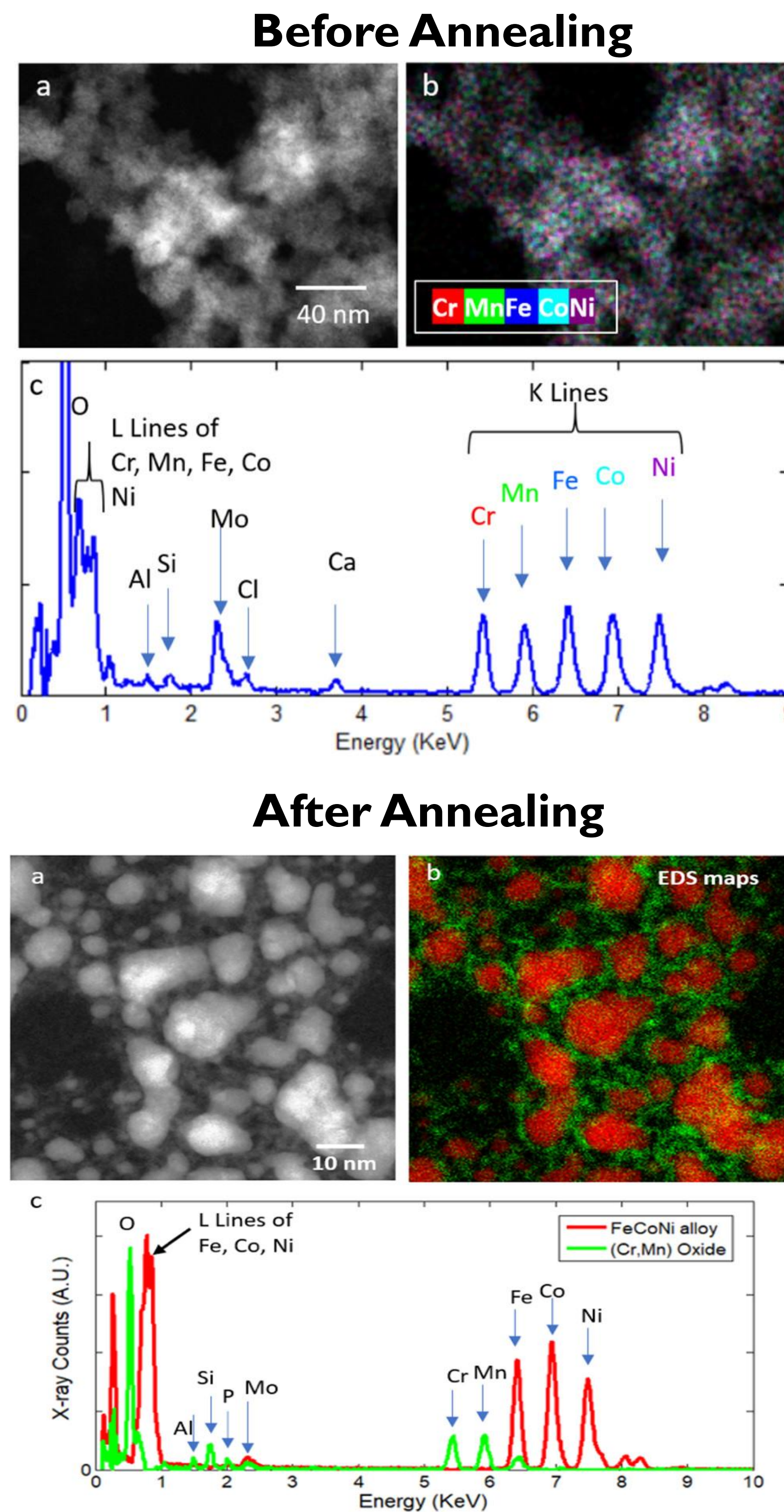
- Investigate transition metals for catalysts as alternate to rare/expensive precious metals
- Highly tunable and versatile process** creates novel high entropy alloys
- Design **compositionally tunable** electrocatalysts for relevant cathodic reactions (ORR and OER) for metal-air batteries

Novel Multi-Phase deposition

- Organic-aqueous nanodroplet formation**
 - Metal ion aqueous solutions combined w/ immiscible organic solvent
 - Ultra sonication to generate nanoscale droplet emulsion
 - Electrochemically deposited onto carbon electrode surface
 - Annealed at 600 °C for 1 hour under argon

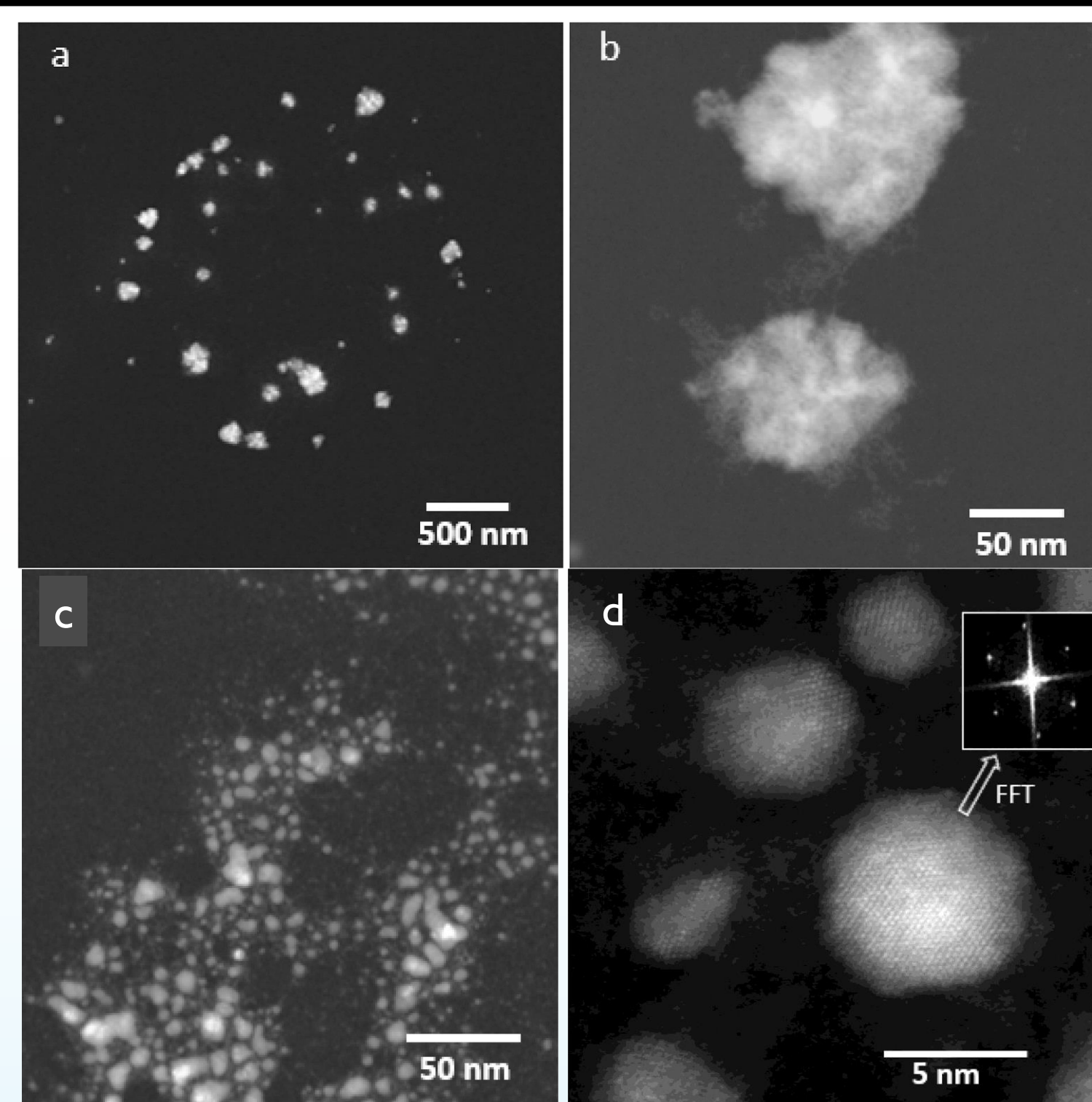


Effect of Annealing



SEM imaging and EDS analysis of FeNiCoCrMn oxide phase: (a) HAADF image; (b) EDS composite color maps; (c) summed EDS spectrum from the particles before and after annealing under argon at 600 Celsius for 60 min.*

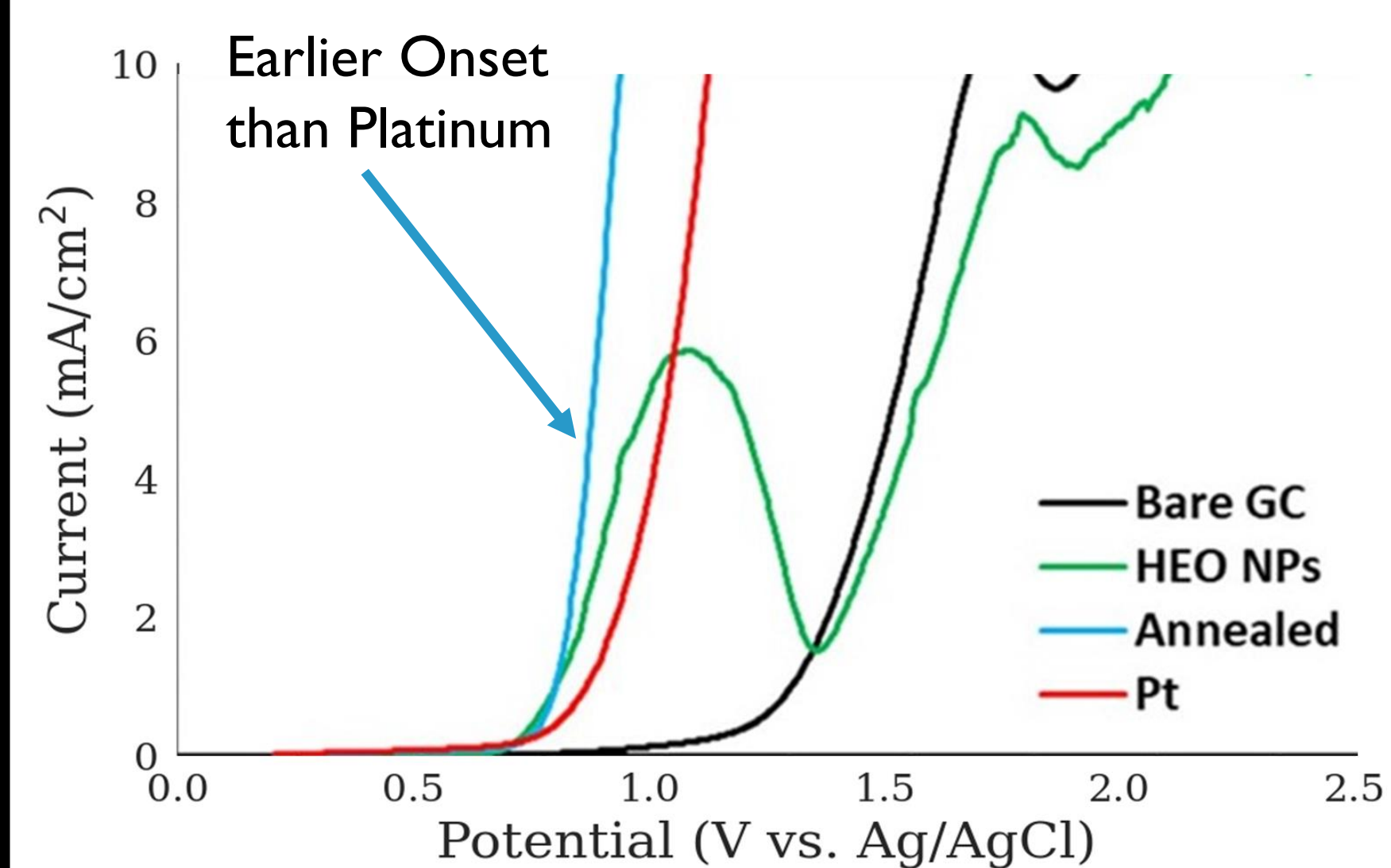
Annealing shifts structure from amorphous nanoparticles to crystalline metal oxide supported alloys!



STEM HAADF images of the FeNiCoCrMn oxide phase before (a,b) and after (c) annealing at 570 °C for 60 min, showing FeNiCo (bright) NPs mixed with the CrMnOx phase. The samples also showed diffraction and crystallinity FCC with a = 3.52 Å (d).*

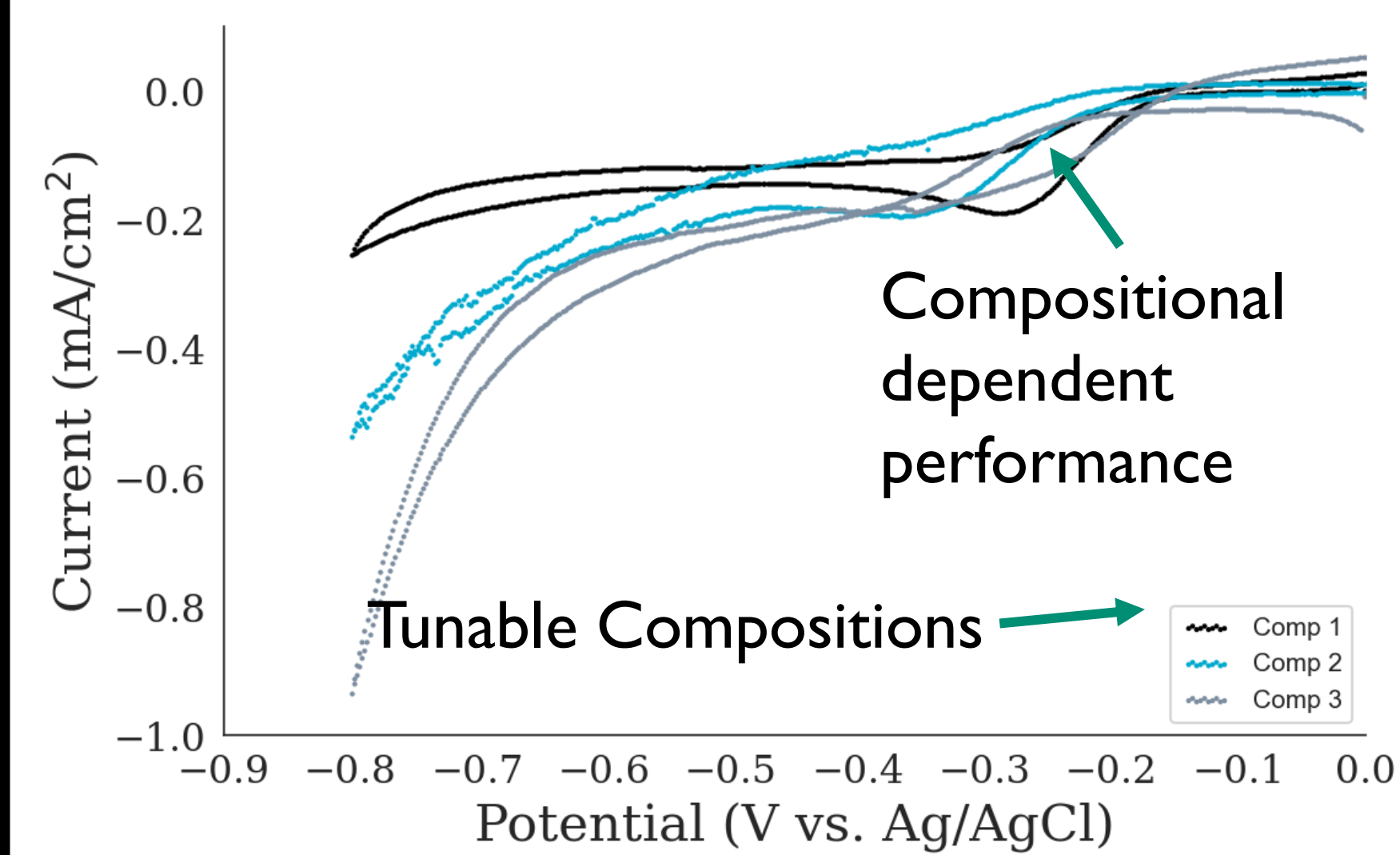
Electrochemical Performance

Oxygen Evolution Reaction



Electrochemical performance of the HEO NPs before and after annealing versus the glassy carbon substrate and platinum foil.*

Oxygen Reduction Reaction



Effects of HEO composition on the cyclic voltammetry of the ORR reaction.

Key Takeaways

- We have developed a new, tunable method for synthesizing high entropy alloys**
- Electrochemical performance as a bifunctional catalyst is dependent on composition**
- HEO-NP's are capable of competing with precious metals**

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