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From atoms to electrodes: Mesoscale effects in electrochemical conversion

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Batteries are complex multicomponent devices wherein mesoscale phenomena—the nanoscale structure and chemistry of different components, and interactions thereof—drive functionality and performance. For example, electron/ion transport within the composite electrodes relies on bi-continuous nanostructuring to form electrically and ionically conductive paths. Electrochemical conversion of different salts of a given metal yields a common and ostensibly identical product: the zero valent metal. For example, maximal lithiation of iron-based electrodes produces metallic iron nanoparticles for oxide, fluoride, and oxyfluoride electrodes alike. Accordingly, these provide an opportunity to explore the coupling of nanostructure development and anion chemistry, and correlate these with electrochemical performance. We combine synchrotron-based small angle X-ray scattering (SAXS) and pair distribution function (PDF) measurements to probe metallic iron formed by electrochemical conversion of different iron compounds across multiple length-scales and decouple the influence of anion chemistry and reaction temperature on the atomic structure and nanoscale morphology.

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