condensed-matter-battery-materials-science-by-infinity-turbine

4/15/2024

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Condensed Matter Battery Materials Science

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Condensed Matter Battery

PDF Version of the webpage (first pages)

https://infinityturbine.com/condensed-matter-battery-materials-science-by-infinity-turbine.html

Condensed Matter Batteries

Condensed matter batteries is materials science and condensed matter physics in a study of a promising solid material that conducts lithium ions.

Improving the efficiency and longevity of energy storage systems based on Li- and Na-ion rechargeable batteries presents a major challenge. The main problems are essentially capacity loss and limited cyclability. These effects are due to a hierarchy of factors spanning various length and time scales, interconnected in a complex manner. As a consequence, and in spite of several decades of research, a proper understanding of the ageing process has remained somewhat elusive. In recent years, however, combinations of advanced spectroscopy techniques and first-principles simulations have been applied with success to tackle this problem. In this Special Issue, we are pleased to present a selection of articles that, by precisely applying these methods, unravel key aspects of the reduction–oxidation reaction and intercalation processes. Furthermore, the approaches presented provide improvements to standard diagnostic and characterisation techniques, enabling the detection of possible Li-ion flow bottlenecks causing the degradation of capacity and cyclability.

Keywords:
Li-ion Battery
Na-ion Battery
Li-air Battery
Spectroscopy Techniques for Batteries
First Principles Calculations
Cathode Materials
Anode Materials
Electrolytes
Li Diffusion and Intercalation
samarium nickelate

4/15/2024

Condensed Matter Batteries Liquid Metal Batteries

Liquid metals are an old source of fascination in condensed matter physics. For exam- ple, understanding their electrical conductivity (even its order of magnitude) was a serious puzzle for many decades, since one cannot use Bloch’s theorem in a setting with no periodic structure. (This puzzle was finally cracked in the 1960s by Ziman gives a very enjoyable overview.) Recent years have seen a mild revival of interest in liquid metals, with a focus on their mechanical properties. For example, the surface tension of many liquid metals is altered enormously by the formation of an oxide layer on its surface, which presumably grows by the Cabrera-Mott mechanism. (Briefly: an electron first quantum- tunnels across the oxide layer from the bulk metal to bind to an oxygen atom on the surface, and then drags a metal ion across the oxide via the Coulomb attraction, so that the oxide thickness is tunneling-limited and grows logarithmically in time.) Consequently, the metal’s surface tension can be strongly altered (and even brought to zero) by an applied voltage; presents some fun experiments in which a spherical liquid metal droplet is reversibly turned into fractal shapes.

The two recommended papers illustrate yet another reason why condensed matter physicists might consider reviving their interest in liquid metals. They concern the operation of a certain new type of battery made from liquid metals. The usefulness of these batteries turns out to be limited by a surprising magnetohydrodynamic instability.

4/15/2024

First Principles Modeling of Electrolyte Materials in All-Solid-State Batteries

This contribution reviews the series of approximations that comprise first principles modeling techniques which we have used in recent years to simulate ideal models of solid electrolytes, some of which are of technological interest in the development of all-solid-state battery technologies.

4/15/2024