Materials Chemistry Research Group

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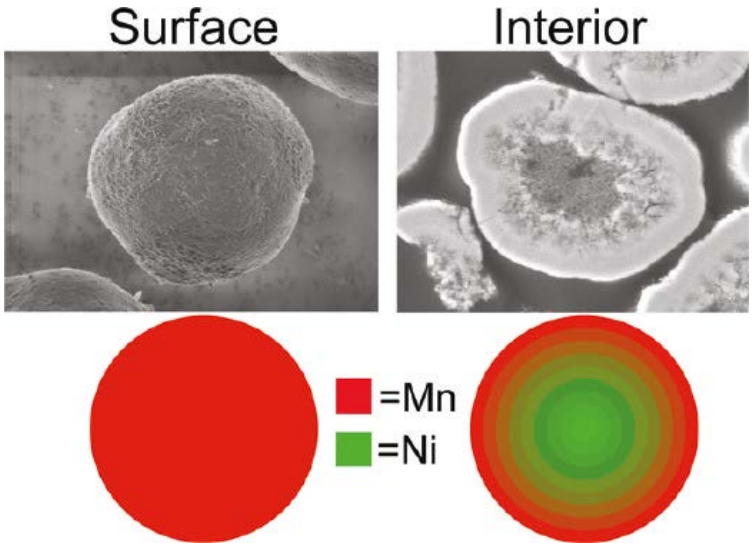

Currently, energy storage is a major challenge for a variety of applications. Batteries with higher energy density, better safety, and lower cost will be needed to continue the deployment of vehicles in the transportation sector that rely on electrical energy to drive their motors. In addition, energy storage is needed to provide energy for intermittent renewable energy sources such as wind and solar when weather conditions limit energy generation. Improving battery performance will require new innovations in battery materials, chemistries, and architectures. Our research investigates the design of new materials and materials' chemistries. This research involves the synthesis, characterization, and evaluation of materials' properties using a variety of techniques. The primary area of application that we focus on is rechargeable battery electrode materials.

"Tailoring synthesis of new materials at multiple length scales."

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Materials for Energy Storage and Electrochemistry

The current energy goals of the U.S. include reducing oil imports, electrifying the vehicle fleet, and reducing greenhouse gas emissions. Increased adoption of hybrid and electric vehicles will be needed to achieve these goals. The major challenge in moving to hybrid and electric vehicles is the cost and performance of the batteries necessary to store the energy that powers them. A variety of electrode materials chemistries are being explored that have the potential to dramatically increase the energy density of lithium-ion batteries. We employ a hierarchical, multiscale approach to tailor the synthesis and assembly of the active materials that comprise battery electrodes. This approach investigates new routes to tune the structure of composite battery electrodes, which can be optimized for active material loading and mechanical robustness. Increasing the loading of active particles in battery electrodes is necessary to enable the next-generation battery chemistries that will be needed for successful implementation of electrification of the transportation sector.

Composite materials

Greater demands on lithium battery applications require materials that provide high capacities, high power, excellent safety and thermal stability, long calendar life, low cost, and low toxicity. Efforts to meet these objectives have initiated research into new materials to replace the currently most common cathode material, $LiCoO_2$. In particular, a variety of materials have been developed to substitute all or some of the cobalt with other transition metals, especially nickel and manganese. We are working on the synthesis of alternative lithium-ion battery materials to traditional chemistries.

RECENT RESEARCH DEVELOPMENTS

- Provisional patent on new high energy density flow battery.
- Research grants on flow batteries from NSF ECCS and I-CORPS programs.
- Published a route to control the morphology of monodisperse battery particles.
- Collaborated with AFRL on all solid-state battery materials.

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