Role of Disorder in Enhancing Lithium-Ion Battery Performance

An invited talk

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Publication date:
2014

Document Version
Accepted author manuscript, peer reviewed version

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Abstract:

Disorder is a universal structural feature of materials and plays a crucial role in inducing and changing functionality of materials. When nanoparticles are embedded in a glassy phase, disorder occurs in nanoparticles, glassy phase and interfaces. By appropriately controlling over the degree and type of disorder, material performances can be significantly enhanced. Disorder can be tuned by doping, calcination, redox reaction, composition tuning, and so on. Recently we have fabricated a cathode material for lithium ion battery by introducing heterostructure and disorder into the material. The material consists of microporous off-stoichiometric lithium iron/vanadium phosphate nanoparticles covered with a phosphate glassy layer, and carbon originated from biotemplates. The nanostructure is created by using biotemplates [1,2]. Superlattice structure is found in the nanoparticles. This particular material exhibits the extremely high reversible lithium ion capacity and extraordinary rate capability with high cycling stability at high discharge current. In this presentation we demonstrate that the disorder plays a decisive role in achieving those exceptional electrochemical performances. We describe how the disorder affects the migration of both lithium ions and electrons. It is found that both the modified glassy surface and the heterogeneous superlattice structure greatly contribute to the extremely high discharge/charge rates owing to the enhanced storage capacity of lithium ions and ultrafast diffusion of both electrons and lithium ions. This work opens a new way towards high performance cathode materials for fabricating a new generation of electrochemical energy conversion devices and minitype high power storage devices.

References:

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