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The effect of particle design on the performance of rechargeable batteries

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Abstract

In addition to the characteristics of electrode materials, the energy density, power density, rate capability and cycle life of rechargeable batteries can be improved by controlling the size, morphology, and surface properties of the particulate materials used in the electrodes. Also, uniformly mixed electrode materials can be beneficial to electrode manufacturing processes, production yield, and battery performance. In this study, an environmentally friendly dry powder processing technique, Mechano Chemical Bonding Technology, was utilized to process anode and cathode materials such as graphite, $LiCoO_2$, $LiFePO_4$, etc. used in the rechargeable batteries and its effects on the performance of electrode powders were elucidated. Experimental results showed that applying Mechano Chemical Bonding treatment to the electrode materials could improve the performance of rechargeable batteries.

Key words: *Rechargeable battery, Secondary battery, Energy storage system, Electrode, Anode, Cathode, Mechano-chemical-bonding, Dry particle coating, Particle surface modification, Powder densification, Mixing*

1. Introduction

Renewable energies from solar cells, wind mills, fuel cells, biomass, etc. and hybrid/electric vehicles have been touted to be the solution to reduce our energy dependency on crude oil and green house gas. But, the alternative energy resources often can not supply stable power supply and hybrid/electric vehicles demand safer, smaller, lighter, and less expensive rechargeable batteries yet with higher rate capability and longer cycle life. The development of new generation materials for rechargeable batteries becomes the name of the game in the energy storage applications. However, in addition to the chemistry of electrode materials, the energy density, power density, rate capability and cycle life of rechargeable batteries can be improved by controlling the size, morphology, and surface properties of the particulate materials used in the electrodes. For examples, smaller particle size of electrode materials permits fast diffusion of Li ions (che *et al*., 1997; Nishizawa *et al*., 1997; Tripton *et al*., 1996; Tran *et al*., 1996); carbon coating can improve electrical conductivity of electrode materials (Kadowaki *et al*., 2001); surface modified graphite can deliver high specific capacity at high C rate (Kottegoda *et al*., 2002). Furthermore, uniformly mixed electrode materials can have better tapped bulk density and workability to improve electrode manufacturing processes, production

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