Rate determining factors of lithium-ion batteries

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The energy densities of lithium-ion batteries (LIB) for portable devices exceed 250 Wh/kg. In addition, those for electric vehicles (EV) have increased to ca. 200 Wh/kg, but the decrease of charging time has still been a serious problem.

To decrease the internal resistances, we have focused the charge transfer (lithium-ion) processes at the interface between active materials and electrolyte solutions, the ion transport processes inside composite electrodes, and reaction sites of the active materials.

The lithium-ion transfer processes at the electrodes require large activation energies which are principally due to the de-solvation of lithium-ion in the electrolyte solution [1, 2]. In the ionic liquids, we elucidated that there exists large activation barrier at electrolyte/electrode interface [3, 4].

The ion transport processes inside the composite electrodes show large resistances. By using the model porous materials of anodic alumina membrane, we showed that the pore sizes influence on the ion transport resistances [5] and evaluated the criterion of the pore sizes for the fast ion transports.

The reaction sites of active materials for lithium-ion to insert/extract are related with the lithium-ion transfer resistances at the electrodes. The evaluation of the reaction sites was conducted by using the model electrode of highly oriented pyrolytic graphite [6].

Based on the above results, I discuss the rate determining factors of LIB in the conference.

References:

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