Structure and conduction mechanism of lithium ion in ionic liquid

Design of electrolyte materials for lithium secondary batteries with high charge rate

Diffusion coefficients and mobilities of the ionic species of lithium electrolytes were measured using the electric field applying pulsed gradient spin-echo NMR technique. Analyses of the dynamic values showed that the lithium ion electrolyte was coordinated by four bis(trifluoromethylsulfonyl)amide anions ($TFSI^-$s) and formed a cluster structure as $Li(TFSI)_4^{3-}$ in an equilibrium state. The electrolyte is lithium bis(trifluoromethylsulfonyl)amide dissolved in ionic liquid, 1-ethyl-3-methylimidazolium (EMI) bis(trifluoromethylsulfonyl)amide. High mobility was observed only when the electric field larger than a certain strength was applied to the electrolyte. This indicates that the ions are orientated in response to the electric field and the orientation may be due to the dielectric polarization of the ions. High mobility reveals the formation of pathways for efficient ion migration by the aligned ions. These results lead to the systematic designing of electrolyte materials applicable to the lithium secondary batteries with high charge rate.

Yuria Saito

Research Institute for Ubiquitous Energy Devices

yuria-saitou@aist.go.jp

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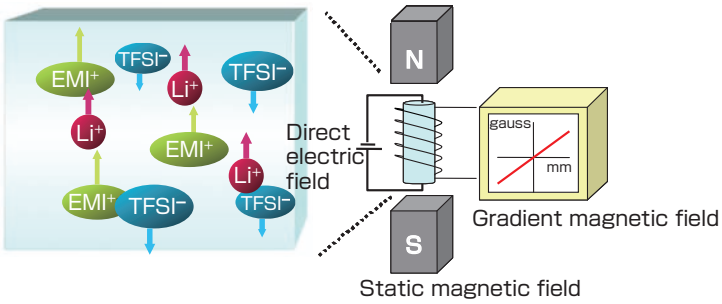

Sketch of electric field applying pulsed gradient spin-echo NMR

A novel easy-to-recycle Li-Cu secondary battery

A large-capacity and low-cost rechargeable battery with metallic electrodes

A novel secondary battery with metal Cu positive electrode and metal Li negative electrode has been developed. Aqueous electrolyte used for Cu electrode and non-aqueous electrolyte used for Li electrode are connected together by a glassy state electrolyte film through which only lithium ions can pass. During the charge and discharge processes, the dissolution-deposition of Cu (or Li) electrode and lithium ions transfer between aqueous electrolyte solution and non-aqueous solution occur. The highly reversible dissolution-deposition process of Cu metal positive electrode results in a capacity of 843 mAh g^{-1}, which is much higher than those of conventional positive electrodes. The active electrode materials of this new type of Li-Cu secondary battery are recyclable.

Haoshen Zhou

Energy Technology Research Institute

hs.zhou@aist.go.jp

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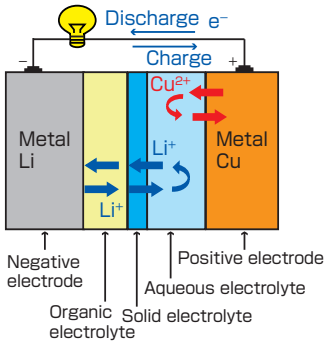

Rechargeable battery	Capacity of positive electrode (Based on active material)	Recycle type
Lithium-ion battery	About 120–150 mAh/g	×
Lithium-copper rechargeable battery	840 mAh/g	○

Left: Schematic illustration of the novel "Li-Cu secondary battery", Right: Comparison of performance of the Li-Cu secondary battery and a conventional lithium-ion battery
Capacity of positive electrode is shown as capacity per unit weight of active material used in the positive electrode (mAh/g).