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Fabrication of ether-based electrolyte solutions for Mg-rechargeable batteries

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Lithium-ion batteries have been extensively studied for these twenty years and the energy density reaches to 250 Wh/kg for portable devices. In contrast, the energy densities of lithium-ion batteries for electric vehicles are ranging from 100 – 140 Wh/kg whose values are almost half as large as those used in portable devices. Therefore, the increase of the energy density is essential for the electric vehicles.

Based on the above requirement, we focused the development of the new electrolyte solutions for rechargeable magnesium batteries.

Electrolyte solutions for rechargeable magnesium batteries have been successfully developed by Aurbach's group. Their approaches are quite reasonable to suppress the passivation film on magnesium metal. Our approach is based on the facile preparation of the electrolytes, which prevent the passivation film on magnesium metal.

Here we report the several electrolyte solutions in which magnesium deposition and dissolution can take place.

- 2-methyltetrahydrofuran (2-MeTHF) system

In this solvent, magnesium bromide ($MgBr_2$) was a good electrolyte salt for magnesium deposition and dissolution. However, the coulombic efficiency was not sufficient.

We added magnesium ethoxide ($Mg(OEt)_2$) in $MgBr_2$/2-MeTHF solutions and found the drastic increase of the coulombic efficiency for magnesium deposition and dissolution. Magnesium ethoxide itself cannot be dissolved in 2-MeTHF, and therefore, the addition of $Mg(OEt)_2$ changed the complex structures between $MgBr_2$ and 2-MeTHF.

- *n*-butyl methyl ether system

Figure 1 shows the cyclic voltammograms of platinum electrode in 0.5 mol dm^{-3} $MgBr_2$/*n*-BME. The voltammograms showed the clear redox peaks corresponding to the magnesium deposition and dissolution. We also measured the charge/discharge behaviors. As a result, the coulombic efficiency was almost 100 %.

- glyme system

Since the above solvents show the low boiling points below 80 ^{o}C, we searched the alternative systems to enhance the boiling points. Glymes and magnesium chloride with aluminum chloride enabled the magnesium deposition and dissolution on platinum electrode with high coulombic efficiency.

We also found the other electrolyte solutions using glymes and will show the results in the conference.

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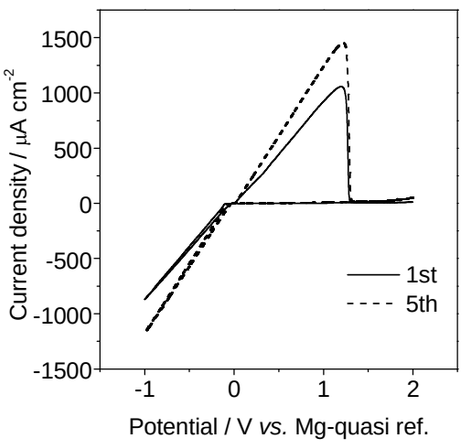

Fig. 1. Cyclic voltammograms of platinum electrode in 0.5 mol dm^{-3} $MgBr_2$/*n*-BME. Scan rate: 1.0 mV s^{-1}