Electrochemical Behavior of Mg Alloy in Organic Solution Containing Magnesium Bis(trifluoromethanesulfonyl)amide

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Rechargeable Magnesium (Mg) battery using metal Mg for the negative electrode is one of the next generation batteries because of high theoretical volumetric capacity of Mg (3832 Ah dm^{-3}) and high natural abundance of the resources. However, the reversible deposition and dissolution of Mg is generally difficult in conventional organic electrolyte solutions such as acetonitrile (AN) dissolving Magnesium Bis(trifluoromethanesulfonyl)amide ($Mg(TFSA)_2$). Recently, utilization of bismuth (Bi) metal as an efficient anode (negative electrode) material has been reported [1]. We have previously reported that the reversible oxidation and reduction behavior of Mg-Bi eutectic alloy prepared by cast method, which can be handled easily in air, was observed in both $Mg(TFSA)_2$/AN electrolyte and $Mg(TFSA)_2$/triethylene glycol dimethyl ether (triglyme, G3) electrolyte [2]. In the present paper, we have investigated the electrochemical behavior of Mg-Bi alloy in the electrolyte solutions using several nitrile solvents with higher boiling points than AN at room temperature.

Magnesium bis(trifluoromethanesulfonyl)amide ($Mg(TFSA)_2$) was used as the electrolyte salt. Organic solvents used in this work were AN and nitrile solvents such as propionitrile (PN) and butyronitrile (BN). The electrochemical oxidation/reduction behavior of Mg was investigated by cyclic voltammetry (CV) at room temperature. A three-electrode beaker cell was used with an Mg alloy (50:50 wt%) as the working electrode. The counter and quasi-reference electrodes were an Mg ribbon and an Ag wire, respectively. The surface of the Mg alloy (50:50 wt%) electrode after CV was observed by SEM.

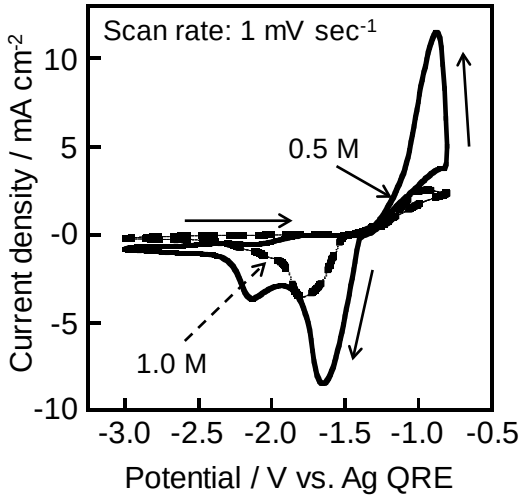

Fig. 1 Cyclic voltammograms for Mg-Bi (50:50 wt%) alloy electrode in 0.5 M or 1.0 M $Mg(TFSA)_2$/BN electrolyte.

Figure 1 shows the cyclic voltammograms at the 5th cycle for Mg-Bi (50:50 wt%) alloy electrodes in 0.5 M $Mg(TFSA)_2$/BN and 1.0 M $Mg(TFSA)_2$/BN. Reversible oxidation and reduction behavior was observed in both electrolytes. The current at the first cycle in 0.5 M electrolyte was larger than that in 1.0 M electrolyte. The current response increased with repeated cycles in both electrolytes.

References:

[1] T. S. Arthur, N. Singh, and M. Matsui, *Electrochem. Commun.*, **16**, 103 (2012).

[2] K. Fujii, N. Yoshimoto, *et al.*, The 9th Asian Conference on Electrochemical Power Sources 2017, MoP8, Gyeongju, Korea (2017).