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Gel polymer electrolytes based on fumed silica filler for magnesium batteries

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The project was focused on designing a novel, low cost, highly conductive gel polymer electrolyte using fumed silica fillers and Mg^{2+} salt. Gel polymer electrolytes synthesized with fumed silica fillers, low molecular weight poly(ethylene glycol), average Mn 400 and $Mg(BH_4)_2$, exhibit conductivities ~10^{-4} S/cm at room temperature (25 °C). Under this project, an electrolyte sample series was synthesized by varying the weight ratio of $Mg(BH_4)_2$: polyethylene glycol: fumed silica. and their conductivity measurements were taken at different temperatures ranging from 25 °C to 65 °C. The highest conductivity achieved was 1.9686 $\times 10^{-4}$ S/cm, and the corresponding sample consisted of 2.0 mg of $Mg(BH_4)_2$, 2.0 mL of poly(ethylene glycols), and 0.16 g of fumed silica. The electrolyte with the highest conductivity was used in a battery setup with a Mg pellet as the anode and TiO_2 mixture (TiO_2 - P_{25} semiconductor powder, carbon powder and PVDF binder) as the cathode, made by doctor blading on to an FTO glass with 1 cm^2 area. The open circuit voltage (V_{OC}) of the battery of configuration Mg/Gel Electrolyte/TiO_2-C was measured through a circuit of an external 60 kΩ resistance. At 25 °C the open circuit voltage was 1.722 V. The battery was run for 48 hours straight and the V_{OC} values were measured at every 2 hours. The V_{OC} value was stabilized at 1.418 V after the initial 48-hour period. The short circuit current density was also stabilized at 73.6118 μA/cm^2 after 48 hours of discharge period through 60 kΩ load, from the initial current density of 179.5211 μA/cm^2. This preliminary study concludes that the prepared electrolyte has high stability. Possibility of using this electrolyte in rechargeable Mg batteries will be studied.

Keywords: *SiO_2, magnesium borohydride, PEG, titanium dioxide*