Support information

A novel rechargeable Li-AgO battery with hybrid electrolyte

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Experimental

Material synthesis

AgO was prepared by a chemical oxidation method: 0.015 mol $Na_2S_2O_8$ and 0.030 mol NaOH were dissolved in deionized water. The mixture solution was added drop by drop to another solution contained 0.005 mol $AgNO_3$ under vigorous stirring at 60 ^oC. A dark suspension was obtained and kept on stirring for another 30 min at the same temperature after the addition of $Na_2S_2O_8$. Then the formed precipitate was filtrated and washed by deionized water for several times. The washed precipitate was dried at 60 ^oC for 12 h under vacuum environment to get the final AgO sample used for further research.

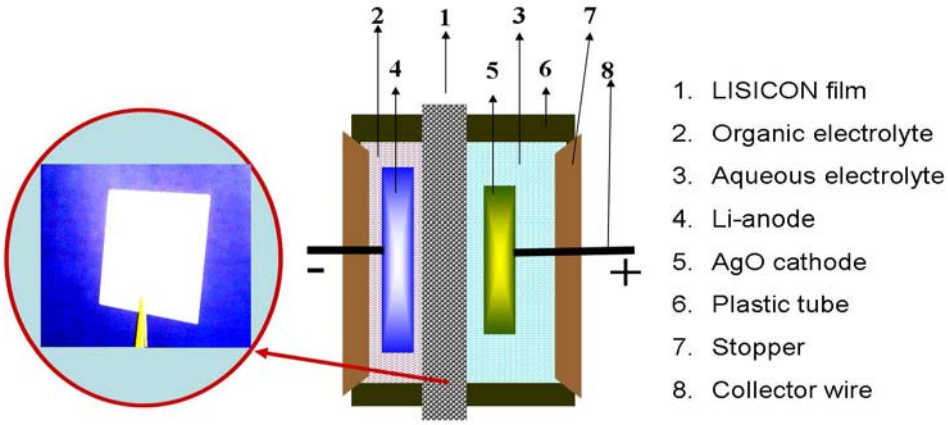
Characterizations

The phase structure of the prepared AgO sample was analyzed using a Bruker D8 Advance X-Ray Diffractometer (XRD) with CuKa radiation. The morphology of AgO was examined using scanning electronic microscope (SEM) on a JSM-6700F instrument. Thermogravimetry-Differential thermal analysis (TG-DTA) was conducted on a MTC1000 thermal analysis system interfaced to a 2000S TG module. Samples were run in aluminum boats over a temperature range of 25~600 ^oC with a heating rate of 5 ^oC/min in a flowing atmosphere (100 ml/min) of dry nitrogen.

Electrochemical measurement

The cathode electrode was prepared by mixing of AgO sample, acetylene black, and polytetrafluroethylene (PTFE) in an agate mortar in a weight ratio of 80%: 15% : 5%. The above

mixture was pressed onto a titanium grid (100 mesh) which served as the current collector. The mass load of cathode electrode was about 5 mg/cm^2; excessive amount of Li metal was used in the anode. A rudimental Li-AgO battery with a cell structure shown below was assembled by using 1 M $LiClO_4$ in ethyl carbonate (EC)/diethyl carbonate (DEC) (EC/DEC = 1 : 1 in volume) as the organic electrolyte for Li anode and an aqueous solution contained 1 M LiOH and 1 M KOH as the electrolyte for AgO cathode.



Schematic cell structure of the rudimental Li-AgO battery

The two electrolytes were separated by a water-stable superionic conductor glass ceramic film (LISICON, $Li_{1+x+y}Al_xTi_{2-x}Si_yP_{3-y}O_{12}$) with a thickness of 0.15 mm. It should be noted that only lithium ions can pass across the LISICON film during charge/discharge processes. The LISICON film was provided by Ohara Inc., Japan and its conductivity was about 10^{-4} Scm^{-1} at ambient temperature. All the electrochemical tests were performed on a Solartron Instrument Model 1287 & 1255 controlled by a computer. For galvanostatic charge/discharge tests, the cell was discharged to a voltage end of 2.7 V and charged to a constant capacity of 455 mAh/g (105% of the theoretical capacity of AgO). All the capacities were calculated based on the weight of active AgO in cathode electrode except otherwise specified.

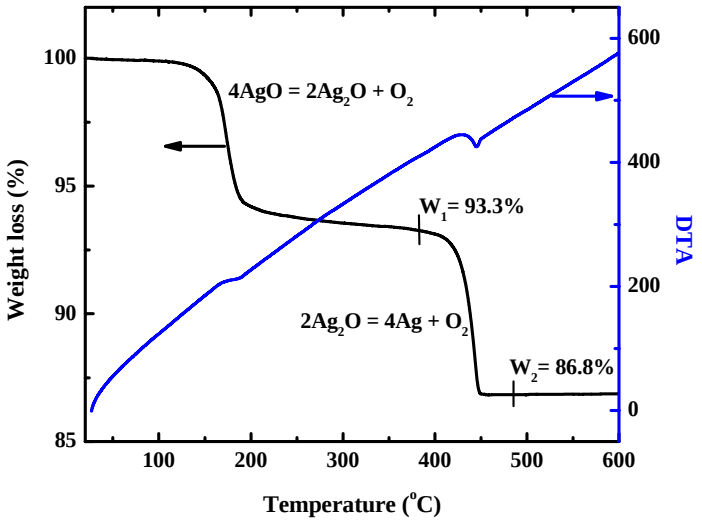


Fig. S1 TG-DTA curves of the synthesized AgO sample in nitrogen atmosphere

The TG-DTA curve demonstrated a two-stage weight loss curve in which the first weight loss was detected in the range of 130 ~ 200 ^{o}C, which can attribute to the decomposition of AgO to Ag_2O. The second weight loss was detected in the range of 400 ^{o}C ~ 450 ^{o}C, which can attribute to the decomposition of Ag_2O to Ag. The occurred reactions during the TG thermal process can be descried as following:

$$4\ AgO = 2Ag_2O + O_2 \qquad (S1)$$

$$2\ Ag_2O = 4Ag + O_2 \qquad (S2)$$

Correspondingly, the DTA curve exhibits two endothermic peaks centered at 175 ^{o}C and 444 ^{o}C, respectively. If assuming that pure AgO is tested, W_1 and W_2 are the remaining weight fractions after reaction (S1) and reactions (S1) + (S2), respectively. Then W_1 and W_2 could be calculated as 93.5% and 87.0%, respectively. According to the above TG curve, the detected W_1 and W_2 were 93.3% and 86.8%, very close to the theoretical values, which confirmed the high purity of the synthesized AgO sample.

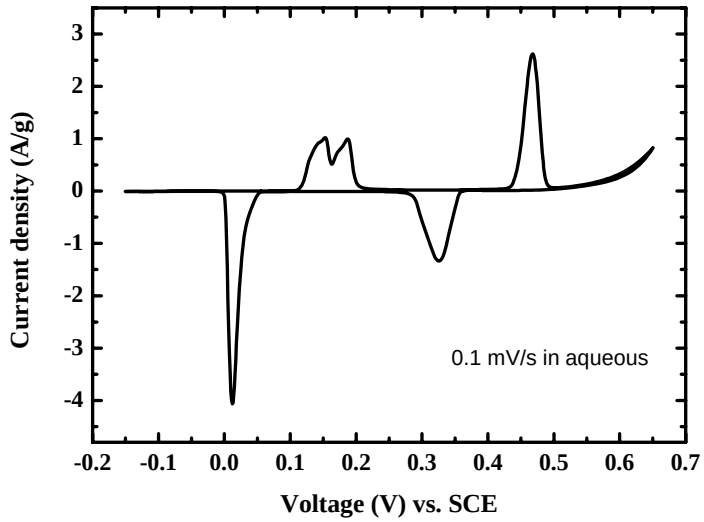


Fig. S2 CV plot of AgO electrode at a scan rate of 0.1 mV/s in aqueous solution containing 1 M KOH and 1 M LiOH, the test was conducted using a three-electrode system in which AgO electrode served as the work electrode, SCE served as the reference electrode and Ti grid served as the counter electrode.

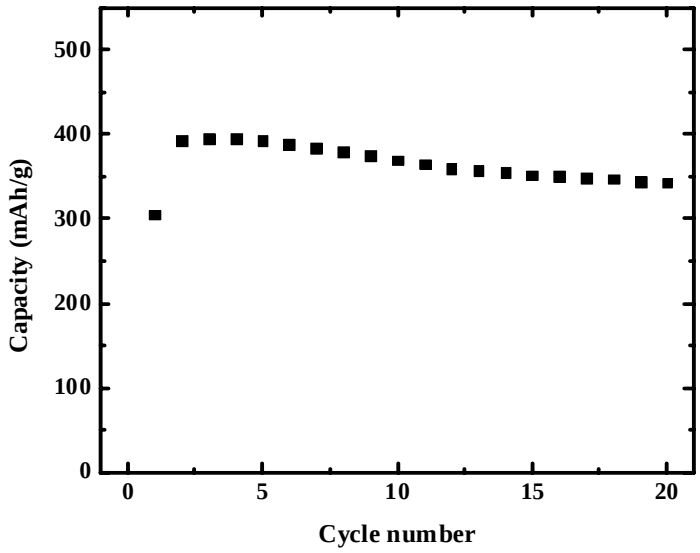


Fig. S3 Cycle performance of the rudimental Li-AgO cell at a constant charge/discharge current of 0.5 A/g.