A Novel Composite Anode For Enhanced Li-Ion Battery Performance

AggiE-Challenge, Texas A&M University
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ABSTRACT

Transparent batteries have recently garnered attention as a viable solution to modern energy storage problems. Optically transparent batteries not only promise to decrease the size of electronic devices, but also create fully-transparent components for those devices. The difficulty in producing transparent batteries lies in designing and synthesizing electrode materials that allow for optical transparency, while retaining properties that are crucial to battery performance. Among these properties are electrical potential, storage capacity, and internal conductivity. Cost effectiveness and mechanical flexibility must be considered as well. Zirconium phosphate and graphite offer potential avenues towards the creation of transparent batteries due to their [1]. The direct synthesis and evaluation of these materials as battery electrodes is the direct consideration of this work.

OBJECTIVE

1. To illustrate relevant models in the synthesis of graphene and zirconium phosphate.
2. To synthesize large amounts of graphene through a feasible wet-chemistry redox routine.
3. To synthesize large amounts of zirconium phosphate through a hydrothermal method.
4. To characterize inelastic light scattering, structure, and morphology of graphene at the nanoscale.
5. To apply a graphene-based nano-composite and zirconium phosphate as an anode for a transparent lithium-ion battery (Fig. 2).

SYNTHESIS

Methodology (cont’d)
- Electrode materials were assembled into four anodes (10% PVDF in NMP as binder) for analysis against a reference cathode (LiCoO2):
  1. Graphite/binder 9:1 (control)
  2. Zr-P/binder 9:1
  3. Graphite/thin film graphene/binder 8:1:1
  4. Zr-P/thin film graphene/binder 8:1:1
- An SEM image of Zr-P product was generated (see Fig. 2).
- Graphene was analyzed by Raman spectroscopy (Fig. 5) and AFM (Fig. 6).

PERFORMANCE TESTING

Methodology
- Zr-P (Fig) was synthesized from ZrOCl2·8H2O and phosphoric acid by an associated student using a hydrothermal method (Fig 2).
- Graphene was prepared through a wet-chemistry redox routine involving five primary steps: oxidation of graphite to graphene oxide, sheet separation, purification to graphene oxide solution (Fig. 3), reduction to graphene, and centrifugation to remove aggregated solids, giving a final aqueous suspension of high-quality graphene (Fig. 4).

RESULTS

- Full cells were assembled for each test anode and charge/discharge curves generated (Fig ) at C/5 charge rate (~200 µA).
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CONCLUSIONS

We successfully synthesized a relatively high-quality aqueous suspension of graphene under mild conditions, and characterized it using atomic force microscopy. Zirconium phosphate was successfully synthesized as well. Both products were used in the construction of Lithium-ion battery anodes, whose performance was evaluated and compared.

REFERENCES


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