The Search for New Solid-State Electrolytes: Investigating the Structural Properties of Substituted Li₅MgO₄ or Li₆MO₄ Antifluorite Materials

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INTRODUCTION

Lithium ion batteries have existed since the 1970s and developments in their efficiency are constantly being addressed. Even with continuous advancements, the Li-ion battery is falling behind in many other technological fields that require battery power for the same reasons. As such, the search for new batteries has continued since 1991. One way to modify lithium ion batteries is to use novel or different compounds that show enhanced ionic conductivity.

Lithium batteries were first developed in 1970 when Osawa Mochi started a project that utilized lithium metal as the anode and titanium (I) sulfide as the cathode. This prototype was able to store up to 1400 mAh/g, a significant improvement over the titanite cathode currently used in today’s lithium batteries.

EXPERIMENTAL

Compounds were synthesized by conventional solid-state reactions. The syntheses of Li₅MgO₄ (M = Al, Ga, In) and Li₆ZnO₄ were summarized in equations 1 and 2.

1. Li₅MgO₄ + 2Li₂O → 2Li₃MgO₄ + Li₂O (eq. 1)
2. Li₅ZnO₄ + 2ZnO → Li₆ZnO₄ (eq. 2)

The results of these reactions are shown in Figure 3.

RESULTS

The Li₅MgO₄ (Fig. 4) and Li₆ZnO₄ (Fig. 5) supports that it was synthesized with the described purity of 95%. The peaks were located at the appropriate 28 values and with similar relative intensities.

DISCUSSION

The XRD data collected using the Rigaku Miniflex diffractometer suggests that the Ti- and Zn-based compounds were incorporated into the antifluorite structure (Fig. 6).

Future Work

- Energy dispersive X-ray analysis will be used to quantify the elemental composition of the Li₅MgO₄ and Li₆ZnO₄ samples.
- Theoretical modeling of the compounds will be used to predict improvements obtained in the crystal structure.
- The inorganic properties of these materials may allow us to synthesize better lithium ion-containing electrolytes for rechargeable lithium ion batteries.

REFERENCES

9. 1D-60 Sample Preparation. https://1d60.xpsaps.gov/1d60_prep.htm (Accessed April 21, 2000).

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