

Exploring a Gallium-Tantalum Dual Doped Lithium Garnet

Thursday, 12 November 2020 17:18 (1 minute)

Lithium garnet oxides have been put forward as a solid-state alternative for Li-ion electrolytes since the Li^+ conducting abilities of $\text{Li}_7\text{La}_3\text{M}_2\text{O}_{12}$ ($\text{M} = \text{Ta}, \text{Nb}$) was discovered in 2003. [1] These solid state materials exhibit physical and chemical properties desired for more efficient and safer Li-ion battery electrolytes. [2] Lithium garnet oxides can exist in tetragonal and cubic phase isomorphs with the latter exhibiting higher conductivities. $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$ undergoes a phase transition from cubic to tetragonal due to the thermodynamic unstable nature of the cubic arrangement. [3] Ionic conductivities of up to $1 \times 10^{-3} \text{ S cm}^{-1}$ have been reported for cubic phase garnet materials of $\text{Li}_{6.4}\text{La}_3\text{Zr}_{1.4}\text{Ta}_{0.6}\text{O}_{12}$. [4] Here we present a dual doped garnet series of $\text{Li}_{6.75-3x}\text{Ga}_x\text{La}_3\text{Zr}_{1.75}\text{Ta}_{0.25}\text{O}_{12}$ and attempt to mimic the high conductivities seen in that $\text{Li}_{6.4}\text{La}_3\text{Zr}_{1.4}\text{Ta}_{0.6}\text{O}_{12}$. The successful synthesis of the proposed series was achieved via standard solid-state sintering from gallium doping up to $x = 0.5$. X-ray and neutron powder diffraction characterisation revealed that Ga has a preference to occupy the Li tetrahedral (Li24d) site over the octahedral (Li96h) site. High-temperature neutron diffraction studies show the relationship between temperature, Ga content, and Li displacement between the Li24d and Li96h sites.

References

- [1]. V. Thangadurai, et al., Journal of the American Ceramic Society, 2003, 86, 437-440.
- [2]. V. Thangadurai, et al., Chemical Society Reviews, 2014, 43, 4714-4727.
- [3]. G. Larraz, et al., Journal of Materials Chemistry A, 2013, 1, 11419-11428.
- [4]. M. M. Ahmad, et al., Journal of Materials Science: Materials in Electronics, 2015, 26, 8136-8142.

Level of Expertise

Student

Speakers Gender

Male

Do you wish to take part in the poster slam

Yes

Primary authors: CHRISTOPHER, Timothy (University of Auckland); SOEHNEL, Tilo (The University of Auckland)

Co-authors: Dr HUANG, Saifang (University of Auckland); Dr CAO, Peng (University of Auckland)

Presenter: CHRISTOPHER, Timothy (University of Auckland)

Session Classification: Poster Session

Track Classification: Chemistry & Crystallography