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Lithium Lanthanide Halides: A New Family of Solid Electrolytes

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The growing need for safe and reliable energy storage has brought the search for stable, high performance solid electrolytes to the forefront of battery materials research. Recently, it has been shown that lithium lanthanide halides (Li_3MX_6 , $M = \text{La-Lu}$, $X = \text{Cl, Br, I}$) with high ionic conductivities can be synthesized through mechanochemical and water mediated routes, creating renewed interest in the family of compounds. However, Li_3MX_6 compounds have only been synthesised with the late lanthanides (Eu-Lu), apart from the isolated case of samarium bromide, and of these compounds, only Li_3MX_6 ($X = \text{Cl, Br, I}$) and Li_3YbCl_6 have had their crystal structures reported. This leaves a large gap in the literature that is yet to be explored. The family of Li_3MX_6 compounds share properties that make them highly appealing for use in all-solid-state batteries. Their structural properties, namely disordered lithium sites and soft anion lattices, allow for Li_3MX_6 compounds to have excellent ionic conductivities of ~ 1 mS/cm, comparable to garnet $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$, one of the most promising solid electrolytes for lithium batteries. Additionally, halides have a favourable decomposition against lithium metal electrodes, forming ionically conductive and electronically insulating LiX interphase materials. These interphase materials are stable during cycling and impede any further electrolyte decomposition, allowing for excellent cyclic stability. These properties, along with the large gaps that are yet to be explored, make research into Li_3MX_6 compounds imperative for the continued development of solid-state electrolytes for all-solid-state batteries.

Level of Expertise

Student

Presenter Gender

Man

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Which facility did you use for your research

None of the above

Students Only - Are you interested in AINSE student funding

Yes

Do you wish to take part in the Student Poster Slam

No

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Yes

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