Molecular Scale Engineering of Locally Concentrated Ionic Liquid Electrolytes

Andy Zhou[a*], Gregory G. Warr[b], Rob Atkin[c], Karolina Matuszek[a]

[a]*Monash University, Melbourne, Australia*
[b]*The University of Sydney, Sydney, Australia*
[c]*The University of Western Australia, Perth, Australia*
**azho0018@student.monash.edu*

Considering modern dependence on batteries in increasingly common devices such as mobile phones, electric vehicles, and medical devices, the importance of highly efficient electrochemical energy storage systems is required to meet the demand. Ionic liquids have generally been highly regarded as effective electrolyte materials owing to its favourable properties including high thermal and mechanical stability, large electrochemical window, nonflammability, and nonvolatility.[1] Ionic liquid electrolytes (ILEs) also have the capacity to form robust, stable solid electrolyte interphases (SEI) which suppress rapid dendrite growth and enhance safety and longevity of batteries.[2] However, the crucial setback lies in the high viscosity of ILEs which results in low ionic conductivity and sluggish ion mobility, impeding the widespread utilisation.[2]
A promising solution to this issue is the design of locally concentrated ionic liquid electrolytes (LCILEs) via addition of non-coordinating diluents to ILEs. Initially reported with hydrofluoroether (HFE) diluents, LCILEs have since shown increased ion mobility, ionic conductivity, dendrite resistance, enhanced cell performance, and stability.[2] A maintained nanostructure in ILEs bulk and electrode interphases have also shown to be crucial towards uncompromised battery performance. The nanostructure of ILEs have seen to be maintained or enhanced after the addition of a diluent, retaining the benefits of ILs.[3] Recent work involving localised high-concentration electrolytes (LHCE) displayed micelle-like structures in high salt concentrations, inspiring thought on similar motifs in LCILEs.[4] However, the fundamental understanding of nanostructure and dynamics of molecules and ions involved in LCILE systems is yet to be fully elucidated with respect to the identity of electrolyte-electrode materials and relative compositions. This work investigated a variety of ILs, salt, and diluent identities and compositions to further understand the effects of intermolecular interactions, like that with HFEs, and their effects on nanostructure using advanced x-ray scattering techniques for the rational design of novel LCILEs.

References

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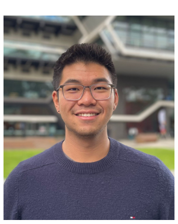

Andy is a current honours student at Monash University under Dr. Karolina Matuszek.