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Structural battery electrolytes: effect of composition on physico-chemical properties

Structural batteries have emerged as promising multifunctional composites in the field of Li-ion batteries. They consist of interpenetrated, multifunctional components: (*i*) carbon-fibers that enable the intercalation of lithium ions and provide electrical conductivity and mechanical reinforcement, and (*ii*) a polymer network that transfers mechanical load while confining (*iii*) the liquid electrolyte responsible for ion transport.[1] With their unique design, structural batteries represent the next generation of load-bearing components for electric transportation, offering lightweight storage of electrical energy throughout the structure of a vehicle. Developing these batteries is crucial for reducing emissions by improving fuel efficiency. For an optimal performance, suitable structural battery electrolytes need to be designed to enable sufficient mechanical load transfer and long-range ionic transport between the electrodes.[1]

In this study, Raman spectroscopy was employed to gain deeper insights into the intermolecular interactions among the various components of the system. The collected Raman spectra were analyzed across three distinct regions: the lower spectral range (240-450 cm^{-1}), sensitive to TFSI conformational changes; the middle spectral range containing a strong vibrational mode at $\simeq$ 743 cm^{-1}, attributed to the expansion-contraction mode of the entire TFSI anion (ν_s S-N-S and ν_s CF_3), which correlates with the TFSI anion coordination; and the spectral range (1550-1650 cm^{-1}), where the degree of curing of the methacrylate-based polymer was estimated. The collected Raman data were then correlated with morphological, thermal and relaxation dynamics data to highlight the fine tunability of the structural battery electrolyte properties with composition.

References

[1] A. Pipertzis, N. Abdou, J. Xu, L. E Asp, A. Martinelli, J. Swenson, Energy Materials, 3 (2023) 300050.
[2] N. Demarthe, L. A. O'Dell, B. Humbert, R. D. Arrua, D. Evans, T. Brousse, J. Le Bideau, Advanced Energy Materials, 14 (2024) 2304342.

Figures

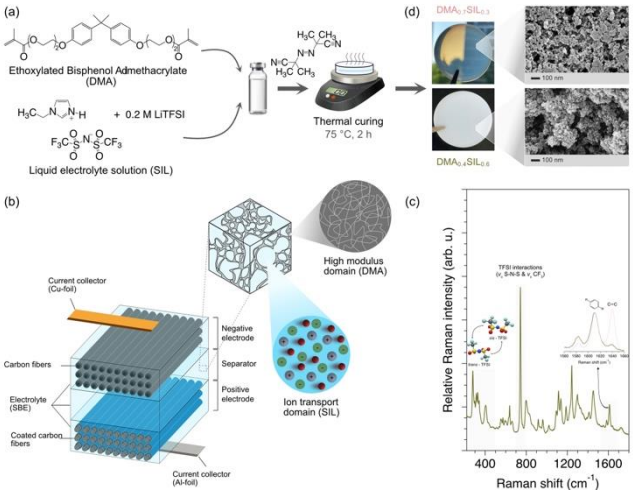

Figure 1: (a) Details of the SBEs synthesis procedure; (b) Illustration of the SBEs concept; (c) Raman spectra of the SBEs collected at RT; and (d) SEM images of the cross-section of samples $DMA_{0.7}SIL_{0.3}$ (top) and $DMA_{0.4}SIL_{0.6}$ (bottom).