

Superionic electrolytes via combination of molecular and colloidal liquid crystals

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Liquid crystals (LCs) have revolutionized the display industry in past and thereby have had a major impact on our daily lives.[1] Thanks to their interesting stimuli-responsive properties, LCs are increasingly explored for advanced applications such as sensing, photonic devices, smart windows, soft actuators, porous membranes and biomimetic systems, to name a few.[2, 3] More recently, their intrinsic anisotropy, self-assembly, and tunable nanoscale organization has attracted growing interest for ionic transport in energy storage devices.[4] The ordered yet dynamic LC environment can provide directional pathways for fast ionic transport, filling the gap between liquid and solid electrolytes.[5] Besides, LC based electrolytes are expected to stabilize the interface between metal electrodes and electrolytes (also referred as solid-electrolyte interface, SEI) in next generation metal batteries, thereby preventing the formation of dendrites that are complicating commercialization of such devices.[6] These advantages position liquid crystals as promising materials for innovative ion-conducting systems.

Here, we will present a new electrolyte concept that synergistically combines the molecular smectic LCs (based on specific anionic surfactants) with colloidal nematic particles (based on cellulose nanocrystals) to create a new class of hybrid LC electrolyte that is able to show superionic transport. This work build on our previous report of modifying CNC surface with surfactants to achieve nematic phase behavior in organic media.[7] In other words, while colloidal particles reinforce the mechanical properties of electrolyte, its ionic conductivity stays almost the same, suggesting decoupling between ionic conductivity and mechanical properties. We attribute this behavior to nanoconfined transport of ions in smectic nanochannels of surfactants while colloidal particles bridge the channels to maintain the ion path continuity. Our concept is generic and can be extended to other tailored combinations of LCs and colloidal particles.

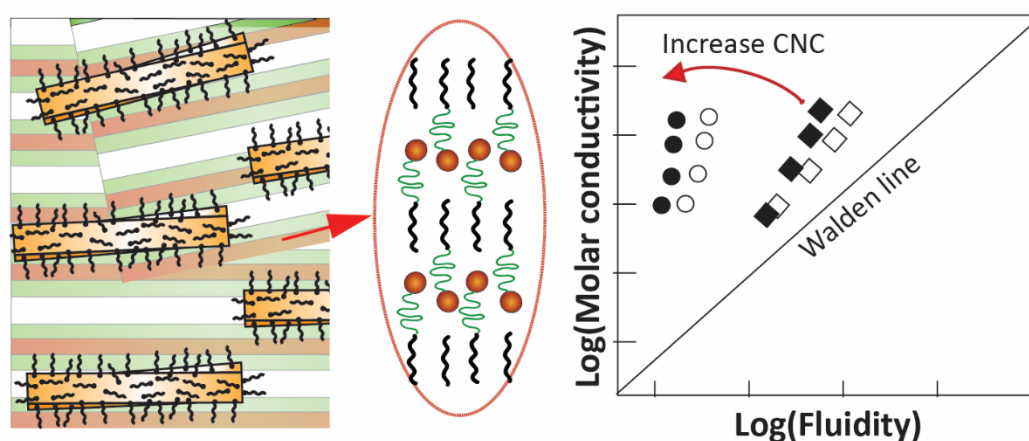


Figure 1. Schematic representation of the material concept highlighting formation of ionic channels and simplified Walden plot suggesting tunable superionic transport.

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