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Dynamics and Phase behaviour of Ionic Liquid Crystal confined in Nanoporous Alumina

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Ionic Liquid Crystals (ILCs) are materials that combine the properties of liquid crystals with the ionic conduction similar to ionic liquids. It's known that liquid crystalline mesophases under nanoconfinement exhibit anomalous dynamics and phase behavior. Here, we investigate the dynamics, and phase behavior of a guanidinium based ionic liquid crystal confined in self-ordered nanoporous alumina oxide membrane of pore sizes ranging from 180 nm down to 25 nm using Dielectric Spectroscopy (DS), X-ray scattering and calorimetry. We aim to understand how the pore size and pore surface wettability (hydrophilic or hydrophobic) influence the dynamics, and phase behavior in this system. Our DSC investigations show: (i) the crystalline-liquid crystalline transition decrease with inverse pore diameter and deviates from the Gibbs- Thomson equation. (ii) the liquid crystalline-isotropic transition is completely suppressed for all the confined samples. DS reveals emergence of adsorbed layer process for the ILC confined in native (hydrophilic) pores of 80 and 25 nm, which is absent for the bulk and hydrophobic case, implying the dynamic heterogeneity in the system. We verify the liquid-crystalline –liquid transition using X-ray Scattering and DS. Scattering investigation reveals a change around 130 –140 ℃, where the liquid crystalline order vanishes. Concomitantly, the dielectric relaxation rates exhibit a change around the same temperature limit, implying the liquid crystalline –liquid transition. This liquid crystalline-liquid transition is a Zero-Entropy producing transition, that's unobserved in DSC, and might be unrelated to thermal events. The ionic conduction shows non-monotonic dependence on both the pore size and pore surface chemistry.

Participation

In-Person

References

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