Structural Evidence for the Superionic-State Formation of Ionic Liquids in Carbon Nanopores

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Ionic liquids (ILs) are pure salts whose melting point are near ambient temperatures. ILs have much attention from the application to the energy storage devices like supercapacitors because of the outstanding electrochemical properties. These excellent properties could be related to the unique microscopic structures, predominated by Coulombic interactions between ions. The Coulombic ordering structure which is normally formed in the bulk ILs would be much affected by the confinement in carbon nanopores.

Recently, Kondrat and Kornishev [1] predicted that ions of same charges can be closer each other in the nanospaces surrounded by conductive pore walls like carbon nanomaterials, because of the electrostatic screening on inter-ion interactions. They named the unique ionic liquid structure in carbon nanopores as "superionic state". However, the definitive evidence whether such a superionic state exists or not is still not obtained although extensive experimental researches have been conducted for the understanding of ionic liquid inside carbon materials[2].

Very recently, we succeeded to describe the detailed 3D structures of ionic liquids in monolayer and bilayer confinements of carbon nanopores with hybrid reverse Monte Carlo (HRMC) simulation-aided X-ray scattering technique. In the monolayer confinement, the pair wise structure formation of same ions with first neighbor distances is increased compared with that of bulk ionic liquid [3]. Furthermore, this non-Coulombic ordering is further enhanced in the presence of an applied external electric potential. Our results would be directly related to the microscopic origin of the high performance of ionic liquid supercapacitors.

References

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