A3-05 Aquatic Functional Materials Harmonizing with Water for Sustainable Applications

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Water is essential in life and societies. Aquatic functional materials show functions in environment where water molecules exist. These materials are critical for healthcare, environment, and sustainable societies. To develop highly functional materials, it is important to understand the interactions between water molecules and materials. We have promoted the project entitled Aquatic Functional Materials supported by MEXT and JSPS from 2019-2024. In the project, we developed new functional materials such as water treatment membranes, biomedical materials, sensing materials as well as hybrid materials obtained in aquatic environment. Here I describe nanoporous self-organized water treatment membranes. We prepared nanostructured polymer membranes by in situ polymerization of columnar, smectic, and bicontinuous cubic LC ionic monomers [1-5]. These membranes have well-ordered nanopores and show unique selectivity of inorganic ions [3-5]. To understand the mechanisms of the ion recognition and selectivity, we examined hydrogen-bonded structures of water molecules in the nanospace using synchrotron-based high-resolution soft X-ray emission spectroscopy [6]. MD simulation also exhibited the structures and stability of confined water molecules inside the ionic nanopores (Fig.1) [7]. Moreover, the membranes showed high removal performance for viruses [8] In addition, selective separation properties for the mixture of CO_2/N_2 under humidified conditions were observed for these membranes [9]. Self-organized nanoporous membranes in aquatic environment have great potentials as functional materials for sustainability.

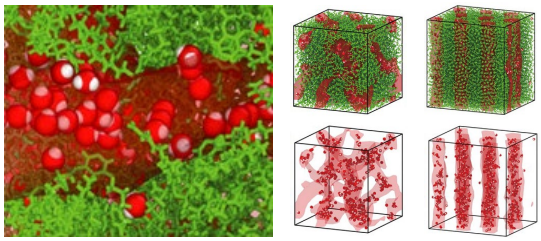

Fig. 1. Snapshots of bicontinuous cubic and columnar liquid crystals containing water molecules confined in the ionic nanopores.

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