Fabrication of a Large-Area and Highly-Uniform Proton-Conducting Nanofilm by Self-Assembly via Hydrogen-Bonding

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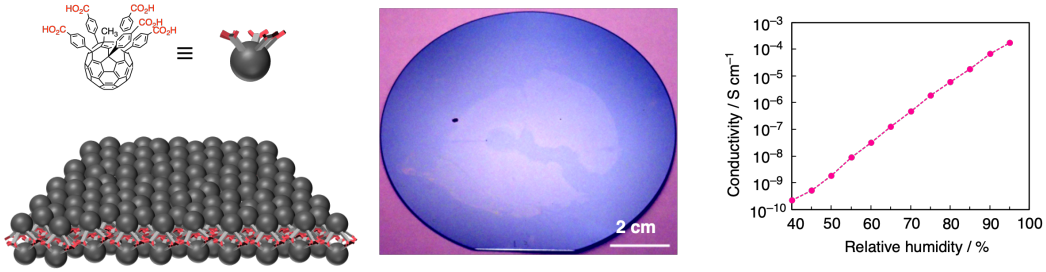
Two-dimensional (2D) nanofilms are of wide interest due to their specific structures and properties. For practical use of 2D materials, large-area synthesis, high uniformity, and precise thickness control are critical issues. However, the ideal synthetic design of nanofilms has been in a difficult situation. In this work, we designed an entangled hydrogen-bonding network to form a 2D reverse bilayer structure from a conical fullerene amphiphile (CFA)[1] with five carboxylic groups, which were capable of intermolecular hydrogen-bonding interaction. Herein, we report the fabrication of a self-assembled fullerene film (FF) with a large area and high uniformity by air/water interface synthesis, precise control of thickness, and 2D proton conduction.[2]

FF was fabricated from CFA solution (toluene/1-butanol = 3/1) by placing it on a water surface and by evaporating, and capable of being transferred onto various substrates. FF was obtained as a 3.0-nm thick nanofilm revealed by atomic force microscopy analysis. X-ray reflectivity analysis of FF on the water surface confirmed reversed bilayer structure, in which carboxylic groups face to the inside of the nanofilm, indicating the formation of bilayer structure via hydrogen-bonding interaction between CFA. Precise and facile control of the thickness of FF was also performed by changing concentration or by transferring one by one. FF was clearly visualized on SiO_2/Si substrate, and the area was evaluated as ca. 30 cm^2. Visible light reflection measurement at some points on FF was also performed to confirm high uniformity in a large area. In addition, relative humidity-dependent conduction measurement indicated high proton conduction via a 2D hydrogen-bonding network.



1) Y.-W. Zhong et al. *Org. Lett.* **2006**, *8*, 1463. 2) P. Ravat et al. *Adv. Mater.* DOI:10.1002/adma.202106465.