Researchers grow regularly-ordered nanometer-scale crystalline thin film using 3D porous material

August 29 2012

A joint research group consisting of the Japan Synchrotron Radiation Research Institute (JASRI located at the SPring-8 site), Kyoto University, and the National Institute for Materials Science (NIMS) succeeded in fabricating a crystalline thin film with a film thickness of nanometer order, in which molecules of a 3-dimensionally strong porous coordination polymer (hereinafter, PCP) are arranged (oriented) in a designated direction, and demonstrated that this thin film has a reversible gas adsorption/desorption reaction function.

A variety of functions can be expected with PCP, which possesses high gas adsorption characteristics and high regularity (crystallinity), including high efficiency separation and concentration of gas molecules, reaction in the interiors of the pores, etc. For this reason, it is possible to fabricate various types of energy related devices, such as high efficiency fuel cells, etc., by integrating PCP having different functions. When constructing devices of this type, fabrication in which the orientations of the crystals in multiple PCP films are aligned, in other words, oriented growth, is necessary and indispensable for integration of different types of PCP with tight adhesion. However, until now, oriented growth had only been successful with planarly-rigid PCP. In order to realize diverse functions, durability of the fabricated device, and adhesion between different types of PCP during integration, a technology which enables oriented growth of crystals of PCP with 3-dimensional rigidity had been desired.

In this work, the joint research group succeeded in fabrication of a 3-dimensional PCP nanometer scale thin film in which oriented growth was realized by selection of an appropriate substrate for oriented growth, surface processing of that substrate, and selection of a metal-organic framework (MOF) material that enables control of the growth direction while also displaying 3-dimensional rigidity. In addition to the fact that a reversible gas adsorption-desorption occurs in this nanometer scale thin film, the rigidity of the thin film was also confirmed, meaning that adsorption-desorption reaction can be performed without accompanying changes in the frame structure. The oriented growth of these nanometer scale thin films and structural changes during adsorption and desorption could be confirmed for the first time in detailed diffraction experiments using the brilliant X-rays at the SPring-8.

Because these research results will provide the basic technology for fabrication of new functional devices by integration of PCP with different functions, it is expected that research and development on functional devices using nanometer scale thin films and application to high performance in fuel cells, etc. will be greatly accelerated.

More information: The original paper in connection with these research results was published in the June 13 edition of the *Journal of the American Chemical Society*. See: pubs.acs.org/doi/abs/10.1021/ja304361v

Provided by National Institute for Materials Science