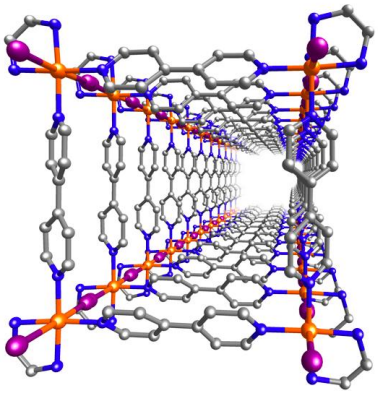
Dimensional crossover in coordination chemistry

Hiroshi Kitagawa
Division of Chemistry, Graduate School of Science& iCeMS, Kyoto University
Kitashirakawa-Oiwakecho, Sakyo-ku, Kyoto 606-8502, Japan

E-mail:kitagawa@kuchem.kyoto-u.ac.jp

Since the discovery of carbon nanotubes, they have attracted very wide scientific interest because of their characteristic electronic structure and conducting properties, and they have motivated the creation of many kinds of tubular nanomaterial. However, sometimes developing the structural and electronic tunings of nanotubes is subject to some potential limitations; for example, extreme synthetic conditions that mainly need high temperatures cause difficulties in the precise control of their size, shape and atomic constituents. Therefore, the fabrication of well-defined nanotubes with high tunability is a very challenging task. In contrast, the bottom-up approach for constructing nanostructures using metal-organic building blocks offers the advantage of controlling their size, shape, electronic states and also their robustness by substituting their structural components. Although many aspects of the physical and chemical properties of carbon nanotubes have been considered, those of metal-organic nanotubes have rarely been discussed so far.

Here, we demonstrate a bottom-up approach for the fabrication of well-defined dimensional-crossover nano-architectures with high tunability using metal ions and organic molecules as building blocks [1-4]. We succeeded in rationally constructing an assembly of square prism-shaped metal-organic nanotubes with aside of 2 nm. A uniform 1D channel is fabricated inside the tube, and H_2O and alcohol can be selectively adsorbed. Its optical gap is about 0.76 eV of semiconductive region, and X-ray and theoretical studies revealed its unique electronic structure of CDW quartets. In addition, its electronic states can be successively controlled by exchanges of structural components and guest molecules. The results presented here demonstrate a rational route to the creation of nanotubes with high tunabilities of structures and electronic states, and might also offer valuable insights into multifunctional nanomaterials.



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Hiroshi KITAGAWA
Professor
Solid-state Chemistry Laboratory, Division of Chemistry,
Graduate School of Science & iCeMS
Kyoto University
Kitashirakawa-Oiwakecho, Sakyo-ku, Kyoto 606-8502
+81(Japan)-75-753-4035
kitagawa@kuchem.kyoto-u.ac.jp

Education
1992 PhD, Chemistry,Kyoto University.

Professional Experience
Research Associate, Institute for Molecular Science, 1991-1994
Assistant Professor, Japan Advanced Institute of Science & Technology, 1994-2000
Associate Professor, Department of Chemistry, University of Tsukuba, 2000-2003
Professor, Department of Chemistry, Faculty of Science, Kyushu University, 2003-2009
Professor, Division of Chemistry, Graduate School of Science, Kyoto University, 2009-
Adjunct Professor,iCeMS, Kyoto University, 2009-
Deputy Executive Vice-President for Research, Kyoto University, 2014-

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Solid-state chemistry, Coordination chemistry, Nano-science, Low-dimensional electron system

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