Dimensional crossover in coordination chemistry

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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 an aside of 2 nm. A uniform 1D channel is fabricated inside the tube, and H2O 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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Solid-state chemistry, Coordination chemistry, Nano-science, Low-dimensional electron system

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