Life is one of the most complicated systems on the earth. To understand the living system, scientists have devoted their efforts in two different ways: (i) to control the living systems by chemicals and/or (ii) to imitate the living systems. So far, I have challenged development of novel chemical approaches based on supramolecular coordination chemistry to achieve the control and imitation of the living system: (1) On-cell coordination chemistry to allosterically control the activities of membrane-bound receptors; (2) self-sorted supramolecular nanofibers; (3) porous crystalline materials with multiple molecular binding sites. My achievements would provide the effective ways not only to understand the living system, but also to realize novel chemical technologies, such as therapeutics, diagnosis, and intelligent biomimetics.

(1) On-cell Coordination Chemistry: allosteric activation of neurotransmitter receptors in live cells by coordination chemistry (ref 1: ***Nature Chem.*** 2016)

I succeeded allosteric activation of membrane-bound glutamate receptors in living cells by using coordination bonding. Membrane-bound receptors, such as ligand-gated ion-channels and G protein-coupled receptors, play vital roles including gene expression, migration, etc. To understand the biological phenomena, the precise regulation of membrane-bound receptors is essential. In this work, I developed a novel chemogenetic method for artificial activation of membrane-bound glutamate receptors based on stabilization and/or induction of their activated structures through coordination bonds. I successfully constructed the engineered ion-channel type glutamate receptors (iGluR), neurotransmitter receptors involved in learning and memory mechanisms, with two His mutations, and found that the activities of engineered iGluR could be allosterically modulated by addition of $Pd(bpy)(NO_3)_2$ (bpy: 2,2'-bipyridine). Also, my strategy could be applied to different types of glutamate receptors, GPCR-type glutamate receptors, strongly suggested that coordination chemistry is the promising tool for controlling and editing the cellular functions in a bioorthogonal manner.

(2) Self-sorted supramolecular nanofibers (ref 2: ***Nature Chem.*** 2016)

Self-sorted phenomenon is essential for construction of complex but well-organized systems like living cells. In this work, I achieved in situ real-time imaging of self-sorted supramolecular nanofibers composed of a peptide-type gelator and an amphiphilic gelator. The self-sorted supramolecular nanofibers were successfully observed through confocal laser scanning microscopy and superresolution microscopy. The real-time imaging technique enabled to visualize formation processes of the nanofibers, revealing the stochastic non-synchronous fiber formation in a cooperative mechanism.

(3) Metal-Macrocycle Frameworks: Porous metal-complex crystals with multiple guest binding pockets (ref 10: ***J. Am. Chem. Soc.*** 2012, ref 7: ***Angew. Chem. Int. Ed.*** 2014, ref 6: ***Nature Chem.*** 2014, ref 4: ***Chem. Sci***. 2016)

I achieved the construction of porous crystals composed of four kinds of metallo-macrocycles (stereoisomers and enantiomers), called Metal-Macrocycle Frameworks (MMFs). MMFs have one-dimensional nano-channel pore with a diameter of ca. 1.5 nm, which possess *ten* types of guest binding sites derived from cavities of metallo-macrocycles. Using the MMF crystals, I performed site-selective and diastero-selective arrangement of small organic molecules on the pore surface through non-covalent interactions (ref 7, 9, 10). Unexpectedly, in-situ X-ray analysis demonstrated *the transient state* of molecular adsorption on the MMF pore surface, which shows the completely different binding mode from that at the thermodynamic equilibrium state (ref 6). These MMF works provide a novel way to decorate the nano-sized space with functional organic/inorganic molecules, leading to enzyme-mimetic functions, such as separation and catalysis.

Publication lists

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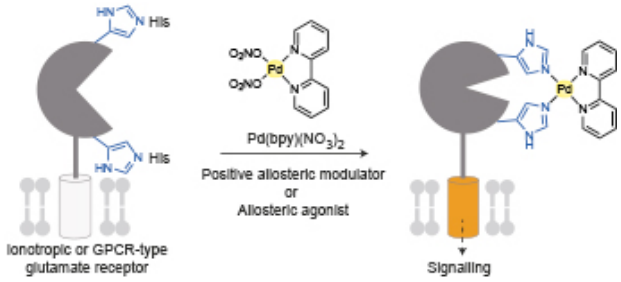

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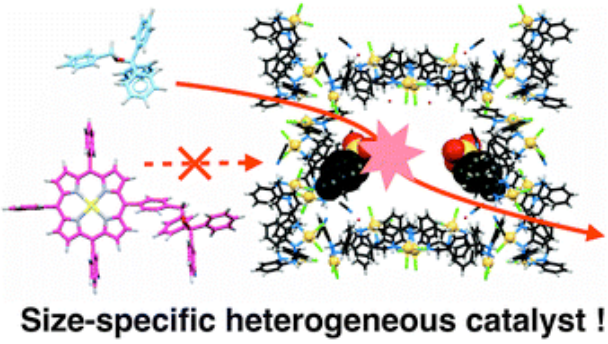

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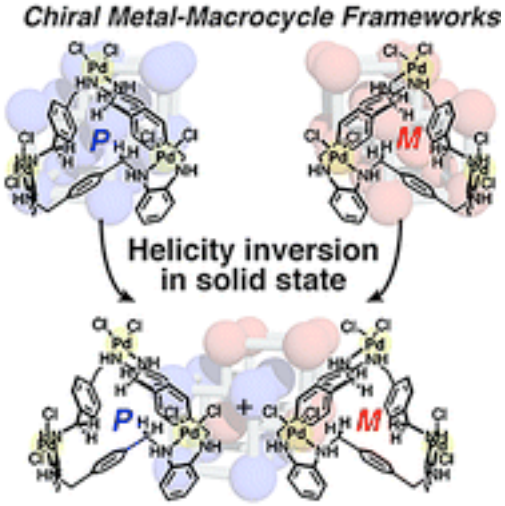

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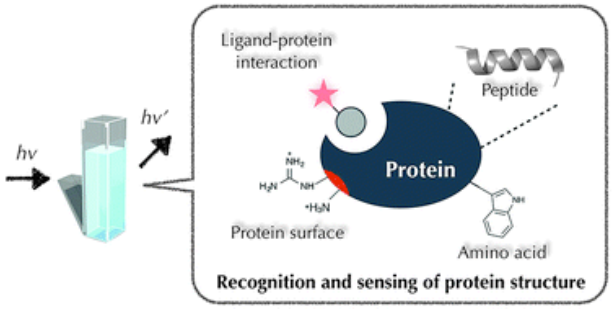

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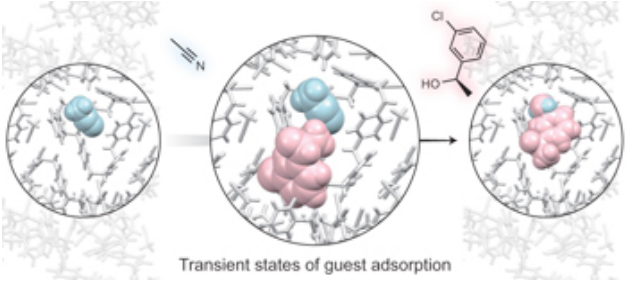

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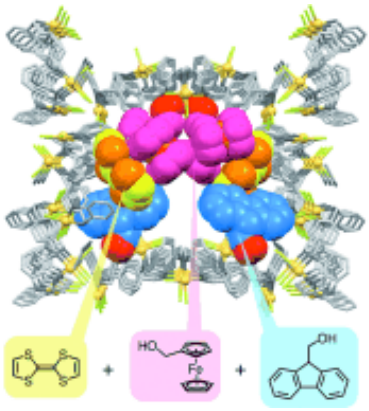

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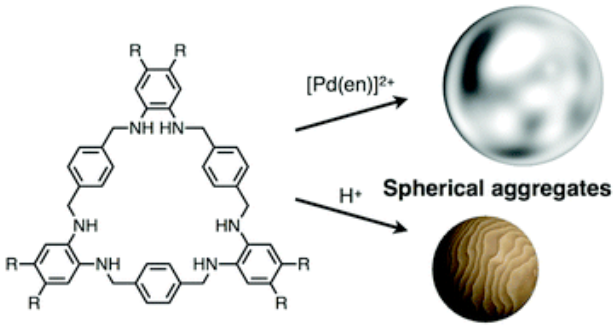

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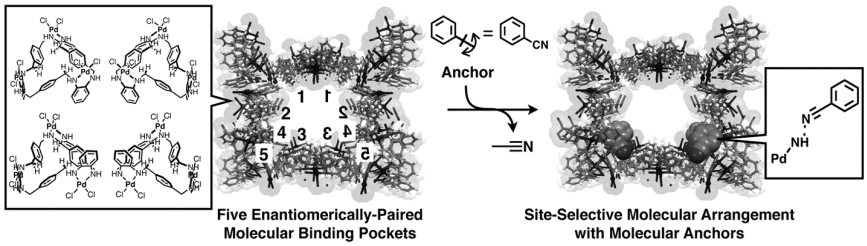

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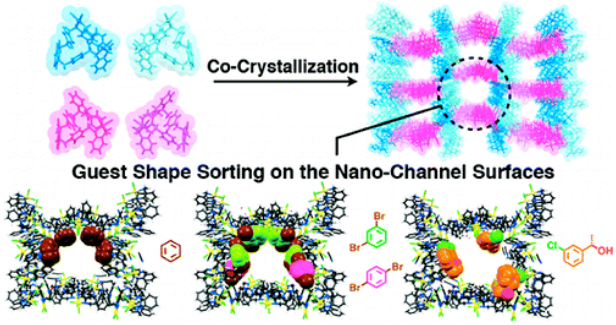
Co-Crystallization
Guest Shape Sorting on the Nano-Channel Surfaces
Br
Br
Br
Br
Cl
I
OH