Designing metal complexes and chemical systems with superb sensing and signaling functions

Biomolecular Engineering Environmentally-Benign Molecular Design and Synthesis (Iki Laboratory)

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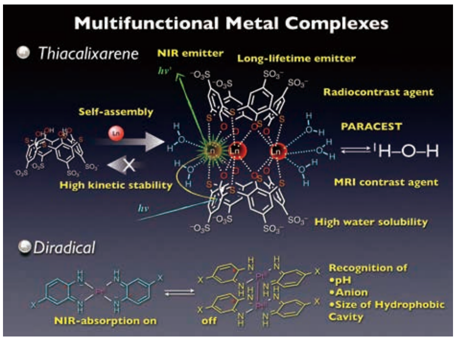
Graduated from Tohoku Gakuin Tsutsujigaoka High School in 1984. Completed a Ph.D. in materials chemistry at the Graduate School of Engineering, Tohoku University, in 1994. Promoted to his current position of Professor of Environmental Science at the Graduate School of Environmental Studies, Tohoku University, in 2014. The Iki Laboratory mottoes are: “Be self-motivated, self-disciplined, and independent” and “Enjoy working.” Professor Iki believes that the secret to sustained research is to maintain a keen interest in substances and enjoy dealing with chemicals and materials. “If you look at everything around you with a sense of wonder, nothing is trivial. For example, look at functional materials, life, and the universe. What are the laws that govern them? How about existence itself? The chemical systems that we create also express functions that surpass what we predict. Enthusiastic students are always welcomed by our group to participate in creating functional chemical systems that people can use.”

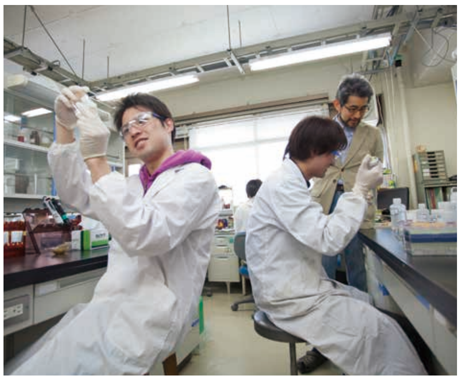
In our group, we are creating chemical systems for the measuring and imaging of key substances in environmental and biomedical systems. Specifically, we design metal complexes consisting of metal ions and ligands, and introduce them into chemical systems to induce molecular recognition and signaling functions.



Currently, most of the methods for measuring substances in the environment and biomedical specimens rely on physical techniques such as instrumental analysis. Although their principle is clear and performance is high, such methods entail many issues such as high-energy consumption, high costs, heavy environmental loads and the need for advanced infrastructure. In contrast, we have adopted a chemical strategy to combine a metal complex with a chemical system that facilitates superb functionality while avoiding those issues.

Although we design complexes and chemical systems in the expectation that they will fulfil a certain function, a system does not necessarily result in the function predicted. It may result in a somewhat different one or in rare cases an unexpected but outstanding function. Furthermore, when dealing with real samples such as biological and environmental systems, functions expressed in the “clean” systems of test tubes may be useless. The unpredictable nature of chemical functions arises from the interaction of many kinds of components such as metals, ligands and concomitant species. This makes for difficulties in research. But the ultimate thrill is getting a system to work as, or better than, intended. One challenge of our work is to design systems that are as simple as possible.

Regarding application to biological systems, we are now designing probes for MRI and near-infrared imaging that can be used in medical diagnoses. Moreover, we are studying complexes able to emit gamma rays or produce reactive oxygen species which can be useful in cancer treatments. In the near future, diagnosis and therapy will be combined into an integrated procedure: theranostics.



Main research themes

- Kinetic differentiation mode separation and detection systems for ultra-trace metal complexes
- Development and applications of a capillary electrophoretic reactor, a direct method to measure dissociation rates of complex species
- Thiacalixarene, a multi-functional molecule
- Construction of theranostic functions based on metal complex systems