Metal Complex based Functional Nanomolecular Systems

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This project, "Nanomaterial-based Photonic, Quantum and Bio Technologies", aims at exploring science and developing innovative technologies on the basis of nanomaterials and nanostructures to contribute to solving problems the society faces in areas as diverse as information, energy, and medicine. Molecules may play major roles in this context as molecules are intrinsic nanomaterials that can incorporate functions. Particularly, metal complexes are versatile functional nanomaterials due to their rich optical, redox, and reactive properties.

Ruthenium polypyridine complexes are well known for their excellent photophysical properties. Polymetallic ruthenium polypyridine complexes with bridging ligands containing an azo group (–N=N–) are further endowed with additional ligand-based redox properties. The excited state dynamics of the metal complexes are significantly affected by the redox state of the azo ligands. This property has been exploited, leading to the development of molecular switches that modulate the excited state energy transfer processes and turn on/off the emission of light.[1,2] Recently, we found that a certain azo-containing ruthenium complex exhibits color changes upon binding to DNA duplexes in a sequence and structure sensitive way.[3]

Molecular machines are the ultimate goal of the ongoing trend of miniaturization for ever smaller machines. Double-decker porphyrins/phthalocyanines are unique metal complexes in which a metal ion is flanked by two macrocycles in a sandwich fashion. The two macrocycles (pieces of bread) rotates with respect to the central metal ion. We successfully visualized the rotation of a double-decker complex immobilized on a surface on an individual molecule basis by means of scanning tunneling microscopy. The result is encouraging toward the development of molecular machines.

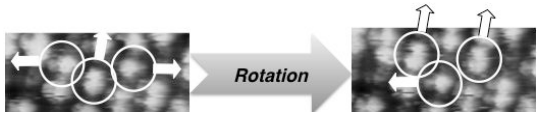

Figure 1. Rotation of molecules visualized.

(1) J. Otsuki, T. Akasaka, K. Araki, *Coord. Chem. Rev.* **2008**, *252*, 32–56. (2) J. Otsuki, A. Imai, K. Sato, D.-M. Li, M. Hosoda, M. Owa, T. Akasaka, I. Yoshikawa, K. Araki, T. Suenobu, S. Fukuzumi, *Chem. Eur. J.* **2008**, *14*, 2709–2718. (3) V. G. Gonzalez, T. Wilson, I. Kurihara, A. Imai, J. A. Thomas, J. Otsuki, *Chem. Commun.* **2008**, 1868–1870.

金属錯体に基づく機能性ナノ分子系

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金属錯体を中心とした分子系のナノ機能開拓を行っている．具体的には，ルテニウム錯体による，分子スイッチング現象の追求および DNA 認識呈色現象の解明，ダブルデッカー錯体による，分子マシン創製の研究を進めている．ダブルデッカー錯体では，分子の回転を初めて分子レベルで証明することができ，表面での回転特性を解析した．この他にも分子系による光エネルギー変換，上記以外の DNA 認識系の検討を進めている．