【Grant-in-Aid for Scientific Research(S)】

Integrated Science and Innovative Science (New multidisciplinary fields)

Title of Project： Chiral Science of an individual molecule

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Research Area：New multidisciplinary fields
Keyword：Single molecular science, Chiral molecule, Optical Activity

【Purpose and Background of the Research】

In the field of biomolecular science, “chirality” is one of the most important properties. All of the biological molecules including amino acids and sugars are alternative enantiomers which show optical activity. An evolutionary origin of such a homo-chirality of biomolecules is still one of the mysteries of nature. So far, the optical activities have been evaluated by the methods in macroscopic scale such as circular dichroism (CD) and optical rotation dispersion methods. For clarifying causality between the optical activities and atomic/electronic configurations, it is quite attractive to investigate the optical properties of chiral molecules at nanoscale. In this research, we begin with a construction of combined analysis system for evaluating various properties of a *chiral* single molecule and/or its nano-assembly, and then proceed mainly to observe the right and left circularly polarized light (CPL) emission distinctively from the chiral molecular system using scanning tunneling microscopy light emission (STM-LE) spectroscopy, etc.

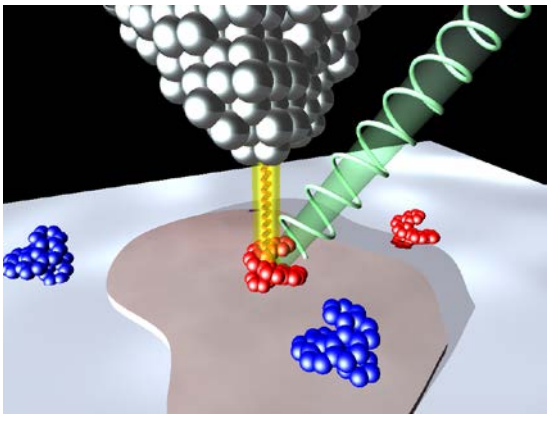

Fig. 1 Schematic of Photon STM

【Research Methods】

1. Construction of combined analysis system with STM-LE spectroscopy, tip-induced CD-Raman spectroscopy, etc.
2. Detection of CPL emission from an individual chiral molecules adsorbed on the solid substrate
3. Detection of CPL emission from chirality-controlled single-walled carbon nanotubes
4. The theoretical analysis by the first-principles calculation for evaluating the correlation between electronic structure and the emission spectra, and the mechanism of CPL emission.

【Expected Research Achievements and Scientific Significance】

The achievement of this research will provide essential information to elucidate the mechanism for the emergence of optical activities in terms of a single molecular level and contribute disciplinary maturing of this field in which Japan plays a trailblazing role starting from asymmetric synthesis. Through controlling the optical activities in the design of nano-chiral systems, it is promising to invent and develop various novel optical devices and to serve the useful guide in medicine manufacturing and so on.

【Publications Relevant to the Project】

A. Fujiki, Y. Miyake, Y. Oshikane, M. Akai-Kasaya, A. Saito and Y. Kuwahara, “STM-induced light emission from thin films of perylene derivatives on the HOPG and Au substrates”, Nanoscale Research Letters, **6** (2011) 347.

T. Uemura, M. Furumoto, T. Nakano. M. Akai-Kasaya, A. Saito, M. Aono, and Y. Kuwahara, "Local Plasmon Enhanced Up-Conversion Fluorescence from Copper Phthalocyanine", Chemical Physics Letters, **448**, pp.232-236 (2007).

【Term of Project】 FY2012-2016

【Budget Allocation】 146,000 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.prec.eng.osaka-u.ac.jp/psthomepage/eng/lab/kuwabara/index.html