

Satoshi Habuchi, Assistant Professor

Department of Organic and Polymeric Materials

1. Main Research Results

We study nanoscale structure and optical properties of organic and polymeric materials using single-molecule spectroscopic techniques.

1) Mapping the emission sites within a single conjugated polymer molecules

We map the emitting sites within a single conjugated polymer molecule (poly[2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene] (MEH-PPV)) directly by means of single-molecule imaging technique. High resolution single-molecule imaging technique allows mapping the emitting sites within nanometer accuracy. Our results clearly demonstrate spatial jumps of emitting sites within a single molecule, which is due to an efficient energy funneling to a small number of the emitting sites. The jump size is distributed between a few nanometers up to tens of nanometers, indicating that more than one mechanism is operative for energy funneling to the trap sites. Our results demonstrate that the high resolution single-molecule imaging would be a powerful tool to study photophysics of macromolecules which have a dimension of nanometers to tens of nanometers.

2) Toward single-molecule chiroptical spectroscopy

We have developed a single-molecule fluorescence microscopy setup to study chiroptical response of single molecules. In order to measure circular dichroism of a single molecule, we designed a fluorescence-detected circular dichroism setup in which the fluorescence intensity was used as a reporter of the differential absorption cross-section for right- and left-circularly polarized excitation. The performance of the setup was examined by measuring (achiral) linear dipole system as well as a conjugated polymer molecule which contained multiple linear dipoles within the molecule.

3) Development of 3D orientation imaging of single molecules and its application for studying orientation of doped molecules in an organic-inorganic hybrid film

We have developed a single-molecule defocused fluorescence imaging technique which allows determining 3D orientation of individual molecules. In collaboration with Prof. Tetsuji Yano in the Department of Chemistry and Material Science, Tokyo Institute of Technology, we used the technique to determine the 3D orientation of doped molecules in an organic-inorganic hybrid film.

4) A single-molecule study on diffusion of a cyclic polymer molecule in a concentrated polymer solution

In collaboration with Prof. Yasuyuki Tezuka in the Department of Organic and Polymeric Materials, Tokyo Institute Technology, we visualized individual fluorescently labeled poly(THF) molecules dispersed in a toluene solution containing highly concentrated non-labeled poly(THF). Using a mean-squared displacement analysis of the fluorescently labeled linear and circular poly(THF) molecules, we determined the diffusion coefficients of those molecules.

2. List of publications (original article, comment/book)

1) Refereed papers

- (1) Lessard, G. A.; Habuchi, S.; Werner, J. H.; Goodwin, P. M.; De Schryver, F. C.; Hoflens, J.; Cotlet, M.: Probing dimerization and interprotein fluorescence resonance energy transfer in a far-red fluorescent protein from the sea anemone *Heteractis crispa*. *J. Biomed. Opt.* 2008, 13, 031212.
- (2) Habuchi, S.; Tsutsui, H.; Kochaniak, A. B.; Miyawaki, A.; van Oijen, A. M.: mKikGR, a monomeric photoswitchable fluorescent protein. *PLoS One* 2008, 3, e3944.
- (3) Hattori, A.; Habuchi, S.; Vacha, M.: Single-molecule imaging with an inexpensive UV-LED light source. *Chem. Lett.* In press.

3. Invited/Plenary Talks in Conference

1) International Conference or Workshop

- (1) Habuchi, S.: Nanoscale characterization of polymer and bio-materials by means of single-molecule techniques (oral). Tokyo Tech – Tsinghua University Joint Symposium. November 19, 2008, Tokyo, Japan.

2) Domestic Conferences

- (1) Habuchi, S.; Walter, J. C.; van Oijen, A. M.: Single-molecule view of DNA-protein interaction (oral). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka
- (2) Habuchi, S.; Tsutsui, H.; Kochaniak, A. B.; Miyawaki, A.; van Oijen, A. M.: mKikGR, a monomeric photoswitchable fluorescent protein (poster). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka.
- (3) Vacha, M.; Ebihara, Y.; Habuchi, S.: Relating conformation and photophysics in single molecules of conjugated polymers (oral). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka.
- (4) Sugimoto, T.; Habuchi, S.; Vacha, M.: A relationship between photophysics and structure in single polythiophene molecules (poster). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka.
- (5) Sekiguchi, Y.; Habuchi, S.; Vacha, M.: Emission characteristic of Ir complex studied on ensemble and single molecule level (poster). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka.
- (6) Furumaki, S.; Habuchi, S.; Vacha, M.: A single-molecule study on inner structure of the light-harvesting complex from photosynthetic bacteria (poster). 2008 Annual Meeting on Photochemistry, September 11 – 13, 2008, Osaka Prefecture University, Osaka.