Molecullar Imaging with Ionophore-Based Probes

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Molecullar imaging is one of key technologies that can be determined in real time and biologically important substances in living cells. I introduce our recent results that have obtained in our JST-CREST Program entitled "Creation and Application of Nanochemical Probes". *

1. Magnesium Imaging Probes Based on Ionophore Design

The molecular probes (KMG-series molecules) for magnesium (Mg) imaging were designed and synthesized based on our prior knowledge of Mg ionophore design. While the first example (KMG-20) was based on a coumarin fluorophore, we later developed the fluorescein derivative KMG-104, which is the best magnesium fluorescent probe for imaging applications in the cytoplasm of living cells. More recently, KMG-301 relying on a rhodamine fluorophore was successfully designed, which is suitable for the magnesium imaging of mitochondria. These and other similar probes can also be applied for the selective imaging of a variety of specific substances using a scanning microscopy technique such as described below.

2. Multi-mode (SECM/NSOM/AFM) Optical Fiber Probes for Cell Imaging

A multimode scanning microscopy system for simultaneous electrochemical, near-field optical, and atomic-force topographic imaging (SECM/NSOM/AFM multimode-imaging) was constructed based on our developed optical-fiber nanoprobe (named bent-type optical-fiber nanoprobe)

To evaluate the possibility of applying the bent-type optical-fiber nanoprobe for living cell imaging, it was first tested for the simultaneous SECM/NSOM/AFM imaging of a model imaging module consisting of an interdigitated electrode (IDE) having 100 nm gold bands separated by 200 nm glass sections. For this purpose, a home built set-up based on a SPM controller system (SPI 4000, SII NanoTechnology Inc.) was used with the nanoprobe in dynamic force mode (DFM) function. As a result, the bent-type optical-fiber nanoprobe allowed obtaining images with a resolution below 100 nanometer. The multimode scanning microscopy was then applied to living PC12 cell imaging. The varicosity site in the neuritis of the PC12 cell was well observed with about ten-fold increased resolution compared to that of a conventional optical microscope. In this case, the Ca and Mg concentration profiles were also imaged with the aid of fluorescent molecular probes. These results suggest that our developed SECM/NSOM/AFM scanning microscopy system is suitable for obtaining topographic profiles of a soft material such as a living cell in aqueous medium with high resolution.

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