High-resolution imaging of a cell-attached nanointerface using a gold-nanoparticle two-dimensional sheet

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This paper reports our original technique for visualizing cell-attached nanointerfaces with extremely high axial resolution (a few tens of nanometers) using collectively excited localized surface plasmon resonance (LSPR) on a self-assembled metal nanoparticle sheet. Oleylamine-capped gold NPs (AuOA, 13nm) and myristate-capped silver nanoparticles (AgMy, 5nm) were self-assembled at an air-water interface and transferred on hydrophobic cover slip by Langmuir-Schaefer method to be an imaging substrate. This self-assembled metal nanoparticle sheet can confine and enhance the fluorescence at the nanointerface. Test experiments on rat basophilic leukemia (RBL-2H3) cells with fluorescence-labeled actin filaments revealed high axial and lateral resolution in the image of focal adhesion at the cell-attached interface even under a regular epifluorescence microscope, which produced higher quality images than those captured under a total internal reflection fluorescence (TIRF) microscope. Recently, the demand for super-resolution fluorescence microscopy is increasing in the field of cell biology because of the requirement to investigate molecular-level dynamic reactions in or near cells. The super-resolution microscopy techniques, such as confocal laser microscopy, STED, SIM, and PALM/STORM, have a significant advantage in their lateral resolution but are not as advantageous in either their axial resolution or temporal resolution because of their scanning criteria. TIRF microscopy provides the highest axial and temporal resolution compared with the other super-resolution microscope systems, although the imaging area is still 100-200 nm from the top surface of a cover slip. The common problem of these state-of-the-art technology is the cost of the apparatus, which prevents it from being standard equipment in basic laboratories. On contrast, our non-scanning-type, high-resolution imaging method using nanoparticle LSPR is very user-friendly and effective tool for monitoring nano interfacial phenomena. This technique will open the possibility for all biochemists and medical scientists to perform state-of-the-art molecular imaging using their own conventional microscope.

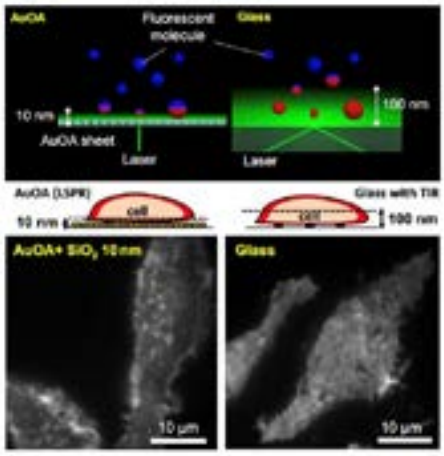

Figure: (a) Schematic drawing of the depth of the LSPR on the AuOA sheet and evanescent fields on glass. (b) Fluorescence images of FITC-labeled actin filaments in RBL-2H3 cells on the AuOA sheet (left) and on glass(right).

Recent Publications

- S Masuda et. al. (2017) High-resolution imaging of a cell-attached nanointerface using a gold-nanoparticle two-dimensional sheet. Sci. Rep. 7:3720.
- M Toma et. al. (2011) Collective plasmon modes excited on a silver nanoparticle 2D crystalline sheet. Phys. Chem. Chem. Phys. 13(16):7459-7466.
- D Tanaka et. al. (2015) Characteristics of localized surface plasmons excited on mixed monolayers composed of self-assembled Ag and Au nanoparticles.
- K Okamoto et. al. (2016) Electromagnetically induced transparency of a plasmonic metamaterial light absorber based on multilayered metallic nanoparticle sheets. Sci. Rep. 6:36165

Biography

Kaoru Tamada is a Scientist in the field of Surface Science and Nanoscience. After 7 years of R&D experience in industry, she joined Prof. Hyuk Yu's lab in Univ. of Wisconsin-Madison and obtained Dr. Sci. at Nara Women's University in 1994. After Postdoc experience in Riken, she worked as a Senior Scientist in AIST Japan for 10 years. During this period, she joined ANU, MPIP and NUS as a Visiting Scientist. She joined TokyoTECH in 2005 as an Associate Professor, and RIEC, Tohoku Univ. in 2007 as a Professor. She moved to IMCE, Kyushu Univ. in 2011, and was promoted to Vice President from 2017. Her research interest is self-assembly of molecules and nanomaterials, plasmonics, and their bio-sensor and bio-imaging applications.

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