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

Broad Section D

Title of Project： Super-resolution live-cell imaging of cell-attached nanointerface using LSPR sheets

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Keyword：Localized surface plasmon resonance, Self-assembly, Live-cell imaging, Super-resolution

【Purpose and Background of the Research】

A breakthrough in image analysis technology using AI is causing a paradigm shift in the field of biomedical diagnostics. When enormous number of images can be processed at high speed, what is needed next is cutting-edge, high-quality image information that matches advanced information processing technology. Our original technique, 'Localized plasmon resonance (LSPR) sheet' composed of self- assembled metal nanoparticles, realizes super-resolution, high-speed imaging of molecular dynamics at the buried nanointerface due to the optical confinement and fluorescence enhancement effect of LSPR. In this study, the LSPR sheet is used to reveal complex molecular level of reactions at the cell attached nanointerface in super-resolution. We challenge to build up new methodology to solve important biomedical issues such as differentiation and reprogramming of stem cells and canceration by use of the LSPR sheet.

【Research Methods】

Our previous study revealed that the LSPR sheets composed of spherical nanoparticles provide the world thinnest fluorescence images in the Z-axis direction due to the light confinement effect by LSPR (Figure 1, Figure 2) [1, 2]. In this new project, we will fabricate new self-assembled sheet composed of different shape of particles in order to realize more stable and stronger optical electric field for super-resolution high-speed 'live-cell' imaging. We will build up system to process large amounts of high-resolution, high-speed images and track and analyze the molecular dynamics of living cells in real time. We will also develop fast diagnosis methods of cell characteristics by use of biochemical and physical stimulation. The Z-position of focal adhesion such as "push in" or "pull up" on a soft gel will be evaluated in nano-sensitivity by the brightness change of focal adhesion spots.

【Expected Research Achievements and Scientific Significance】

One of our goal is to bring new discoveries in the life science field by use of our unique LSPR sheet. Another goal is to complete our LSPR sheet as a global standard technology, and contribute to the society by the development of "high-throughput diagnostic system of cellular activity and tumors".

【Publications Relevant to the Project】

1. Masuda, S.; Yanase, Y.; Usukura, E.; Ryuzaki, S.;

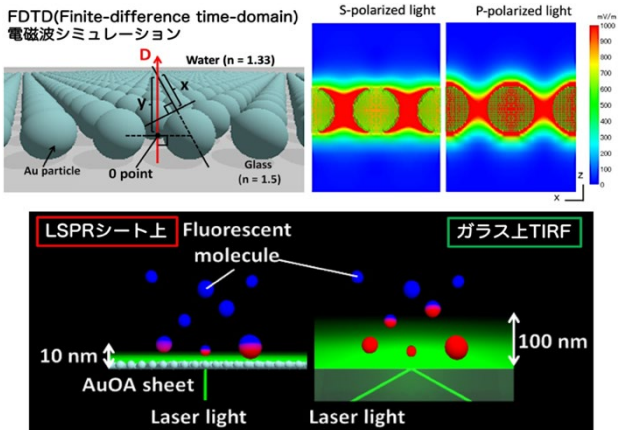

Fig.1 Electric field excited by self-assembled spherical metal nanoparticles.

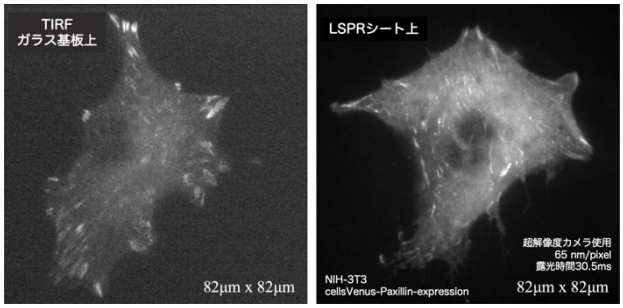

Fig.2 Image of immobilized cell on LSPR sheet in comparison with regular TIRF image.

Wang P.; Okamoto, K.; Kuboki, T.; Kudoaki, S.; Tamada, K.*, High-resolution imaging of a cell- attached nanointerface using a gold-nanoparticle two dimensional sheet, **Sci. Rep.** 7, 3720 (2017).
2. Usukura, E.; Yanase, Y.; Ishijima, A.; Kunoki, T.; Kidoaki, S.; Okamoto, K.; Tamada, K.*, LSPR mediated high axial-resolution fluorescence imaging on a silver nanoparticle sheet, **PLoS ONE**, 12, e0189708 (2017).

【Term of Project】

FY2019-2023

【Budget Allocation】

149,100 Thousand Yen

【Homepage Address and Other Contact Information】

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