

## Optical Response of Nonequilibrium Nano-system with Biomaterials

Takuya Iida<sup>1,\*</sup>, Mamoru Tamura<sup>1</sup>, Yushi Nishimura<sup>1,2</sup>, Shiho Tokonami<sup>2,\*</sup>

<sup>1</sup>Department of Physical Science, Osaka Prefecture University, 1-2, Gakuencho, Nakaku, Sakai, Osaka 599-8570, Japan

<sup>2</sup>Nanoscience and Nanotechnology Research Center, Osaka Prefecture University, 1-2, Gakuencho, Nakaku, Sakai, Osaka 599-8570, Japan

Inspired by excellent biological functions, we are trying to study optical response of nanoscale systems under nonequilibrium conditions. The random energy of "heat" and "fluctuations" plays crucial roles in biological systems consisting of various nanostructures for the transport, the arrangement control, and the structural change in nanospace. In order to realize these functions, they modulate the spatiotemporal structure of potential with physical and chemical external stimuli. Paying attention to a variety of phenomena produced by such biological systems, we are challenging to construct the "Biomimetic Nano Optical Engineering" [1] based on the perceptual change using the thermal processes while the heat was often considered as the disturbing factor in the conventional nanoscience and nanotechnology. Particularly, we pay attention to metallic nanoparticles (MNPs) that can be optically manipulated even in liquid medium at room temperature. In this talk, we will report our developed guiding principles for the optical assembling of MNPs, and the research achievements on light-induced dynamics in complex system with high-density MNPs and biomaterials. Main topics are as follows:

<A> Development of self-consistent theory of light-induced dynamics of nano-objects under thermal fluctuations[2-5].

<B> Broadband optical response of densely-assembled MNPs and its application for the detection of small amount of proteins [6,7].

<C> Novel detection principle of nucleic acids with collective optical response of electronic systems in high-density MNPs [8].

[1] T. Iida, S. Ito, S. Tokonami, C. Kojima, "Nano-optomechanics by tailored light fields under fluctuations", *Progress in Nanophotonics III*, (Eds). M. Ohtsu, T. Yatsui (Springer, 2015).

[2] T. Iida, *J. Phys. Chem. Lett.*, **3**, 332 (2012).

[3] M. Tamura, T. Iida, *Nano Lett.*, **12**, 5337 (2012).

[4] S. Ito, T. Iida, S. Tokonami, et al., *Sci. Rep.* **3**, 3047 (2013).

[5] M. Tamura, S. Ito, S. Tokonami, T. Iida, *Res. Chem. Intermed.*, **40**, 2303 (2014).

[6] S. Tokonami, T. Iida, et al., *J. Phys. Chem. C*, **117**, 15247 (2013).

[7] Y. Nishimura, S. Tokonami, T. Iida, et al., *J. Phys. Chem. C*, **118**, 18799 (2014).

[8] S. Tokonami, T. Iida, et al., *J. Phys. Chem. C*, **118**, 7235 (2014).