Development of On-demand Light-induced Acceleration System
Targeting Various Biological Samples

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A rapid, highly sensitive and specific detection methods of various nano-biomaterials and microbes (bacteria, viruses etc.) are required in the fields of medical care and food hygiene. A biomolecular recognition (for example, DNA double strand formation, antigen-antibody reaction etc) is crucial for the high selectivity for the specific detection. Biomolecule-modified nanoparticles (NPs) as the probe are useful for the control of these processes [1], and the detection efficiency can be dramatically increased if the probe NPs and target biomaterials would be remotely assembled into the observation region.

On the other hand, the optical guiding method with laser irradiation is promising for this purpose. Based on our simulation methods for light-induced nano-dynamics [2] with the unified theory of light-induced force (LIF) exerted on nanomaterials [3], the selective assembly of NPs with specific properties and the control of their quantum mechanical properties such as radiative decay rate were predicted and experimentally demonstrated [4,5]. Moreover, if probe NPs have high photothermal properties, the light-induced convection (LIC) can be exploited for the transportation over macroscopic region.

Paying attention to the synergetic effect of such LIF and LIC as the "optical guiding force" [6], we are trying to develop the methods for the dynamics control of nano-biomaterials and microbes to realize the extremely high performance bio-analysis based on "light-induced biomolecular recognition". Here, we would like to talk about our recent research achievements focusing on three topics as follows: (i) photothermal detection methods of pg-level to fg-level proteins [6,7], (ii) submillimeter network formation triggered by light-induced hybridization of zmol-level DNA [8], and (iii) assembling and rapid counting of small amounts of microbes with optical and electric fields [9-12]. Based on these achievements, we would like to introduce our challenge in the development of the "light-induced acceleration system (LAC-SYS)" for various biochemical reactions and the prospects for the next generation smart biophotonics.

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Reference