Structures of DNA origami studied with scattered light imaging

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Single molecule imaging is a cutting-edged technique that enables quantitative measurements of various molecules and materials at single-molecule level. If this technique is successfully employed as a detection system of various conventional bioanalyses, such as electrophoresis, immunostaining, etc., it will become possible to achieve great improvement of the detection limit up to a real 'single-molecule'. So far, our group have attempted to introduce single molecule fluorescence imaging techniques into conventional bioassays, and succeeded to obtain several representative results.

On the other hands, fluorescence detection merely provides information about the presence or abundance of the fluorescent tags. This limitation inspired us to detect scattering light, which includes information about the target size, structures, and chemical compositions in their absolute intensities, intensity trajectories, and energies (i.e., wavelengths), respectively. Furthermore, it holds great potential to enable label-free detection of biomolecules since any molecules are able to exert scattered light upon light irradiation.

Herein, we used scattering light imaging to characterize various properties of the biomolecules with an aid of our home-built single-molecule microscope. First of all, scattering intensities of standard polystyrene beads (e.g., a few tens of nanometers) were measured, and found that the intensities were proportional to approximately the sixth power of the bead diameters. This result agreed to the theoretical values of Rayleigh scattering intensities calculated from their sizes. Moreover, it was possible to detect relatively large protein molecules with scattering imaging, implying its probable application towards ultrasensitive bioanalyses.

Finally, DNA origami was used as standard molecules to investigate a shape effect on the light scattering. Not only construct a precise 3D structure with the rational design, DNA origami can also work as host or template molecules that may report the additional information about the target biomolecule. For this purpose, we prepared multiple DNA origami samples with different 3D structures, and analyzed their structures with our scattering microscope. In this presentation, we will present the up-to-date results and insights regarding this approach.