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A Nanobiosensor Based on Structural Analysis of Nanobiomaterials in Solutions

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Rapid structural analysis methods for biomolecules and biomaterials consisting of single or several molecules in solution represent innovative technologies to reveal their functions because the functions strongly depend on their own structures [1]. However, there presently exist no rapid structural analysis methods for single nanomaterials flowing in liquid environment. Nanopore technologies have the capacity to investigate the volume and shape of single nanomaterials in solutions owing to changes in ionic currents passing through the nanopores. Nanopores must have high spatial and time resolutions to determine the structures of the single nanomaterials.

Here we report the development of low-aspect-ratio nanopores with a spatial resolution of ca.35.5 nm and a fast current amplifier, resulting in realization of ultrafast time resolutions of 1.0 μs. Combining state-of-the-art technologies with multiphysics simulation methods to translate ionic current data into structures of nanomaterials passing through a nanopore, we have achieved rapid structural analysis of single gold nanorods, single polystyrene (Pst) beads, and single dumbbell-like Pst beads in aqueous solutions. The present nanopore devices will be innovative technologies for the fields of nanobiodevices and structural biology.

[1] Zachary A. Bornholdt, et al., Cell 2013, 154, 763.

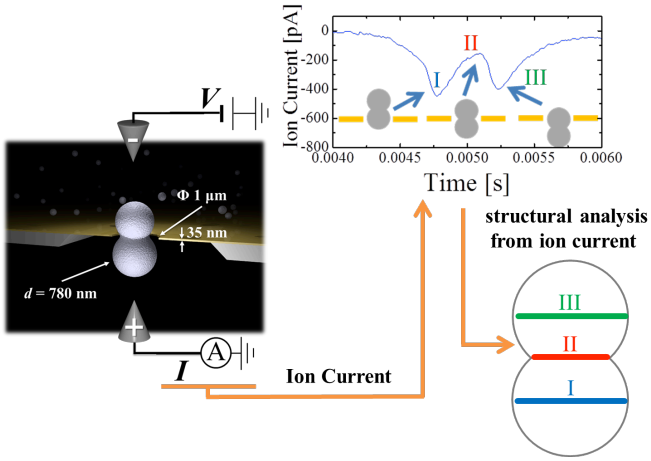

Figure 1. Schematic illustration of the present structural analysis method using a nanopore. A low aspect ratio nanopore is capable of structural analysis like a 3D scanner because the shape of ion current blockade due to a material translocation in a nanopore reflects the tomograms of the material passing through the nanopore.