Towards the Plasmonic Nanopore with Nanoscale Double Slits For Next Generation Single Molecule Sensor

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About 60 years ago, the huge biological cell counter with an electrical detection technique was invented by Dr. Coulter. Due to fast developing nanofabrication technology, the tiny nanobio device for single molecule detection has been tested and manufactured [1, 2]. However, considering the fact that most biosensors are utilizing the optical detection technique, the optical pore device can be an excellent candidate for the next generation single molecule sensor. The nanopore with ~ nm diameter for an optical detection technique has yet to be fabricated, and the tiny nanometer size aperture with its diameter of ~ 10 nm or less would have negligible optical transmission from Bethe's law; $T \sim (d/\lambda)^4$. Optical transmission through the tiny nano-aperture should be enhanced either by providing the groove patterns or periodic arrays [3]. We previously reported fabrication of the nano-aperture surrounded by the periodic patterns on pyramidal probes to improve the low transmittance of light through the nanosize aperture [4]. We have also reported the nanopore with its diameter ranging from 10 nm to 3 nm, and the nanopores with nanoscale double slits by using various surface modifications [4-6]. Spinodal decomposition of Au and carbon atms, and along with Ostwald ripening of Au atoms on the Au-C mixture membrane have been observed. In addition, the surface plasmonic wave from the nanoscale size slits provides the interference phenomena in the nanoscale slits which reduces or enhances the intensity of the far-field [7,8], and fabrication of the Au aperture array with nanoscale double slits will be reported. When the incident light is TM-polarized, electric field aligned perpendicular to the slits, the surface plasmon wave that is excited at one of the slits propagates towards its other slit. There will be three possible types of physical mechanisms; **first,** the slits transmit part of the incident radiation, together giving rise to a conventional Young-type interference pattern. **Second**, each slit scatters part of the incident radiation into a plasmonic channel, bridging the momentum gap between the surface plasmon and free-space radiation. **Third**, each slit provides a mechanism for back-converting a surface plasmon into free-space radiation. Hence, the strength of each of these sources is enhanced or reduced due to the interference of a photonic and a plasmonic channel. The optical characterization of the fabricated nano-slit devices have been carried out by using Halogen lamp installed at Nikon TE eclipse microscope. For nanoscale double slits, we observed the constructive and destructive interferences dependent on the gap.

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