Towards the Next Generation Plasmonic Nanopore for Single Molecule Analysis

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Recently there have been tremendous interests about the plasmonic optical nanopore fabrication for single molecule detection and manipulation. Presently the MINion solid state nanopore device for single molecule detection, with an electrical detection technique have been fabricated by Oxford Nanopore, USA. However, high error rates have been reported due to various detection difficulties such as formation of the electrical double layer along the pore wall. In this talk, we present the fabrication of a plasmonic nanopore on the Au membrane, which can provide huge enhancement of the Raman signal intensity, for optical detection and optical manipulation of single molecules such as DNA, RNA, and protein. Initially, the nano-apertures with its diameter of ~ 100 nm on the vacuum deposited Au film were drilled with a 30 keV Ga ion focused ion beam technique. The periodic grooves were initially engraved by using FIB, prior to Au nanopore formation. The Au nanopore can be fabricated either by diffusion of Au atoms under electron beam irradiation, or by drilling an Au membrane on the center of the periodic grooves on the Au film by using focused electron beam irradiation. We found the diffused membrane contains Au and C atoms. Then, several months later, the Au clusters of (2~ 6) nm size are formed due to Ostwald ripening process. Drilling an Au nano pore with its diameter less than 5 nm by using 200 keV electron beam can be also achieved. During this process, evaporation of Au atoms induced by electron- beam thermal spike may occur. The Au nanopore array formed either by diffusion of Au atoms or drilling an Au membrane can be utilized for the next generation portable bio-sensor technology for single molecule manipulation and detection.