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ナノリソグラフィーにする銀微粒子シートの局所酸化

Local oxidation nano-lithography on silver nanoparticles monolayer

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Local oxidation nano-lithography (LON) has been widely utilized to obtain nanometer-sized patterns on both metal and semiconductor thin films **[1]**. The LON works normally by adding a bias potential between a conductive atomic force microscopy (AFM) tip and the sample surface. However, there were few literatures related on the oxidation of metal nanoparticles using LON **[2]**.

In our previous work, we developed a method to synthesize silver nanoparticles (AgNPs) and successfully fabricated Langmuir film with those AgNPs on air-water interface **[3, 4]**. The Langmuir film of AgNPs can be easily transferred to hydrophobic substrates by Langmuir-Schaefer (LS) method. In this work, we report a novel approach to fabricate nanometer patterns on the Langmuir film of AgNPs.

The Langmuir film of AgNPs was transferred to a C_{12} thiol-treated gold substrate. Then, a conductive AFM tip was used for the oxidation lithography. As shown in Fig.1a, a negative bias was added on the tip. The relative humidity was controlled in the range of 30% to 60%. A nanometer-sized water bridge formed due to the intense electrical field between the tip and sample. In the water bridge, an electrochemical reaction occurred, and finally the AgNPs were finally oxidized. After oxidation, the volume of AgNPs increased and showed a height change in AFM image (Fig.1b). The oxidation line width was about 150 nm. In order to confirm the chemical change after lithography, Kelvin probe force microscopy (KPFM) was used to measure the surface potentials. It is obvious that the surface potential decreased after lithography as shown in the KFM image (Fig.1c). In summary, we successfully wrote nanometer sized patterns on a AgNPs monolayer, and the patterns are expected to give interesting controllable plasmonic properties.

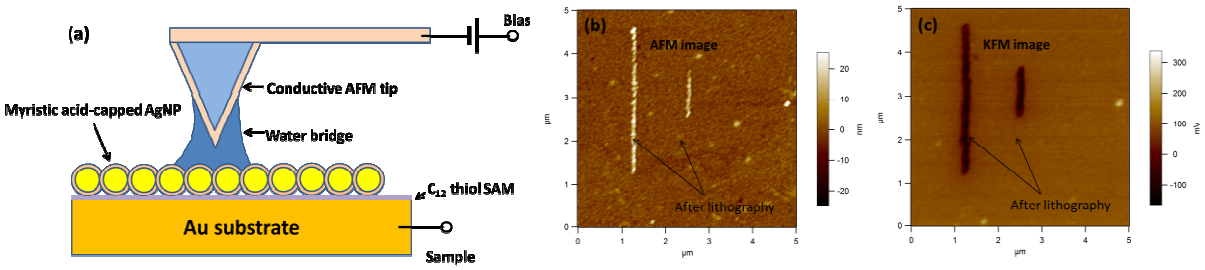

Fig.1. (a) Schematic diagram of the local oxidation nano-lithography on LB film of AgNPs. The AFM tip was coated by Ti/Ir. AFM (b) and KFM (c) images of silver nanoparticle monolayer after local oxidation nano-lithography.

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