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<td>Imasaki, Gyotaro; Sagara, Takamasa</td>
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Synthesis of Gold Nano-structure and its Photoelectronic Function

Gyotaro Imasaki¹, Takamasa Sagara²*

¹Department of Materials Engineering and Molecular Science, Graduate School of Science and Technology
²Department of Applied Chemistry Faculty of Engineering
Nagasaki University, 1-14 Bunkyo-machi, Nagasaki 852-8521, Japan
Tel: +81-95-819-2676, E-mail: sagara@nagasaki-u.ac.jp

Metal nano-structures exhibit specific light absorption, so-called plasmon absorption, due to the excitation of collective oscillation of conduction electrons in the nano-structures. This absorption is accompanied by enhancement of electromagnetic field in the close proximity of the nano-structure. The optical and electronic properties of nano-structures depend on their sizes and shapes as well as inter-structure interaction. When metal nano-structures are immobilized on an electrode surface, one can regulate the photoelectronic functions of the modified electrode by potential control [1].

As the nano-structures to be immobilized on electrode surfaces, most of the previous works used sphere or rod shapes. It is fascinating to scan other shapes of nano-structures of free-electron metals (eg. Ag and Au) to attain a variety of functions at an electrified interface. For example, we may have a new class of nano-structure, such as nano-ring, in or around which absorption, emission and Raman-scattering properties of dye molecules are highly and selectively enhanced.

In this study, we tried to synthesize Au nano-ring of a circular shape and applied it to fabricate a functional electrode. It is known that Au nano-rings produce enhanced electric fields both inner and outer ring surface regions independently [2]. The absorption band position is also expected to be modulated by the size of the ring. By improving previously reported methods [3], we have synthesized pseudo-ring structures of Au as shown in Fig. 1. In the synthesis, Ag precursor nano-circular plates were subjected to metal-replacement redox reaction with AuCl₄⁻ to convert it into a Au nano-ring [4,5]:
\[3\text{Ag}^0 + \text{AuCl}_4^- \rightarrow 3\text{Ag}^+ + 4\text{Cl}^- + \text{Au}^0\]

Thus obtained pseudo-Au nano-ring showed clearly a plasmon absorption band around 720 nm, in accord with prediction. We are currently trying to remove the residual structures being present in the ring-inside.

Reference