# 論文 / 著書情報
# Article / Book Information

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# 論 文 要 旨

THESIS SUMMARY

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| 専攻：<br>Department of | 機械制御システム　専攻 | 申請学位（専攻分野）：<br>Academic Degree Requested | 博士　（　工学　）<br>Doctor of |
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）


In this research project, new efficient fabrication methods of three-dimensional (3D) plasmonic nanostructure arrays are proposed and their feasibilities are verified. A multilayer nanodot array, a Dot-on-Plate (DoP) nanostructure array and a nanopillar array are realized utilizing a single layer Au nanodot array fabricated by the templated thermal dewetting method. Their optical properties and applications for biosensors are studied.

Firstly, a two-dimensional (2D) nanodot array is fabricated by combination of top-down and bottom-up approaches. A nanoplastic forming (NPF) technique is utilized as the top-down approach to fabricate a groove grid pattern on an Au layer deposited on a substrate, and self-organization by thermal dewetting is employed as the bottom-up approach. It is found that the ordered nanodot array exhibits strong extinction spectrum due to the Localized Surface Plasmon Resonance (LSPR). And the tunability of LSPR could be achieved by controlling the fabrication conditions such as annealing temperature, annealing time and pitch setting. A theoretical model is proposed, which is in agreement with the experimental data. Furthermore, fabrication of ordered nanorod array is examined. Rectangular parallelepiped patterns are fabricated by NPF and nanorod array is formed by the following thermal dewetting process. The condition parameters influencing the nanorod formation including the pre-treatment and the annealing conditions are investigated. The plasmonic properties of the nanorod array are studied and the LSPR spectra could be tuned by thermal dewetting.

A multilayer metallic nanodot array is fabricated by repeating sputter coating of $SiO_2$ layer and Au layer followed by thermal dewetting on a single layer nanodot array. The effective parameters influencing dot formation on the second layer, including Au layer thickness and $SiO_2$ layer thickness, are studied. It is demonstrated that a 3D nanodot array of good vertical alignment is obtained by repeating the $SiO_2$ deposition, Au deposition and thermal dewetting. The mechanism of the dot agglomeration process is studied based on geometrical models. The effects of the spacer layer thickness and Au layer thickness on the morphology and alignment of the second layer dots are discussed. The optical properties of double-layer and multilayer nanodot arrays are studied. It is found that the intensity of the extinction spectrum increases linearly with an increase in the number of layers in multilayer nanodot structures.

Then, a DoP nanostructure array is fabricated from a double layer Au nanodot array employing selective etching by reactive ion etching (RIE) technique. Optical property of the DoP array is discussed, and application to molecular analysis by Surface Enhancement Raman Scattering (SERS) is investigated. It is found that the DoP nanostructure is shown good performance as a SERS-active substrate. The effect of pitch setting and spacer layer thickness on SERS intensity is discussed. The milling of $SiO_2$ spacer layer by dry etching is studied and the relation between the plasmonic properties and SERS enhancement is discussed.

Finally, a nanopillar array is fabricated by applying RIE to a single layer nanodot array. It is shown that an Au nanodot is placed on the top of a $SiO_2$ nanopillar. The LSPR properties of the plasmonic nanopillar arrays are studied. It is demonstrated that the Au-capped nanopillars exhibit much higher refractive index sensitivity than that of the Au nanodot arrays. The calculated results using Kuwata's model are in agreement with the experimental results. In order to improve the SERS performance of the nanopillar arrays, Ag coating is conducted on the Au-capped nanopillars. The Au-capped nanopillar array with Ag coating is shown good performance as a SERS substrate.


備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).