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金属ロッド配列ナノレンズによる超解像イメージング

Nanolens made of metallic rods array for super-resolution imaging

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Metallic nanostructured materials exhibit interesting optical properties such as imaging, field enhancement, optoelectronic devices, and biosensors. In particular, the early researches by other scientists have aimed to achieve super-resolution imaging by using metallic subwavelength structures with distinct shapes and arrangement [1]. Although such structures act as a lens with super-resolution, they still have two major restrictions. The first restriction is that they can only work at one particular resonant wavelength. The second is that the image can only be transferred for a short distance within the limits of the near field and is therefore undetectable in the far field. Recently, our group has proposed a lens made of stacked metallic nanorods array tapered at a certain angle for magnification as shown in Figure 1 [2, 3]. This nanolens realize the subwavelength super-resolution color imaging in visible range. The image is magnified by plasmonically transferred through metallic nanorods arrays, until it is detectable in far field.

To fabricate nanolens, we require strict control of sizes: 10 nm gap in a longitudinal direction and ~20 nm separation in a transverse direction between nanorods. Tapered array structures with 13-layered silver nanorods shows the plasmon resonance at 482 nm [2]. The precise fabrication and arrangement of metallic nanorods have been expected for the resonance control.

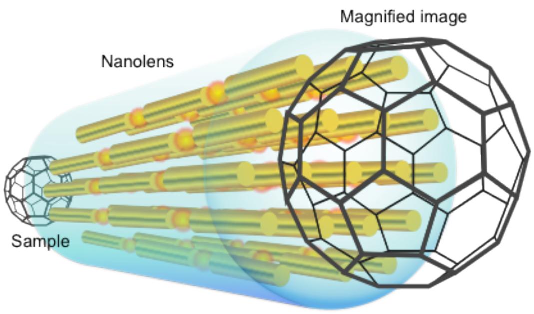

Figure 1. Metallic nanolens magnifying a subwavelength sample (e.g. fullerene) image

We fabricated gold (Au) nanorods arrays by combination of lithography and self-assembly technique [4]. Au nanorods of 50 nm height and 15 nm diameter were chemically synthesized. As Figure 2(b) shows, those Au nanorods were aligned in a sub-100 nm trench patterned by focused-ion beam (FIB) lithography on a glass substrate. 8-10 nm gaps were formed by CTAB surfactant attached on the Au surface. According to Finite-difference time-domain (FDTD) calculation (Figure 3), we found the surface plasmon resonance peak at 727 nm wavelength. These results show that the combination of lithography and self-assembly has the potential to realize plasmonic nanolens made of Au nanorods. The final goal is to construct 3D cylindrical structure layer with sectorially aligned Au nanorods arrays.

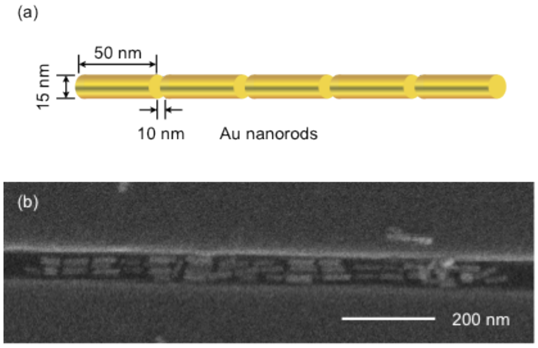

Figure 2. (a) Aligned Au nanorods of 50 nm height, 15 nm diameter and 10 nm gap. (b) SEM image of self-assembled Au nanorods in a 60 nm trench patterned by FIB on a glass substrate.

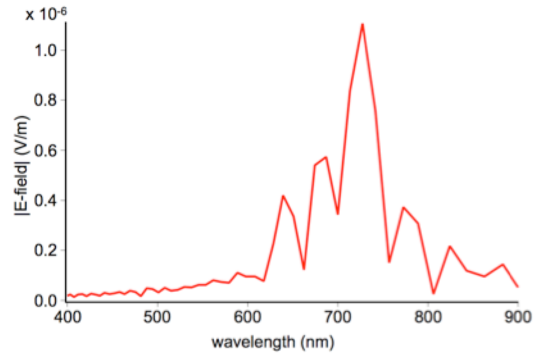

Figure 3. FDTD calculation of E-field at the output side of 10 aligned Au nanorods chain in air, illuminated by a dipole source from the input side. The maximum resonant peak appeared at 727 nm.

References:

[1] J. B. Pendry, *Phys. Rev. Lett.* **85**, 3966–3969 (2000).

[2] A. Ono et al., *Phys. Rev. Lett.* **95**, 267407 (2005).

[3] S. Kawata et al., *Nature Photonics* **2**, 7 (2008).

[4] J. A. Liddle et al., *J. Vac. Sci. Technol. B* **22**, 3409 (2004).