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Fluorescence-intensity enhancement of dye molecules by Si wire array

○Masanori Sakamoto[1], Hironori Tamamitsu[1], Ken-ichi Saitow[1,2]

[1] Grad. Sc. Sci., Hiroshima Univ.

[2] Natural Science Center for Basic Research and Development (N-BARD), Hiroshima Univ.

When nanostructure made of noble metal is optically excited, strong localized electric field is generated the metal surface. When molecules in the vicinity of the surface are excited by the localized electric field, their fluorescence intensities result in the significant increase. This phenomenon has been called metal enhanced fluorescence (MEF) and studied from the point of view on natural science and practical use in near future. However, it has been recognized that some problems lie on the MEF. Namely, 1) noble metal is no cost-effective material, 2) fluorescence is quenched by the energy transfer from the excited molecule to the noble metal. Thus, the number of studies relating to the enhancement effect by localized electric field increases using the other materials [1]. In our previous studies, the fluorescence-intensity enhancement of dye solution was observed using silicon (Si) nanoparticles [2] and submicron particles [3]. The former and latter enhancement factors (EF) were reported as 9 and 180, respectively. Here, we show the fluorescence-intensity enhancement of dye solution by the Si wire array structure. It was observed that the high EF (130) and high reproducibility of EF are established at the same time.

The Si wire array was prepared by dry etching with polystylene microsphere and oxygen plasma and by wet etching with HF and H_2O_2 solution. By observing the structure fabricated by the two etchings with a scanning electron microscope, two-dimensional Si array was observed as 1.8 μm in diameter and 3.0 μm in length. The fluorescence spectra of crystal violet (CV) solution with and without the Si-wire array were measured by *in situ* microscope spectrometer at the excitation wavelength of 633 nm. As a result, the fluorescence intensity of CV solution was enhanced up to 130-fold using the Si wire array. In addition, high reproducibility of the value of EF was observed.

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