Electrochemical tuning of coupling strength in strong coupling system between lattice plasmons and molecular excitons

([1]*Graduate School of Chemical Sciences and Engineering, Hokkaido University*, [2]*Department of Chemistry, Faculty of Science, Hokkaido University*)
○Takahiro Hayashi,[1] Shunpei Oikawa,[1] Hiro Minamimoto,[2] Kei Murakoshi[2]
Keywords: Lattice Plasmon; Strong Coupling; Molecular Exciton

It is well known that the strong electric field forms in the vicinity of the metal nanoparticles under the visible light illumination due to the excitation of plasmon resonance. In such plasmonic fields, various interesting photochemical phenomena, including the formation of the strong coupling states, have been reported. The strong coupling between plasmons and molecular excitons leads to the generation of the new hybridized states via the coherent light energy exchange.[1] However, the relatively shorter lifetime of the plasmon derived from the radiative energy loss often limits to its application. On the other hand, the two dimensionally arranged metal lattice structure has been receiving much attention because such structure can suppress the radiative damping due to the interaction between the collective electron oscillation and the diffractive light, resulting in the excitation of the lattice plasmon mode.[2] In this study, we have focused on the longer lifetime of lattice plasmon mode to construct strong coupling system using Au lattice structures and organic dye molecules. In addition, we have tried to control the coupling strength of strong coupling via electrochemical potential control.

The Au lattice structures were fabricated on the conductive glass substrate by electron beam lithography method. To construct strong coupling system, the Nafion thin film with dye molecules (S0366) absorbed by the cation-exchange method was prepared on the lattice structure. The new energy states, indicating the formation of the strong coupling regime, has been successfully observed as the peak splitting on angle-resolved extinction spectra. In addition, we revealed that the peak splitting of the strong coupling system was reversibly tuned by the electrochemical potential as shown in the figure. This result suggests that electrochemical potential control is effective for active tuning of the coupling strength of the strong coupling system.

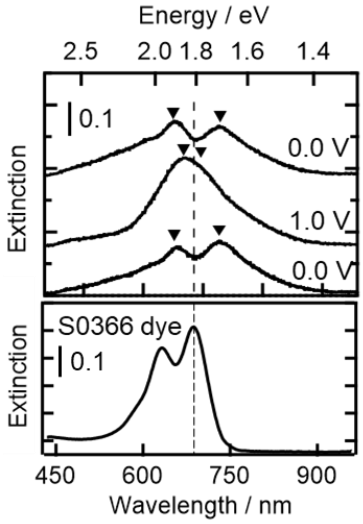

Fig 1. Extinction spectra of S0366 dye molecule(bottom) and S0366 dye supported Au lattice structure under electrochemical potential control(top). Potential sweep direction is upper direction.

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2) T. Hayashi *et al*., *J. Phys. Chem. C.,* **2018**, 122, 25, 14162-14167.