Plasmon-influenced photoluminescence blinking behavior of lead halide perovskite quantum dots

([1]*Hokkaido University*)○Tianci Wang,[1] Lei Duan,[1] Takuya Okamoto,[1] Vasudevanpillai Biju[1]
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Lead halide perovskite quantum dots (PQDs) show excellent optical and electronic properties due to the halogen- and size-dependent bandgap engineering. Single PQDs show photoluminescence (PL) blinking due to charging-discharging process induced by Auger ionization, which is further complexed by intermittent carrier trapping and de-trapping[1]. The PL of the PQDs can be enhanced or quenched by coupling the QD exciton with the localized surface plasmon resonance (LSPR) of metal nanoparticles (NPs)[2]. However, plasmonic effects of Au NPs on the PL blinking behavior of PQDs are yet to be understood entirely. Here, we investigate the plasmon-influenced PL blinking behavior of PQDs on the Au NP films.

We synthesized ligand-free or ligand-capped methylammonium lead iodide ($MAPbI_3$) PQDs, respectively, by a spray or the ligand-assisted reprecipitation (LARP)[3] method. The LSPR substrate was prepared by tethering a monolayer of Au nanorods (NRs) on silanized glass substrate (Figure 1). Next, PQDs were deposited on the Au NR film (Figure 1). The PQD-Au film was excited by a 532 nm cw laser, where the Au LSPR couples with proximal PQDs, thus affected the PL. Using an electron-multiplying CCD camera, we recorded the emitted photons from the LSPR-coupled or -uncoupled PQDs. PQDs on glass substrate without Au NRs, were also studied as control samples.

$MAPbI_3$ PQDs illustrated clear on-off two states blinking. The blinking trajectories changed after coupling with Au NRs, showing PL intensity enhancement in most cases. We discussed the blinking change and intensity enhancement in terms of the effect of ligands.

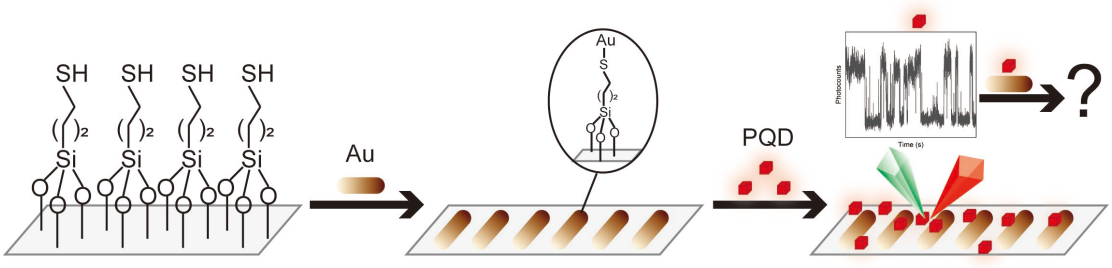

Figure 1. A scheme of Au NR tethered on a glass substrate and PQDs on the Au NR film.

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