In-situ Investigation of Surface Plasmon Resonance Enhanced Fluorescence Properties of Gold Quantum Dots on Polyelectrolyte Multilayers

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In this work, we demonstrate an in-situ investigation of surface plasmon enhanced fluorescence emission from the gold quantum dots (AuQDs) during the deposition on polyelectrolyte multilayers ultrathin films. When the size of gold particles is decreased (< 2 nm), they are known as gold nanoclusters or AuQDs, on which localized surface plasmons cannot be excited. Instead, the AuQDs exhibit quantum confinement effects, meaning that the number of gold atoms in the AuQDs determines the wavelength of the fluorescence emission in the visible range.[1,2] AuQDs have been applied to biosensor, organic electronic devices, and so forth. In this work, we studied the SPR enhancement fluorescence phenomenon of AuQDs by controlling the thickness of polyelectrolyte multilayer ultrathin films (intermediate layer) between the metal surface and AuQDs layer. Poly(diallyldimethylammonium chloride) (PDADMAC) and poly(sodium 4-styrenesulfonate) (PSS) were used as the polyelectrolyte layers. The polyelectrolyte multilayers was deposited on an aluminum surface using a layer-by-layer (LbL) adsorption technique by sequentially dipping the aluminum-coated high refractive index glass substrate into the positively charged PDADMAC aqueous solution and negatively charged PSS aqueous solution, alternately. Finally, a monolayer of AuQDs was deposited on PDADMAC/PSS films by spin-coating technique. The fluorescence of AuQDs was monitored by surface plasmon enhanced fluorescence (SPFS) measurement as schematically shown in Figure 1.[3] As the number of PDADMAC/PSS films increased up to 12 bilayers, the fluorescence intensity of the AuQDs increased. Then, the fluorescence intensity decreased when the number of layer became more than 12 bilayers as shown in Figure 2. This result indicated that the optimum distance between the AuQDs and aluminum layer was 12 bilayers, i.e. ca. 20 nm. The enhanced fluorescence phenomenon of AuQDs was applied to tuning the fluorescence intensity by the detection the H_2O_2 with AgNPrs. The fluorescence intensity of AuQDs decreased when the AgNPrs was deposited on the AuQDs/PDADMAC-PSS film due to the energy transfer from the AuQDs to AgNPrs. However, the fluorescence could be recovered in the presence of H_2O_2, which is attributed to oxidation of AgNPrs into soluble Ag^+ by H_2O_2.[4]

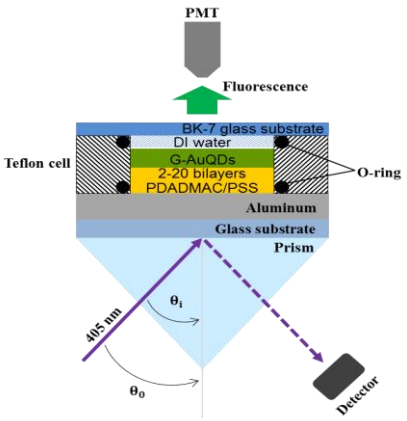

Fig. 1. SPR-enhanced fluorescence experimental set-up.

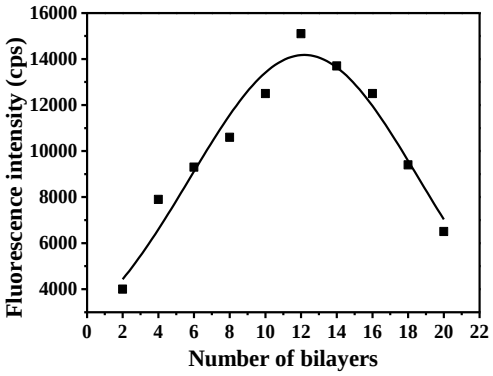

Fig. 2. Surface plasmon enhanced fluorescence of AuQDs on polyelectrolyte multilayers as a function of number of layer of PDADMAC/PSS films.

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