

Electrochemical modulation of single-layer MoS₂ photoluminescence under aqueous electrolyte solution for potential biological sensing

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Functionalization of the surface of biosensors with biomaterials such as proteins and DNA has been widely employed to establish a specific selectivity and high sensitivity to target molecules. As for sensing materials, a group of transition metal dichalcogenides (TMDC), *e.g.*, MoS₂ and WS₂, has attracted much attention due to their superior optoelectronic properties as well as its atomically flat surface. Single-layer MoS₂ has shown strong photoluminescence (PL) under photoexcitation, and the PL is largely affected by surrounding environments, such as molecular adsorption and solvent [1,2]. Thus, MoS₂ can be a good candidate for an optical biosensor under physiological condition due to its high sensitivity to the environments. To this end, it is necessary to investigate the optical response of MoS₂ to various aqueous conditions of pH and ions. However, despite of intensive studies, the MoS₂ PL under aqueous solution is poorly investigated.

To address it, we have established a system of single-layer MoS₂ on a cover glass, where the electrochemical potential of MoS₂ can be controlled by applied voltage with a Pt electrode. MoS₂ was synthesized by chemical vapor deposition on Si wafer. Then, Au electrode was patterned on the MoS₂ by photolithography. The MoS₂/Au sample was transferred to a transparent cover glass with a polymer thin film. To apply the electrochemical potential, aqueous electrolyte solutions was placed on the sample, followed by an insertion of a Pt electrode into the droplet. Under the controlled potential, we measured PL images and spectra with a CCD and spectrometer combined to an inverse fluorescent microscope. In this measurement, we utilized normal pulse voltammetry (NPV) to analyze time-dependent modulation of PL intensity against ion adsorption upon an applying voltage. Compared to the case of unmodified MoS₂, MoS₂ functionalized with self-assembled peptides showed long decay time of PL modulation under various ionic aqueous solution, which may indicate strong interactions between ionic species and surface peptides layer with a monomolecular thickness on MoS₂. In the presentation, we will discuss the correlations of ionic species and type of peptides on the PL time-dependency controlled by the NPV.

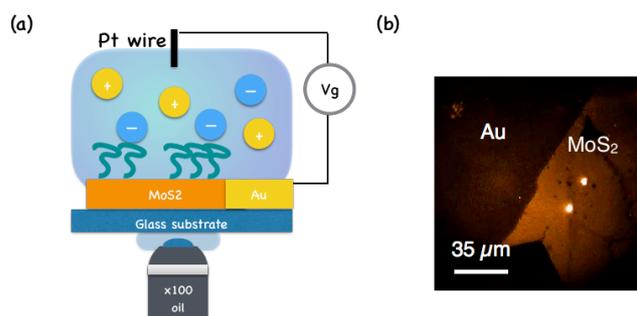


Figure 1. (a) Schematic illustration of the experimental setup. (b) PL image of MoS₂/Au sample.

[1] Mouri, S.; Miyauchi, Y.; Matsuda, K. *Nano Lett.* **2013**, *13* (12), 5944–5948.

[2] Mao, N.; Chen, Y.; Liu, D.; Zang, J.; Xie, L. *Small* **2013**, *9* (8), 1312–1315.