Stability of monolayer WSe_2 and MoS_2 in an aqueous solution under light irradiation

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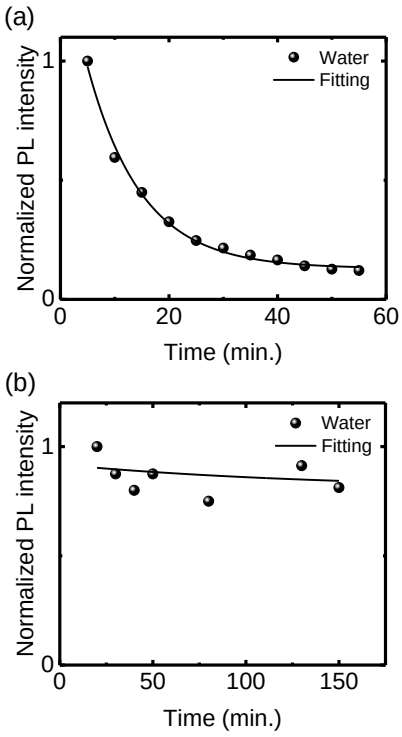
Atomically thin transition metal dichalcogenides (TMDCs) MX_2, where M and X are a transition metal and a chalcogen, respectively, have become attractive candidate for future electronics and optoelectronics applications such as gas/bio sensors and photocatalyst because of their unique optical and electrical properties[1-4]. Due to their extremely large specific surface area, their physical or chemical performances and stabilities are easily affected by the surface electrochemical interactions between TMDCs and their environment[5]. Thus, it is important to clarify the impact of surface interactions on the stability of TMDCs for their real applications.

Here we report the stability of monolayer (1L) WSe_2 and MoS_2 under light irradiation in aqueous solutions with various pH. We probed degradation of the sample as a function of time using photoluminescence (PL) spectroscopy. PL properties in air and aqueous solutions were compared for 1L-WSe_2 and 1L-MoS_2.

Figure 1 shows the PL intensity change of 1L-WSe_2 and 1L-MoS_2 in distilled water (pH = 7) under visible light irradiation (580 nm, 800 W/cm^2). The PL intensities of 1L-WSe_2 show remarkable decrease whereas 1L-MoS_2 were stable. These results suggest that only 1L-WSe_2 was degraded. These differences are mainly attributed to the different surface reactions between 1L-TMDCs and O_2/H_2O redox couple; the difference is induced by the alignments of band levels of 1L-WSe_2(MoS_2) and O_2/H_2O redox potentials and photo-generated holes.



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