Optical Spectroscopy of Artificial Hetero-structure of Monolayer $MoSe_2$ and Manganese Oxide

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Due to the direct bandgap coupled with spin-valley degree of freedoms[1], two-dimensional (2D) semiconducting transition metal dichalcogenides have attracted much attention. Recently, the artificial hetero-structures based on monolayer transition metal dichalcogenides and various 2D materials such as insulators, ferromagnetic semiconductors and metals were extensively studied. Among them, a strongly correlated electron system of manganese oxides exhibits unique magnetic and carrier transport properties. Hence, it is interesting to explore excitonic physics and applications in the artificial hetero-structure using manganese oxides.

In this work, we studied artificial hetero-structure of monolayer (1L) $MoSe_2$ and manganese oxide ($La_{1.2}Sr_{1.8}Mn_2O_7$). The $La_{1.2}Sr_{1.8}Mn_2O_7$ is a ferromagnetic metal below T_C = 126 K, and shows large negative magnetoresistance[2]. The temperature dependence of photoluminescence (PL) spectra of hetero-structure (1L-$MoSe_2$/$La_{1.2}Sr_{1.8}Mn_2O_7$) and reference (1L-$MoSe_2$/SiO_2) were measured. Figure 1(a) shows the PL spectra of 1L-$MoSe_2$ in the hetero- and reference-structure at 10 K. In both spectra, the two-emission peaks from exciton (X) and charged exciton, trion (X^-) were observed. Figure 1(b) shows the temperature dependence of PL intensity ratio of X^- and X (I_{X^-}/I_X) in the hetero-structure and reference. We observed that significant difference of PL intensity ratio of X^- and X in the hetero-structure and reference, which suggests that the doped carrier density of 1L-$MoSe_2$ is much different in the hetero-structure and reference because the PL intensity of X^- reflects the doped carrier density. We will also discuss the excited state dynamics within the framework of an exciton and a trion[3].

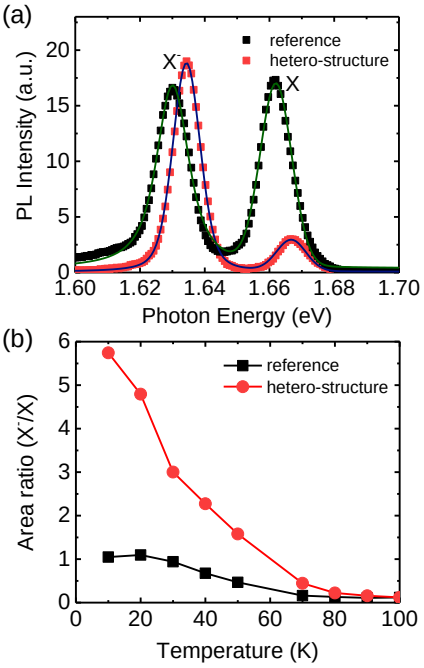

Figure 1(a) PL spectra of hetero-structure and reference at 10 K. (b) Integrated area ratio of trion and exciton as a function of temperature.

References

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