CHAPTER V

CONCLUSION AND FUTURE RESEARCH

5.1 Conclusions

In this thesis, the surface of monolayer MoS_2 was modified by low-energy electron irradiation via SEM. The physical and optical properties were investigated using several spectroscopy techniques to illustrate the effect of low-energy electron irradiation. Upon electron irradiation, we did not observe any shift in the PL spectra that has been previously associated with the generation of vacancies, confirming that the structure remained unchanged after electron irradiation. As the sample was exposed to a high power 532-nm laser, quenching areas were observed. After being stored in ambient conditions for 10 hours, the PL intensities recovered. To identify the gas species associated with the PL recovery mechanism, we investigated the PL behavior of the sample in a nitrogen (N_2) atmosphere for 10 hours, followed by 10 hours of ambient storage. The PL intensity remained unchanged in the N_2 atmosphere. Furthermore, we observed a red shift in the PL spectrum after laser exposure, which remained unchanged during storage in a nitrogen (N_2) atmosphere. On the contrary, the spectrum reverted to its original position after subsequent exposure to ambient conditions. However, the PL intensity recovered in ambient conditions, which contain oxygen (O_2) molecules. Therefore, O_2 is essential for the PL recovery process of the sample. Analysis of deconvoluted spectra revealed a sudden decrease in integrated A exciton intensity, accompanied by an increase in trion intensity, while the B exciton intensity remained relatively unchanged under N_2 atmosphere. Conversely, exposure to ambient conditions for 10 hours led to an increase in A exciton and a decrease in trions, indicating electron depletion from the sample by O_2.

Therefore, we can conclude that low energy electron irradiation induces a negative charge on the surface of MoS_2, which stimulates O_2 adsorption. And the adsorption and desorption of O_2 molecules can affect charge transfer from MoS_2. This process results in changes in the exciton and trion transitions and the recovery of PL intensity.

5.2 Improvement and future research

To understand the mechanism within MoS_2 that enables PL intensity recovery after high power exposure, we need to conduct further experiments by varying the dose of electron irradiation. In a previous experimental study with only two doses, we could not explain the threshold dose for the non-recovery of PL intensity. Therefore, we designed to investigated electron irradiation of the sample with 13 electron doses ranging from 0.1×10^3 to 5.3×10^3 $\mu C/cm^2$ (see appendix). If we could further conduct PL intensity recovery experiments in all areas, it would help explain the effects of electron irradiation and photobleaching where PL cannot recover.