Tunable optical response of monolayer MoS_2 via fluence-controlled high-energy electron-beam irradiation

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Monolayer molybdenum disulfide (MoS_2) provides an excellent platform for exploring strong light–matter interactions [1,2], enabling applications in electronic and optoelectronic devices. Owing to its large surface-to-volume ratio, the properties of MoS_2 can be readily modulated through extrinsic means [3]. In this work, we employ high-energy (1 MeV) electron-beam irradiation to controllably introduce defects in CVD-grown monolayer MoS_2 by varying the irradiation fluence [4]. Low-temperature photoluminescence (PL) measurements reveal the emergence of a broad defect-related emission band located approximately 0.2 eV below the A exciton. The enhanced defect peak intensity at higher fluence indicates an increase in defect density. Furthermore, circular polarization-resolved PL spectroscopy shows strong suppression of valley polarization following electron exposure. The observed changes arise from the enhanced Mo-O bonding and the resulting p-type doping, as evidenced by x-ray photoelectron spectroscopy and Kelvin probe force microscopy. Our findings provide insight into fluence-controlled defect engineering in monolayer MoS_2 and its implications for the design of optoelectronic devices operating in radiation-rich environments.

References

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