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Photoluminescence Quenching in Single-Layer MoS₂ via Oxygen Plasma Treatment NARAE KANG, HARI P. PAUDEL, MICHAEL N. LEUENBERGER, LAURENE TETARD, SAIFUL I. KHONDAKER, NanoScience and Technology Center and Department of Physics, University of Central Florida — Ultrathin two-dimensional (2D) layered transition dichalcogenides (TMDs) families have emerged as a new class of semiconducting candidates due to its intrinsic bandgap. The ability to control the properties of 2D TMDs will become a key in the development of future electronic and optoelectronic applications; however, altering the properties via creating and manipulating defects through external control is not fully investigated yet. In this work, we studied tunable optical properties of single-layer (SL) MoS₂ by applying time-dependent oxygen plasma exposure. As the exposure time increased, the strong photoluminescence (PL) of SL MoS₂ changed to complete quenching accompanied by clear changes in Raman spectra with gradual reduction of MoS₂ peaks as well as an appearance of oxidization-induced peak of Mo-O bonds formation. Using band structure calculations, we found that the creation of MoO₃ disordered-domains led to plasma-induced direct-to-indirect bandgap transition in defected SL MoS₂, resulting in PL quenching with lattice distortion. Our results suggest new opportunities of tailoring and understanding the properties of 2D TMDs.

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