Enhancement of Second and Third Harmonic Generations in MoS_2 via Optical Defect-Engineering

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Two-dimensional (2D) materials have many beneficial physical properties that can be readily modified due to the atomic thickness of the materials.[1] Defect engineering of 2D materials has been shown to trigger, for example, phase change in transition metal dichalcogenides (TMDs), which can improve performance in electrical and optoelectrical applications. However, industrial defect introduction methods are often harsh and cannot be deterministically conducted after device fabrication. Inducing defects optically offers a gentler and more cost-effective way to obtain desired properties.[2] In this research, up to 30 nm tall structures with a 3.3-fold second harmonic generation (SHG) enhancement and a 50-fold third harmonic generation enhancement are created on a monolayer molybdenum disulfide (MoS_2) by femtosecond laser irradiation[3] in an inert environment. A schematic of the optical defect engineering process is presented in Figure 1a and a SHG map showing the enhancement on the irradiated areas in Figure 1b. The enhancement is attributed to defect-induced mid-gap states, confirmed by the appearance of a new excitonic peak at low-temperature photoluminescence measurements, while the elevation of the irradiated areas is attributed to the build-up of amorphous carbon. These results are especially promising for improved applications in optoelectronics, quantum photonics, and energy solutions.

References

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Figures

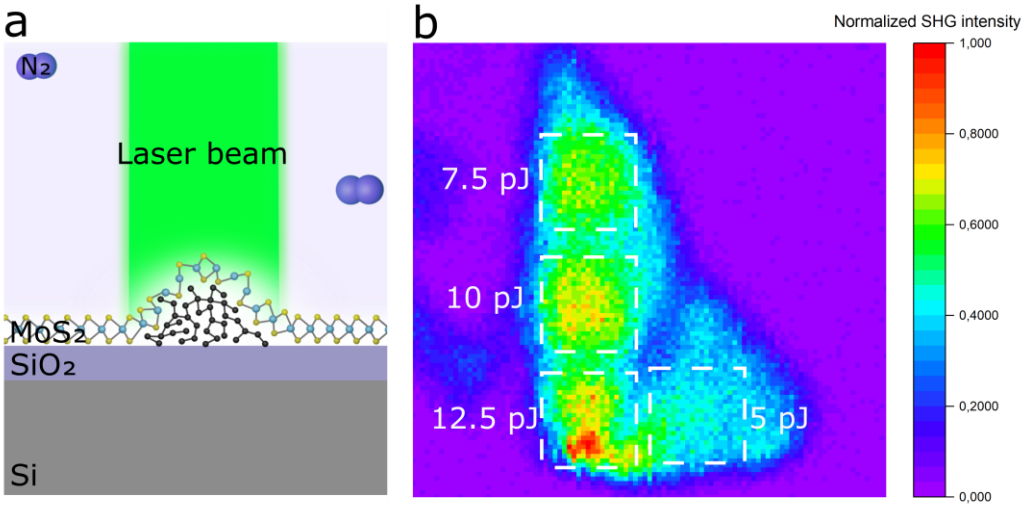

Figure 1: Optical defect engineering process (a) and SHG map (b) of optically modified monolayer MoS_2 flake. The pulse energies used to optically form the four square patterns on the flake are marked in (b).