Strain Induced Phase Transition of Atomically thin WSe_2

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Strain engineering is a promising approach to modify the electronic and optical properties of 2D materials such as graphene and transition metal dichalcogenides (TMDs)[1]. Atomic Force Microscopy (AFM) based nanoindentation techniques can be used to apply controlled mechanical strain to 2D materials, thereby modulating their band gap and influencing their potential applications in electronics and optoelectronics. The study of the effect of strain on 2D materials is an active area of research, with the goal of exploring the limits of their mechanical and electronic performance and enabling the development of new devices and applications. In this study, we explored the effect of controlled mechanical strain on the electronic and optical properties of 2D transition metal dichalcogenides (TMDs), with a focus on monolayer WSe_2 due to its' low energy barrier for transitioning from the 2H (semiconductor) to 1T (metallic) phase[2]. Atomic Force Microscopy (AFM) based nanoindentation techniques were used to apply strain, with the goal of modulating the band gap and investigating the mechanical and electronic performance of 2D materials. We used a sharp diamond AFM probe to apply strain locally to a suspended monolayer of WSe2 on etched micro wells and observed the change in bandgap. Our findings were validated using density function theory (DFT) calculations. Further, we investigated the amount of strain required to transition monolayer WSe2 from a semiconductor to a metallic phase.

References

[1] A.C. de Palma, G. Cossio, K. Jones, J. Quan, X. Li, and E.T. Yu, Journal of Vacuum Science & Technology B 38, 042205 (2020).

[2] A. Ghasemi and W. Gao, Extreme Mech Lett 40, 100946 (2020).