# Defective 2-Dimensional Materials: From Photo Detectors to Molecular and Strain Sensors

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An overview of different defects in 2-Dimensional materials including graphene and Chalcogenides will be presented. We will first focus on: *1)* defining the dimensionalities and atomic structures of defects; *2)* pathways to generating structural defects during and after synthesis and, *3)* the effects of having defects on the physico-chemical properties and applications. We will then discuss how monolayers of nitrogen- and boron-doped graphene sheets can be synthesized and used as efficient molecular sensors. In particular, Graphene enhanced Raman spectroscopy (GERS) will be introduced and it will showed that for Nitrogen-doped graphene, the Fermi level ($E_F$) of graphene shifts, and if this shift aligns with the lower unoccupied molecular orbital (LUMO) of a molecule, charge transfer would be enhanced, thus significantly amplifying the molecule's vibrational Raman modes. Concentrations as low as $10^{-11}$ mol/L of different dye molecules can be detected using GERS. It will also be demonstrated that B-doped graphene can be used as effective toxic gas sensor for $NH_3$ and $NO_2$, detections limits of parts per billion and parts per trillion will also be introduced. The electronic performance of monolayers of $MoS_2$, $WS_2$ and hetero-systems operating under flexural strain will also be presented. Our findings demonstrates that it is now possible to use chalcogenide layers for the fabrication of flexible electronic devices, however, defect control is required to tailor their performance.

References

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Figure

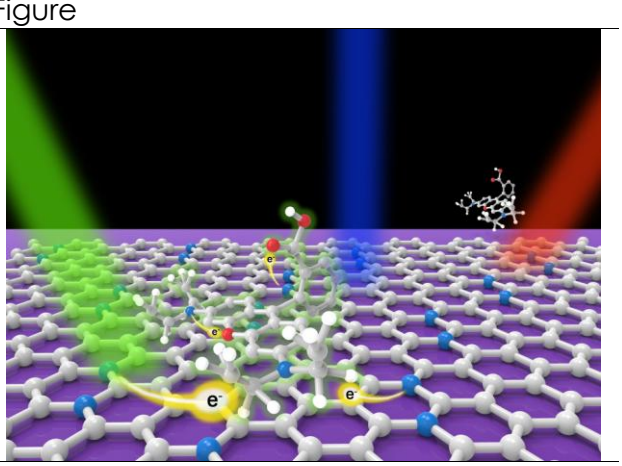


**Figure 1:** Molecular model of N-doped graphene and molecules detected using GERS