Flexible 2D material transistors under controlled biaxial deformation

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Semiconducting two-dimensional Transition Metal Dichalcogenides (2D - TMDCs) can sustain very large deformations before failure (up to 8%) while presenting large (1.5 to 2.0 eV) and extremely strain-sensitive (50-130 meV/%) direct bandgaps. Thus, this class of materials holds great promise in strain engineering applications. Over the decade, in the bulk of the published works, 2D – TMDC crystals have been tested under various types of strain [1-3]. However, with respect to flexible electronics, where a large number of interfaces is involved, the extend to which mechanical strains can be efficiently transferred to the 2D crystal requires further attention.

In this work it is shown that despite the larger number of interfaces occurring in a 2D material transistor, biaxial strain can be efficiently imposed on the devices in a controllable manner. In particular, WSe_2 and MoS_2 field effect transistors, fabricated on flexible polyethylene napthalate (PEN) substrates are subjected to biaxial strain. The efficient strain transfer is verified using in-situ Raman mapping over the whole channel of several devices. Additionally, it is shown that in the spectroscopically difficult case of WSe_2, where the strain sensitive E' mode is accidentally degenerate with the more intense and strain insensitive A_1' mode, the second order Raman active modes around 350 - 400 cm^{-1} can be used as efficient strain indicators.

References

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