2D Xenes for Straintronics

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Abstract

The tremendous success of graphene has initiated a paradigm shift towards the expedition of various properties of graphene-like 2D materials, referred to as Xenes. The rapid miniaturization of silicon devices and beneficial electro-mechanical properties of silicene in the field of flexible electronics [1] have paved the way for the xenes in nano electro-mechanical systems (NEMS). Based on the results obtained for silicene [2], we extend this investigation to inspect the utility of straintronics for other xenes in nanoscale regime using ab-initio density functional theory and quantum transport approach based on Landauer formalism. Effect of strain on K-point is seen in the band structure for silicene, germanene and stanene. The directional piezoresistances have been calculated as per the critical strain limit, and the relevant gauge factors are compared. They sinusoidal dependence on the transport angle akin to silicene and graphene [3]. Another application like conductance modulation has been explored, which is quantized in nature. The strained tight binding parameters of phosphorene have been evinced, which is the first of its kind. Based on the above results, we propose a voluminous model for the monolayer Xenes keeping the perspective of straintronics and its applications.

References

[1] H. Zhao et al., Physics Letters A 376(46), (2012.
[2] S. Sahoo *et al.*, *JPD: Applied Physics*, 55.42 (2022).
[3] A. Sinha *et al.*, *Phy. Rev. Research.*, 2.4 (2020).

Figures

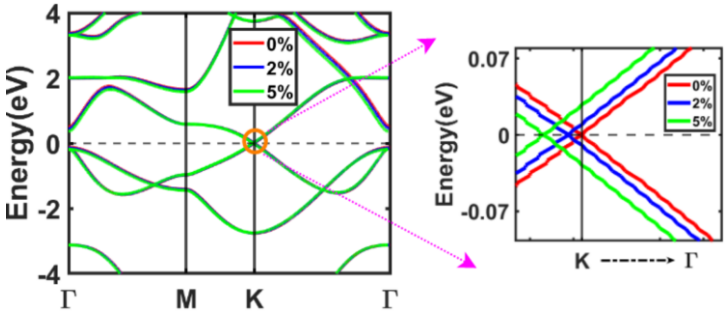

Figure 1: Band structure of stanene, showing movement of K-point with AC strain applied.

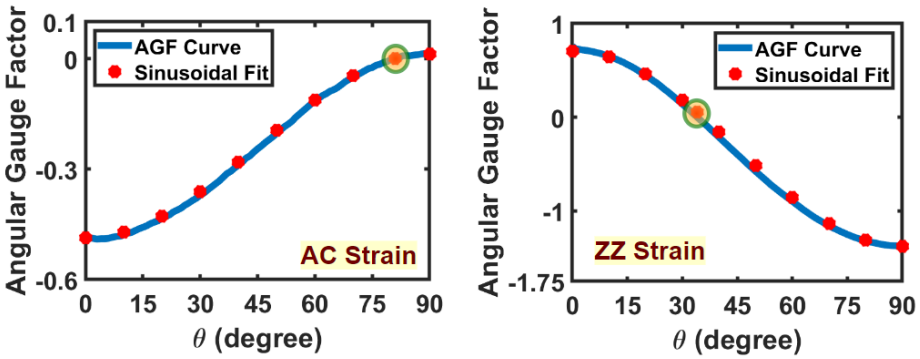

Figure 2: Variation of Gauge factor and it's sinusoidal fit for silicene against transport angle.