Monolayer Xenes for Straintronics and Spintronics

Swastik Sahoo[1]
Satadeep Bhattacharjee[2] and Bhaskaran Muralidharan[1]
[1]*Indian Institute of Technology, Bombay Powai, Mumbai, 400076, India.*
[2]*Indo-Korea Science and Technology Center, Bengaluru,560064, India.*
Swastik.sahoo79@gmail.com

Abstract

The rapid miniaturization of silicon devices and beneficial electro-mechanical properties of silicene in the field of flexible electronics have paved the way for the xenes in nano electro-mechanical systems (NEMS). Based on the results obtained for silicene [1], 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 [2]. The capability of high-speed computing for spintronics has led to its development in the last two decades. The paramount acumen of controlling spin transport properties in non-magnetic materials is the usage of spin-orbit coupling (SOC). We propose a model to calculate the spin hall angle (SHA)[3] for the elemental monolayers of group 4 with a buckled honeycomb structure. The device is introduced to some manual defects, manual dislocations, and interface-induced spin-orbit coupling. The SHA of these devices also illustrates the mesoscopic fluctuations, which can be a comparative measure for graphene and other metal devices.

References

[1] S. Sahoo *et al.*, *JPD: Applied Physics*, 55.42 (2022).
[2] S. Sahoo et al., ACS: Applied Nano Materials (2024)
[3] da Silva, Juliana M., et al., *Journal of Applied Physics* 132.18 (2022).

Figures

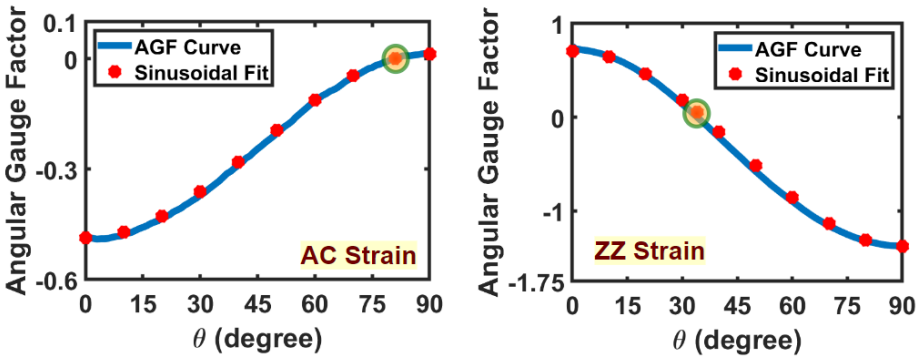
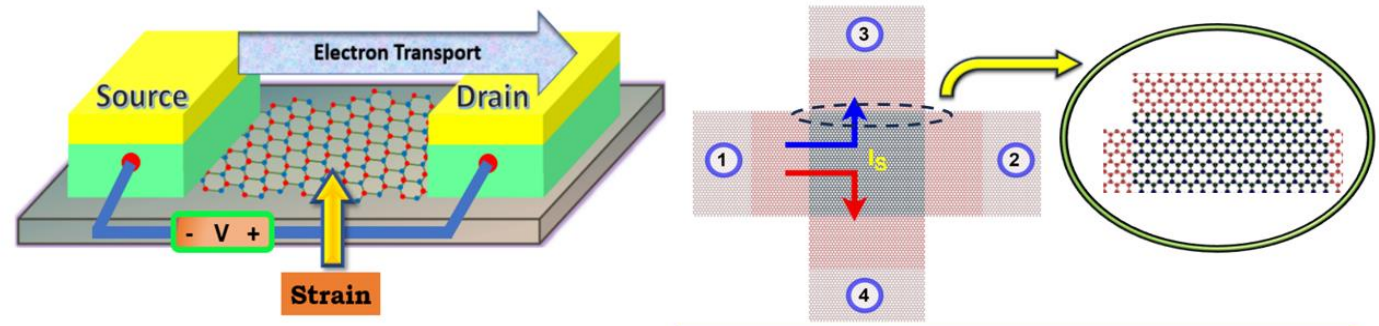


Figure 1: Variation of Gauge factor and it's sinusoidal fit for silicene against transport angle.



Piezoresistance setup of monolayer buckled Xene sheet

The spin Hall device design of monolayer buckled Xenes. The scattering sample with disorder and strong SOI is connected to four semi-infinite leads.

Figure 2: Monolayer Xenes for Straintronics and Spintronics: A Proposed Template