A Monte Carlo study of electronic transport in silicene: importance of out-of-equilibrium phonons

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Silicene, the silicon analogue of graphene, is an emerging two-dimensional material with very attractive electronic properties for a wide range of applications [1]. In particular, it could be interesting to develop new nanoelectronic applications using this material due to its direct compatibility with silicon technology and the possibility of inducing an electrically tunable bandgap.
In this work, we study the effect of a phonon out-of-equilibrium population on the electronic characteristics of free-standing silicene. Our ensemble Monte Carlo simulator for 2D materials, that has been applied successfully in previous works to the case of graphene [2], has been used here for the modelling of silicene by incorporating the corresponding band structure and scattering mechanisms as described in [3,4]. The phonon relaxation times were obtained from [5].
The impact of out-of-equilibrium phonons shows to be more important at moderate and high electric fields, provoking a reduction of the saturation velocity and enhancing of energy (Fig. 1). A microscopic study in terms of the electron coupling with phonons and their consequent heating (Fig. 2) reveals an important dependence on the carrier concentration considered. The role of flexural acoustic phonons is also discussed. More results will be presented at the conference.
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References

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Figures

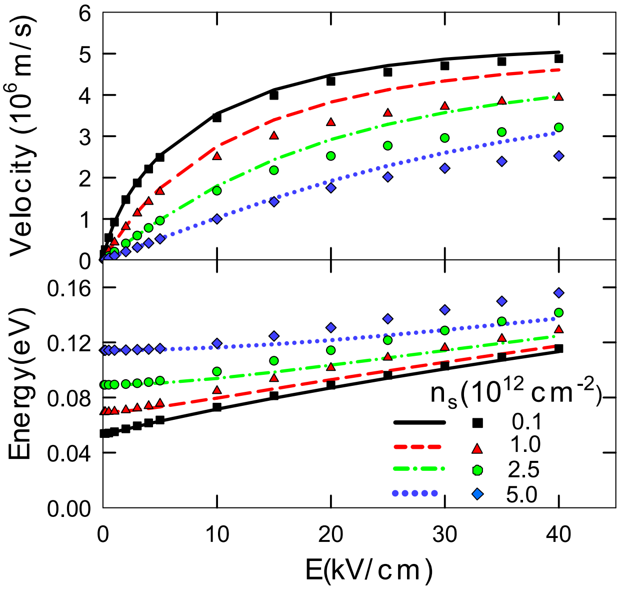

Figure 1: Average drift velocity and energy, as a function of the longitudinal electric field *E*, obtained for four different carrier concentrations (n_s): without (lines) and with (symbols) out-of-equilibrium phonons.

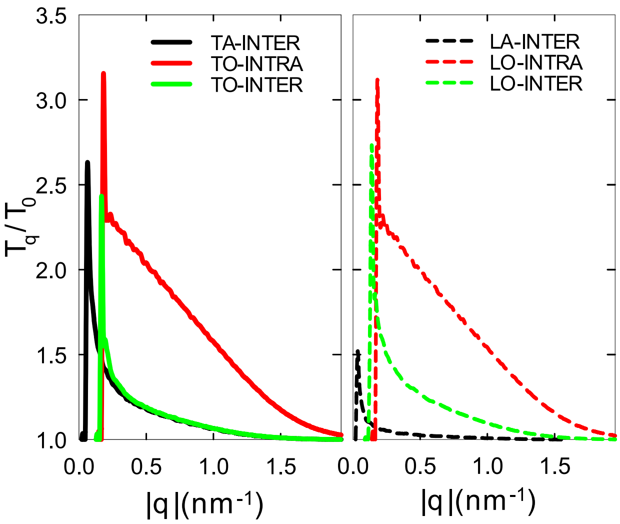

Figure 2: The normalized phonon temperature T_q as a function of the wave vector |q|. T_0 = 300K, E=40kV/cm, n_s=5x10^{12}cm^{-2}.