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Thermal and electro-thermal properties of a graphene sheet

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In this work, we investigate some thermal and electro-thermal properties of suspended monolayer graphene. In particular, by means of a two-step numerical experiment, made using a hydrodynamical like model for charge and energy transport in graphene [1], we analyse how fastly a suspended graphene sheet heats up when it is subject to a constant homogeneous electric field and how it reaches the equilibrium state after the electric field is turned off. We consider all phonon branches and electron-phonon interactions, and show that the influence of the out-of-plane acoustical phonons on the final equilibrium temperature is notable, due to their great heat capacity. While, the influence of the electrons on the final temperature is through the energy that they gain on account of the work of the electric field. This energy is greater at higher Fermi energy, since the number of electrons in the conduction band increases with the latter.
The electron-phonon system relaxes towards the equilibrium state with the temperature which corresponds to the total energy the system has at the time when the electric field is turned off. We provide a theoretical justification of this behaviour of the system, which is based on the conservation of the total energy and on the total entropy of the electron-phonon system, of which we give an almost explicit expression.
Eventually, we furnish an expression of the graphene thermopower as function of the Fermi energy and of the temperature.

REFERENCES

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