Thermal conductivity of supported graphene nanowires

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Improve energy conversion is a major societal concern, particularly in nanoelectronics. In this domain, the discovery of 2D materials has opened new routes of investigation. The thermoelectric (TE) efficiency at a given temperature, ZT, is the relevant parameter for applications that researchers struggle to increase. It depends on the material Seebeck coefficient (S) and on its electrical (σ) and thermal (k) conductivities [1-2]. If the measurement of the first two quantities is relatively easy to perform, the evaluation of the thermal conductivity is strongly influenced by the measurement conditions, the environment, the sample fabrication. However, for a reliable estimation of the figure of merit ZT, a precise evaluation of the thermal conductivity is mandatory. In this talk, I will discuss the self-heating method [3] as a tool to measure the thermal conductivity of supported 2D materials, allowing to characterize the efficiency of on-substrate thermoelectric devices where the interaction with the environment is a dominant factor. We have applied this method to supported multilayer graphene nanowires, as test bed 2D material, fabricated over 5 µm-thick SiO_2 substrate. We reveal low k values (≈ 45 W/mK) in the 400K-500K temperature range. This result can be particularly intriguing to conceive alternative graphene-based solutions to face the heat waste problem in nanoscale systems.

References

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[3] T. Kodama et al., 13th InterSociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems, (2012) 250-255.
[4] Callaway, Phys. Rev. 113 (1959) 1046.

Figures

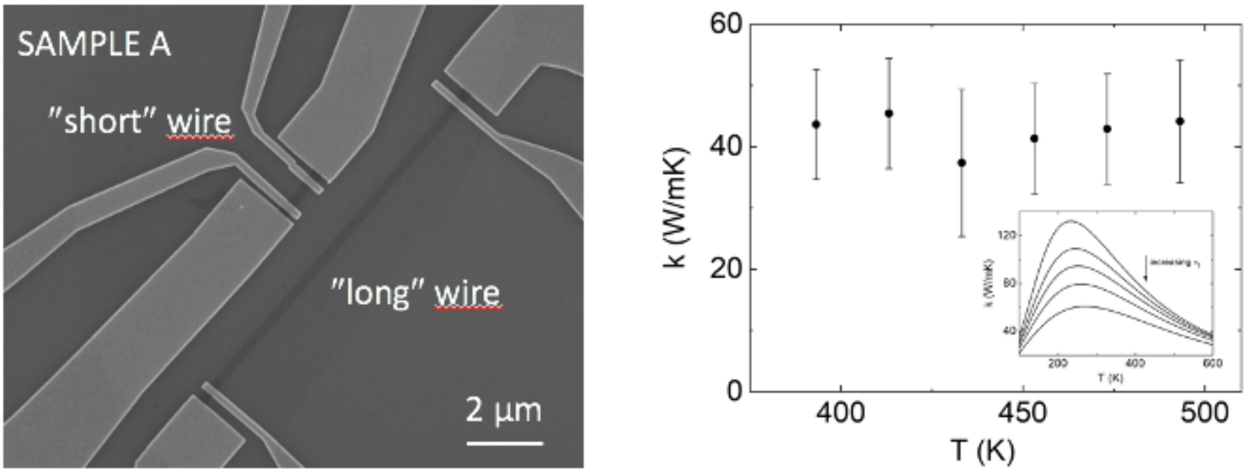

Figure 1: (left) Scanning electron microscope image of a short and a long multilayer graphene nanowire (MLG) with electrical connections for 4-point measurements. (right) Thermal conductivity of supported MLG nanowires in sample A as function of temperature. The inset shows a comparison of the extracted k values with the Callaway model [4] for increasing scattering with impurities.