Supporting Information: Active electron cooling of graphene

F. Paolucci,[1,*] F. Bianco,[2] F. Giazotto,[2] and S. Roddaro[3,†]

[1] *INFN Sezione di Pisa, Largo Bruno Pontecorvo 3, I-56127 Pisa, Italy*
[2] *NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza San Silvestro 22, I-56127 Pisa, Italy*
[3] *Dipartimento di Fisica "E. Fermi", Università di Pisa, Largo Bruno Pontecorvo 3, I-56127, Pisa, Italy*

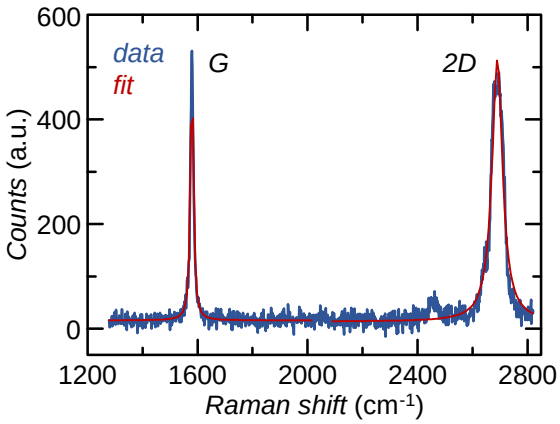

FIG. 1. **Raman spectroscopy.** Typical Raman spectrum of the graphene channel of our thermal transistor (blue) along with the Lorentian fit (red) of the G and $2D$ peaks. The position of the two Raman modes is ~ 1582.7 cm^{-1} and ~ 2676.5 cm^{-1} for the G and $2D$ peak, respectively. By constructing the related correlation plot [1], we extracted a small strain ($\sim 0.1\%$) and a charge concentration $n_G \simeq 3 \times 10^{12}$ cm^{-2} for the graphene channel.

* federico.paolucci@pi.infn.it
† stefano.roddaro@unipi.it

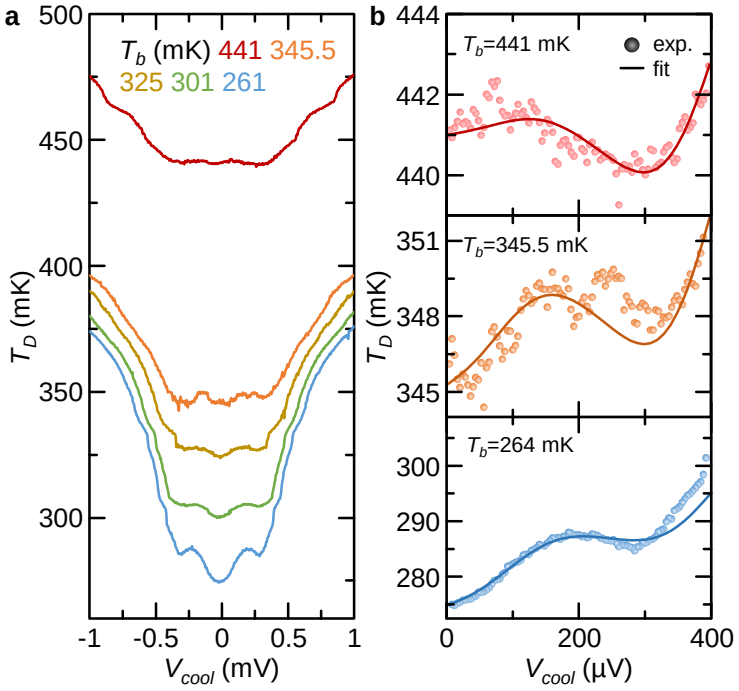

FIG. 2. **Temperature modulation of the drain electrode for data set** B**. a** Electronic temperature of the drain electrode (T_D) as a function of the voltage bias of the source coolers (V_{cool}) recorded at selected values of phonon temperature (T_b). **b** Experimental modulations of T_D (circles) by V_{cool} along with the theoretical model (lines) obtained at $T_b = 441\,\mathrm{mK}$ (red), $T_b = 345.5\,\mathrm{mK}$ (orange) and $T_b = 264\,\mathrm{mK}$ (turquoise).

[1] J. E. Lee, G. Ahn, J. Shim, Y. S. Lee, and S. Ryu, Optical separation of mechanical strain from charge doping in graphene, Nat. Commun. **3**, 1024 (2012).