

## HOW TO MAKE GRAPHENE SUPERCONDUCTING

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Graphene[1] is the physical realization of many fundamental concepts and phenomena in solid state-physics[2], but in the long list of graphene remarkable properties[3,4,5,6], a fundamental block is missing: superconductivity. Making graphene superconducting is relevant as the easy manipulation of this material by nanolytographic techniques paves the way to nanosquids, one-electron superconductor-quantum dot devices[7,8] and superconducting transistors at the nano-scale[9].

We used first-principles density functional theory to study the dynamical properties of graphene and a recently developed Wannier function approach[10] to understand the peculiarities of the electron-phonon coupling. We show various methods in order to enhance the electron-phonon coupling and thus induce a superconducting instability in graphene. New experimental routes will be investigated and proposed to enhance further the superconducting critical temperature.

### References

- [1] K.S. Novoselov *et al.*, Science, 306 (2004) 666.
- [2] A.K. Geim, Science, 324 (2009) 1530.
- [3] M.I. Katsnelson, K.S. Novoselov and A.K. Geim, Nature Physics, 2 (2006) 620.
- [4] K.S. Novoselov, Z. Jiang, Y. Zhang, S.V. Morozov, H.L. Stormer, U. Zeitler, J.C. Maan, G.S. Boebinger, P. Kim, and A.K. Geim, Science, 315 (2007) 1379.
- [5] Y. Zhang, Y.W. Tan, H.L. Stormer, P. Kim, Nature, 438 (2005) 201.
- [6] R.R. Nair, P. Blake, A.N. Grigorenko, K.S. Novoselov, T.J. Booth, T. Stauber, N.M.R. Peres and A.K. Geim, Science, 320 (2008) 1308.
- [7] S. De Franceschi, L. Kouwenhoven, Ch. Schönberger and W. Wernsdorfer, Nature Nanotechnology, 5 (2010) 703.
- [8] M. Huefner, C. May, K. Kicin, K. Ensslin, T. Ihn, M. Hilke, K. Suter, N. F. de Rooij, and U. Staufer, Phys. Rev. B, 79 (2009) 134530.
- [9] J. Delahaye, J. Hassel, R. Lindell, M. Sillanpää, M. Paalanen, H. Seppä, and P. Hakonen, Science, 299 (2003) 1045.
- [10] M. Calandra, G. Profeta and F. Mauri, Phys. Rev. B, 82 (2010) 165111.