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Semiconducting carbon nanotubes in optoelectronic and nanophotonic devices

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The exciting optical and electronic properties of semiconducting carbon nanotubes are inspiring more and more demonstrations of their applicability in nanometer scale optoelectronics and photonics. Integrated in a device, however, the physical properties of carbon nanotubes are subject to strong modifications. The presence of dielectric substrates, external electric fields and electrostatic doping significantly alters the optical properties of carbon nanotubes [1, 2]. Also, charge carriers involved in electrical transport along carbon nanotubes excite non-equilibrium phonon populations and couple to surface polar phonons of a dielectric substrate [3]. As a result, the response of carbon nanotubes to external perturbations will ultimately determine the overall performance of a carbon nanotube device. By combining electrical measurements and optical micro-spectroscopy, it is possible to observe experimentally the different effects on the single nanotube level and elucidate the role of the various physical interactions that occur simultaneously in an operating carbon nanotube transistor.

[1] M. Steiner et al., Applied Physics A 96, 271-282 (2009)
[2] M. Steiner et al., Nano Letters 9, 3477-3481 (2009)
[3] M. Steiner et al., Nature Nanotechnology 4, 320-324 (2009)