Computational Approach to Electrical Contacts in Carbon Nanotube Transistors

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Electrical properties of low-dimensional devices are dominated by the contact resistance. For carbon nanotube field effect transistors (CNT-FETs) [1], as for graphene [2] and MoS_2 transistors, the electrical contacts are a key factor limiting device performance. Contact resistance reflects a complex interplay of many factors. With advances in scaling, the contact resistance and transfer length are becoming even more critical. We have developed a general purpose CNT device simulator which is unique in including quantum-mechanical tunneling, both acoustic and optical-phonon scattering, as well as the crucial transfer of carriers between the CNT and metal contact. CNT-FETs integration requires closely-spaced arrays of tubes, with several tubes per device, to give adequate drive current. We find that with scaling of the tube spacing toward smaller pitch, there is a structural transition to a geometry in which the metal poorly wets the nanotube and substrate. This gives a sudden decrease in contact adhesion, and probably also an increase in contact resistance. Several interesting aspects of the wetting geometry will be discussed [3]. [1] V. Perebeinos, J. Tersoff, W. Haensch, Phys. Rev. Lett. 111, 236802, (2013). [2] F Xia, V. Perebeinos, Y Lin, Y Wu, P Avouris Nature Nano 6, 179 (2011). [3] V. Perebeinos, J. Tersoff Nano Lett. 14, 4376 (2014).