Invited Speaker

SELF-EXCITATION IN NANO-ELECTROMECHANICAL SYSTEMS

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In this talk I want to give an overview of mechanically mediated electron transport in nano-electromechanical systems (NEMS). One aspect will cover self-excitation in NEMS: self-excitation is a mechanism, which is ubiquitous for electromechanical power devices such as electrical generators. This is conventionally achieved by making use of the magnetic field component in electrical generators, where a good example are the overall visible wind farm turbines. In other words, a static force, like wind acting on the rotor blades, can generate a resonant excitation at a certain mechanical frequency. This mechanical resonance is then usually transformed into electrical energy.

For nanomechanical systems such a self-excitation mechanism is highly desirable as well, since it can generate mechanical oscillations at radio frequencies by simply applying a DC bias voltage. This is of great importance for low-power signal communication devices and detectors, as well as for nanomechanical computing [1]. For a particular nanomechanical system – the single electron shuttle – this effect was predicted some time ago by & Gorelik *et al.* [2]. Here, we use a nano-electromechanical single electron transistor (NEMSET) to demonstrate first mechanical mixing and then self-[i]excitation for both the soft and hard regime, respectively [3,4]. The ability to use self-excitation in nanomechanical systems may enable the detection of radiation via rectification, the discovery of quantum mechanical backaction effects in direct tunneling, and macroscopic quantum tunneling in NEMS.

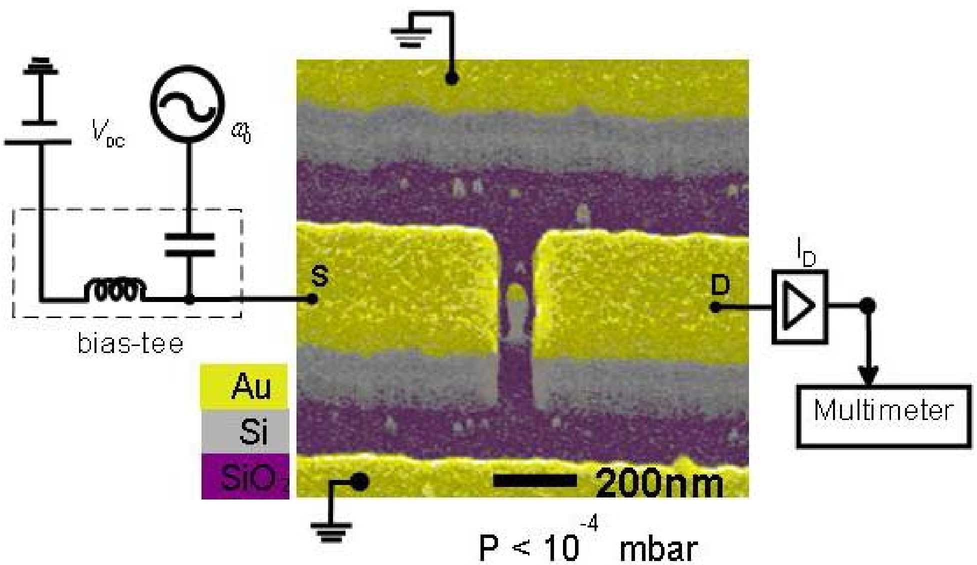

Fig. 1. Nanopillar between source and drain electrode for probing mechanical electron shuttling. The devices are fabricated in silicon-on-insulator materials with a metalized top layer.

References:
[1] Robert H. Blick, Hua Qin, Hyun-Seok Kim, and Robert Marsland, New J. Phys. **9**, 241 (2007).
[2] L.Y. Gorelik, A. Isacsson, M.V. Voinova, B. Kasemo, R.I. Shekhter, and M. Jonson, Phys. Rev. Lett. **80**, 4526 (1998).
[3] H.-S. Kim, H. Qin, M.S. Westphall, L.M. Smith, and R.H. Blick, Applied Physics Letters **91**, 143101(2007).
[4] H.-S. Kim, H. Qin, and R.H. Blick, submitted to Nature Nanotechnology.