A new force sensor for atomic point contacts

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The electrical properties of metallic atomic point contacts have been studied extensively in the past few years. The mechanical properties however, have so far only been studied in a few experiments. But since for a metal the two are closely related, it is very important to have a sensor that allows measuring both properties simultaneously.

We have developed a new sensor to study the mechanical properties, i.e. the spring constant of atomic size contacts. It is a modification of the Mechanically Controllable Break-Junction technique. In this case one side of the metal wire is glued on a quartz tuning fork resonator. A change in the spring constant of the nanowire will result in a change in the resonance frequency of the tuning fork. The nanowire can be contacted electrically in the standard way, thus allowing measurement of the conductance.

In comparison with the techniques that have been used before, which were AFM/STM-measurements, this sensor has a higher stiffness (two orders of magnitude), and thus an increased mechanical stability. Perhaps even more important is the fact that with the (modified) break junction technique all metals can be investigated. This is in contrast to the AFM/STM where only a limited number of metals can be used as tip (and substrate) material, in view of the difficulty of preparing chemically clean surfaces.

We present first results of measurements of the forces in the formation of chains of single metal atoms, where the changeover of individual atoms from the banks into the chain can be observed. Also the forces in the tunneling regime and the jump to contact are investigated.