Measurement of the capacitance across a tunnel barrier

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Abstract

Electronic transport in the process of the formation of nanocontacts between two metallic electrodes can be measured by bringing together two metallic wires made of the same material using different techniques such the Scanning Tunneling Microscope (STM) [1]. Most of the experiments have been focused to measure the conductance of the junctions, however until now very little attention has been paid to other electronic characteristics of this system such as the capacitance[2].
Here we report the measurement of the whole impedance characteristics of a controlled vacuum gap in between two metallic electrodes using a homemade STM. High vacuum and cryogenic conditions are necessary to achieve the desired low mechanic (below 10pm) and thermal noise. Electronics is carefully implemented taking care to reach low electronic noise too. In order to measure the impedance of the atomic junctions, a lock-in amplifier technique has been used.
In our experiments we have observed a decrease of capacitance when the tunnel current is increasing, as predicted by theory[2-4]. On an other hand, we also observe such a decrease in the field emission regime when increasing the applied bias voltage in between electrodes (shown at the figure), and when each field emission resonance state (Gundlach oscillations) takes place. This effect has also been independently observed by the measurement of the forces at the junction by the Tuning Fork technique.

References

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Figures

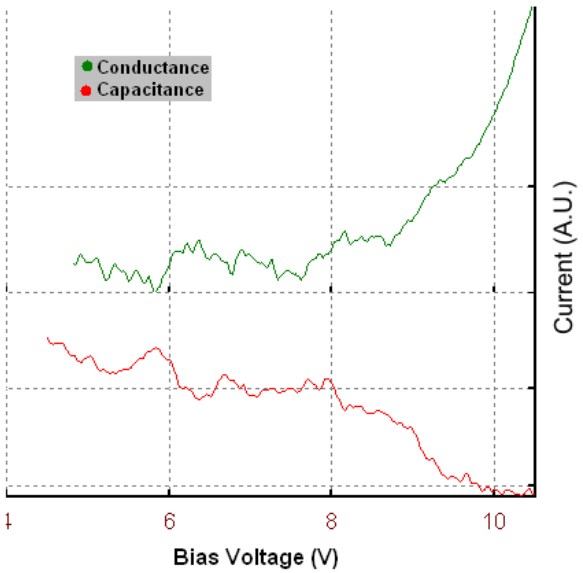

Figure 1.- Au>Au measurements taken at 4.2*K* and cryogenic vacuum using STM where distance between tip and sample is held constant.