Gold and Silicon Microheaters for Nanotube and Graphene Applications

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We present progress in the fabrication of microheaters, designed for possible applications with carbon-based nanomaterials, such as carbon nanotubes (CNTs) and graphene.

The first type of heaters we fabricate, which we call gold heaters, is schematically shown in Fig. 1 (a, b). It consists of a thin gold layer (70nm), on a suspended, non-conductive 350 nm silicon beam. Joule heating is induced upon passing large currents. At the same time the temperature is monitored by measuring the resistance (and using the measured resistance-temperature coefficient of the system). We achieve temperatures up to 600 C. The limit is given by the maximum current density that can be passed through the gold wire (about 0,5*10^9 A/m2).

For the other type of heaters, which we call silicon heaters, the device consists of a highly doped silicon beam covered by an insulating layer of oxide and a thin platinum layer (Fig.2). High current is passed through the silicon to induce heating. The temperature is measured by probing the resistance of the platinum. The advantage of this layout is that Si is mechanically very stable and can sustain high current densities. Also, since it is not suspended, we avoid possible bending of the structure.

The heaters can be integrated with graphene and nanotubes. Using the microheaters it is possible to introduce controlled temperature gradients in suspended nanotubes or graphene. This will be useful for various applications, for instance in nano electromecanical systems (NEMS). As it was reported in the work of Barreiro et al. [1] thermal gradients can induce motion of objects. The movement direction is from the hot to the cold spot. The heaters will also be used to study heat transport and dissipation.

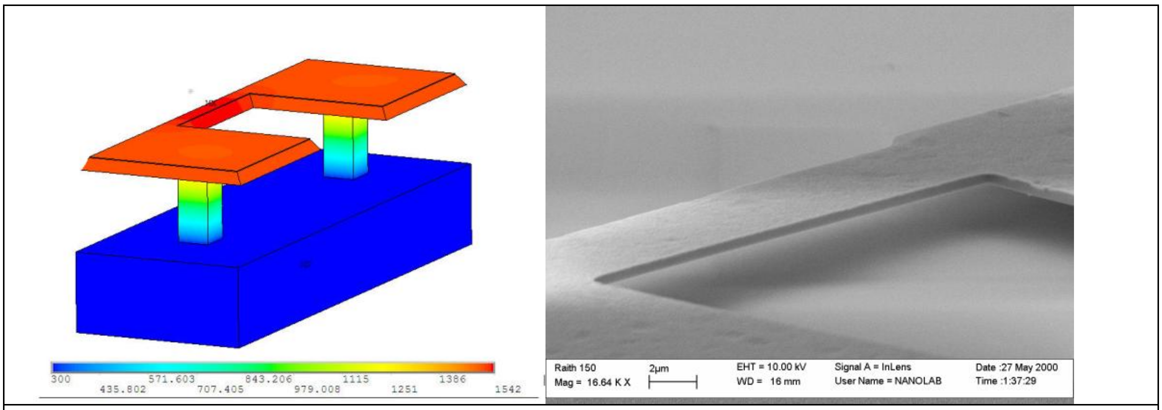

Fig. 1 (a) Schematic of a suspended gold heater. Colour scale for temperature. (b) SEM image of a suspended gold heater.

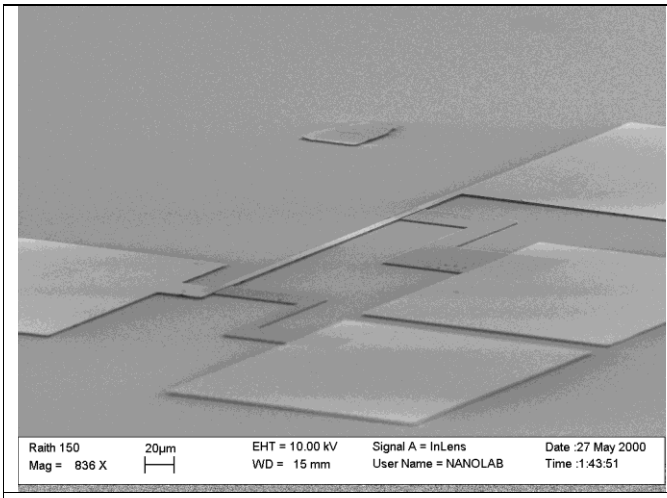

Fig. 2 SEM image of a silicon heater

References

[1] Barreiro et al., Science **320** *(5877) 775*