FisMat2019 - Submission - View

Abstract's title: Investigating simultaneously energy (heat) exchange and surface physics on samples at the nano-scale

Submitting author: Stefano Veronesi

Affiliation: NEST, Istituto Nanoscienze - CNR and Scuola Normale Superiore

Affiliation Address: Piazza S. Silvestro 12, 56127 Pisa

Country: Italy

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Other authors and affiliations: L. Basta (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy), T. Papa (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy), Y. Murata (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy), Z. Dubois (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy), N. Mishra (Center for Nanotechnology Innovation @ NEST, Istituto Italiano di Tecnologia, Piazza S. Silvestro 12, 56127 Pisa, Italy and Graphene Labs, Istituto Italiano di Tecnologia, Via Morego 30, 16163 Genova, Italy), F. Fabbri (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy), C. Coletti (Center for Nanotechnology Innovation @ NEST, Istituto Italiano di Tecnologia, Piazza S. Silvestro 12, 56127 Pisa, Italy and Graphene Labs, Istituto Italiano di Tecnologia, Via Morego 30, 16163 Genova, Italy), S. Heun (NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza S. Silvestro 12, 56127 Pisa, Italy)

Abstract

The family of devices at the micro- or nanoscale is exponentially growing in the last decades, pushing research to develop new experimental techniques to characterise them. In particular, a general method for the direct evaluation of the energy balance of such systems is not available at present. Calorimetry usually requires samples having mass in the 10-100 mg range, while nano-devices range in the ng-mg. Here we report on the development of an original experimental setup able to detect temperature variations as low as 10 mK in a sample of ~10 ng, using a sensitive gold film thermometerwith physical dimensions of 5x5 mm^2 [1]. We have used this technique to measure the enthalpy release during the adsorption process of D_2on a titanium decorated monolayer graphene sample. Ti-MLG has been extensively investigated for application in the hydrogen storage field [2-6], which makes this system a benchmark and a reference.The sensitivity of this thermometer allows to detect a hydrogen uptake of ~10^{-10} moles, corresponding to ~0.2 ng, with a temperature increase of ΔT=0.065 K and an enthalpy release of ~23 μJ. A limitation of the thermometer is the surface roughness, which does not allow atomic resolution with the STM probe. Therefore, we have developed an upgraded version.

Here we present the fabrication, characterization, and calibration of an atomically flat, monocrystalline gold film thermometer on mica substrate [7]. Gold re-crystallization is obtained inside the STM chamber, allowing the successive investigation of the thermometer surface by LEED and with STM imaging. Large gold terraces allow achieving a resolution comparable with atomic dimensions during STM imaging of the surface. Moreover, the gold-on-mica thermometer performs about 10 times better than the previous sensor based on a Si substrate. This work opens the possibility to investigate simultaneously energy (heat) exchange mechanisms and surface physics with the same physical support, opening a unique perspective in understanding physics and chemistry at the nanoscale.

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