Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **2999** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

Surface Conduction Measurement of Si Nanostructures by Ohmic Two Probes in a Multi-probe Scanning Tunneling Microscope

Thursday, 9 June 2022 10:45 (15 minutes)

Improving the characterization of microscopic surface electronic properties is necessary for the miniaturization of electronic devices. Specifically, achieving the ultimate goal of miniaturization, which involves atomic-scale devices such as atomic-scale logic gates [1] and memories [2] composed of dangling bonds on hydrogen-terminated Si surfaces, demands characterization of ultra-small one- and two-dimensional structures.

While imaging, fabricating, and measuring of local electronic properties of these ultra-small structures can be performed with a one-probe scanning tunneling microscope (1P-STM), assessing the electrical conduction properties lateral to the surface requires a two-probe (2P-) and four-probe (4P-) scanning tunneling microscope (STM). The advantage of 4P-STM conductance measurement over 2P-STM is that it can eliminate the probe-to-surface contact resistance and Schottky barrier in semiconductor samples. Yet, it is an arduous task to place four probes into a nano-scale region. Here, we propose a method to solve the considerable contact resistance issue with the 2P configuration [3]. Cleaning tip apices by field evaporation ensured metallic probes that produced linear IV curves on the metallic Si(111)-(7 × 7) surfaces and eliminated the problem of the Schottky barrier. By employing the Ohmic 2P-STM method, we measured the surface conductance on the Si(111)-(7 × 7) surface at low bias voltages that limited conduction through bulk states. Furthermore, we created nano and atomic scale regions on the surface of Si(111)-(7 × 7) and H-Si(100) using STM lithography and measured their conduction properties by utilizing the Ohmic 2P-STM.

References:

[1] T. Huff et al., Nat. Electron. 1, 636 (2018).
[2] R. Achal et al., Nat. Commun. 9, 1 (2018).
[3] J. Onoda et al., ACS Nano 15, 19377-19386 (2021).

Primary author: Dr KHADEMI, Ali (Metrology Research Centre, National Research Council of Canada)

Co-authors: Dr ONODA, Jo (Nanotechnology Research Centre, National Research Council Canada); Prof. WOLKOW, Robert (Department of Physics, University of Alberta); Dr PITTERS, Jason (Nanotechnology Research Centre, National Research Council Canada)

Presenters: Dr KHADEMI, Ali (Metrology Research Centre, National Research Council of Canada); Dr PITTERS, Jason (Nanotechnology Research Centre, National Research Council Canada)

Session Classification: R2-5 Materials Synthesis and Characterization (DCMMP) | Synthèse et caractérisation de matériaux (DPMCM)

Track Classification: Technical Sessions / Sessions techniques: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)