Novel 1D silicon nanoribbons

M. E. Dávila[1], M. Jimenez[2], M, Izquierdo[3], P. de Padova[4], I. Montero[1], J. I. Cerdá[1], J. Sławinska[1], J. M. Gómez-Rodríguez[2,5,6] and G. Le Lay[7]

[1]*Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC, Cantoblanco, 28049, Madrid, Spain*

[2]*Departamento de Física de la Materia Condensada, Universidad Autónoma de Madrid, E-28049 Madrid, Spain*

[3] *European XFEL GmbH, Albert Einstein Ring 19, 22761 Hamburg, Germany*

[4] Consiglio Nazionale delle Ricerche-ISM, Via Fosso del Cavaliere 100, 00133 Roma, Italy

[5]*Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid, E-28049 Madrid, Spain*

[6]*Instituto Nicolás Cabrera, Universidad Autónoma de Madrid, E-28049 Madrid, Spain*

[7]*Aix Marseille Université, CNRS, PIIM UMR 7345, 13397, Marseille, France*

Contact@E-mail mdavila@icmm.csic.es

Abstract

One-dimensional atom-thin Si nanoribbons (1D SiNRs) could be key elements in future high performance devices. Here, we will compare different SiNRs grown *in situ* under ultra-high vacuum on two noble metal substrates with practically the same lattice parameter, namely, Au(110) and Ag(110).

In particular we will address the role of the initial missing row (MR) reconstruction formed spontaneously on the clean bare Au(110)(2×1) template. This reconstruction is washed out upon forming firstly a two-dimensional surface alloy and is followed by the growth of a variety of massively parallel 1D SiNRs aligned along the Au(110) [1-10] direction observed and analysed in high-resolution Scanning Tunneling Microscopy and synchrotron radiation PhotoElectron Spectroscopy, respectively [1].

Instead, the MR reconstruction of the Ag(110) surface is promoted by the adsorption of silicon. The atomically precise SiNRs residing there comprise solely unique alternating Si pentagons in either single strands, 0.8 nm in width upon room temperature preparation, or 1.6 nm wide associated double strands after annealing or preparation at 200°C [2]. They can form by self-assembly a highly perfect (5×2) grating covering the entire surface. It is the first pure pentagonal phase ever found for silicon low-dimensional structures, i.e., a 1D form of pentasilicene. These unique SiNRs with Dirac-like signatures can be detached from the substrate surface by the STM tip [3].

Possible applications of this taxonomy of SiNRs, typically as 1D channels in future transistors, will be discussed.

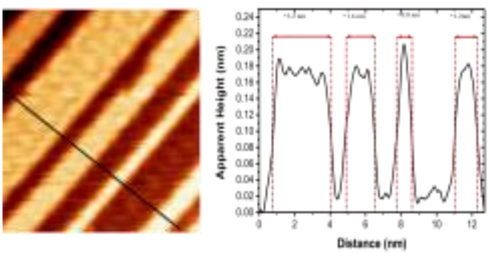
References

[1] M. E. Dávila, M. Jimenez, M, Izquierdo, P. de Padova, J. M. Gómez-Rodríguez, and G. Le Lay, submitted

[2] J. I. Cerdá, J. Sławińska, G.Le Lay, A. C. Marele, J. M. Gómez-Rodríguez and M. E. Dávila, Nature Communication, 7 (2016) 13076

[3] R. Hiraoka, C.-L. Lin, K. Nakamura, R. Nagao, M. Kawai, R. Arafune, and N. Takagi, Beilstein J. Nanotechnol., 8, 1699 (2017)

Figures



Silicon nanoribbons grown within a 2D surface alloy on Au(110)