

## Silicene: first Combined non-Contact Atomic Force Microscopy and Scanning Tunnelling Microscopy Observations

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Silicene is a honeycomb arrangement of silicon atoms forming a new synthetic atom-thin two dimensional honeycomb silicon allotrope. This new silicon structure, which does not exist in nature, has recently generated a very strong interests [1] since it was first grown by silicon deposition on Ag(111) substrates [2]. Silicene first layer synthesis appears now as well recognized by the research community. Recently the research effort has been on the growth of silicene multilayers. Here, we report observations of the two major silicene structures, single layer and double-layer, epitaxially grown on silver (111) surfaces. For the first time they are observed by combining non-contact Atomic Force Microscopy and Scanning Tunneling Microscopy. Comparison of consecutively acquired AFM and STM images reveals the dominant role of geometry over electronic effects, typically, in the appearance of the archetype single silicene layer, which is  $3 \times 3$  reconstructed ( $4 \times 4$  supercell in terms of Ag(111)). We further establish that the following  $\sqrt{3} \times \sqrt{3} R(30)$  silicene reconstruction ( $4/\sqrt{3} \times \sqrt{3} R(30)$  with reference to Ag(111)) is observed upon further silicon deposition, stems from the second layer grown, thus suggesting the existence of bi-layer silicene. We also extend the interpretation of the Ag(111)  $\sqrt{7} \times \sqrt{13} R(13.9)$  reconstruction [3], recognizing the four domains arising from the rotational epitaxy of first layer  $\sqrt{7} \times \sqrt{7} R(19.1)$  honeycomb domains in coincidence with the silver superstructure, therefore suggesting that also this arrangement might effectively belong to silicene.

[1] M. Xu et al., *Chemical Reviews* 10.1021/cr300263a (2013).

[2] P. Vogt et al., *Phys. Rev. Lett.* **108**, 55501 (2012).

[3] C.L. Lin et al., *Appl. Phys. Exp.* **5**, 045802 (2012).