

Carborundene: sp^2 bonded carborundum



Principal investigators

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Two-dimensional (2D) crystals of ultimate thinness possess properties which qualitatively contrast from those of their bulk counterparts. The recent discovery of various such materials, including graphene and transition metal dichalcogenides, have seeded the concept of fully 2D photonics, spintronics and micro/nanoelectronics. Carborundene, a new silicon carbide polymorph with structure akin to graphene, is predicted to be stable. The project aims at demonstrating the synthesis of this wide band-gap 2D semiconductor, which is envisioned as a building block in optoelectronics heterostructures.

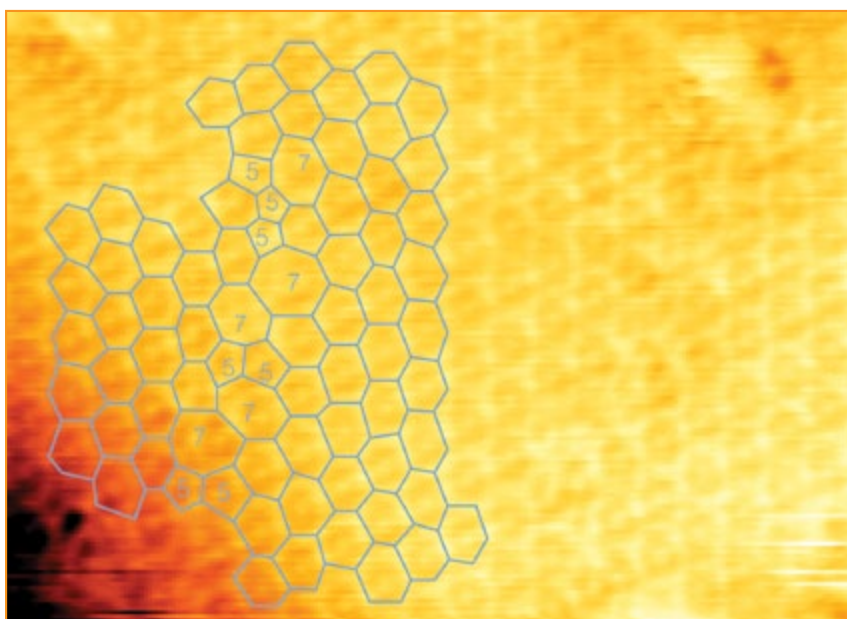
Description

The preparation of carborundene is challenging, since it is not the only stable structure silicon and carbon can form together and separately. Hence synthesis strategies that select the proper reaction pathway must be chosen. Inspired by the only report of sp^2 SiC growth to our knowledge, in the form of nanotubes, we plan to explore the reaction between ultrathin, flat silica and a carbon feedstock.

Accordingly the first part of the PhD project has focused on the preparation of silica layers with the proper amount of silicon for carborundene formation, i.e. monolayer 2D silica, another 2D crystal recently discovered.

Surface science investigations, combining scanning tunnelling microscopy, electron diffraction, and density functional theory calculations, have allowed us to control the growth of this material on ruthenium. This detailed study has unveiled the fine structure of 2D silica, the nature of its defects (see Figure) and the mechanisms driving their formation. Such knowledge is a key in view of the further controlled growth of carborundene, and also gives rich insights concerning 2D silica itself.

Forthcoming work will address the interaction of 2D silica with carbon, provided from either gas phase or temperature-induced surface segregation of a carbon-enriched substrate.



Scanning tunnelling topograph ($6 \times 9 \text{ nm}^2$) of a monolayer of silica arranged in a honeycomb lattice, and structure of the grain boundary between two silica domains shifted laterally by 2.74 \AA .

Outcomes: S. Mathur et al., Domain formation in crystalline monolayer silica, article in preparation. ANR Project " OH-RISQUE 2DTransformers " accepted for funding in 2015.

Award: Best poster award at European Materials Research Society Spring Meeting - May 2015 in Lille, France "Formation of Anti-phase domain boundaries in two-dimensional silica via transformative recrystallization" S. Mathur, S. Vlaic, E. Machado-Charry, E. Hadji, P. Pochet, J. Coraux

Collaborations : A. Locatelli (ELETTRA - Sincrotrone Trieste, Italy) for low-energy electron microscopy and G. Renaud (INAC) for synchrotron X-ray diffraction experiments.