Master thesis proposal

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Director: Max Marangolo

Title: Exotic 2D lattices with Sn

Keywords: 2D materials, epitaxy, structure, growth, STM, SXRD

Scientific description: Theoretical studies have shown that new physical properties such as tunable gap opening or quantum spin Hall effect could be expected from group IV graphene analogues (silicene, germanene, stanene) [1]. For example honeycomb silicene layers have been identified on various Ag surfaces [2], and growth of honeycomb stanene has been achieved on Cu(111) at low temperature. On the other hand, theoretical research on the topological properties of 2D materials has expanded to other families of lattices, such as Kagome, Su–Schrieffer–Heeger or Lieb lattices (see Fig).

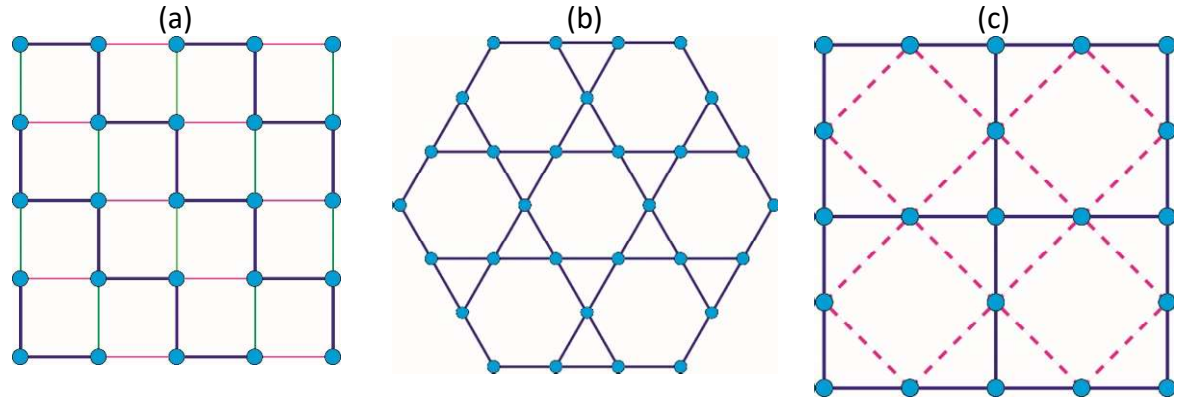

Fig.. a) 2D SSH lattice. b) Kagome lattice. c) Lieb lattice. Continuous lines correspond to Nearest Neighbour bonds, of different values schematized by line color. Dotted lines correspond to next nearest neighbour bonds.

For the realization of such novel lattices, Sn appears as a promising material, since bulk Sn exists as two allotropes. Using Surface X-ray diffraction experiments at SOLEIL synchrotron, we have evidenced several complex phases obtained by evaporating Sn on Cu and Ag surfaces. The aim of the internship is to follow in situ and in real-time with scanning tunneling microscopy (STM) the deposition of tin on such Ag and Cu surfaces to determine the relation between substrate symmetries and film structure. For this purpose, real-time STM experiments [3] will be performed during Sn evaporation at various temperatures. The objective is to determine, using SXRD results already obtained and STM results, the structure of these novel 2D materials.

[1] S. Cahangirov, M. Topsakal, E. Aktürk, H. Şahin, S. Ciraci, Phys. Rev. Lett. 102, 236804 (2009)
[2] L. Masson and G. Prévot, Nanoscale Adv. 5, 1574 (2023)
[3] K. Zhang, R. Bernard, H. Cruguel, Y. Borensztein, G. Prevot, Phys. Rev. B 102, 125418 (2020)

Techniques/methods in use: Scanning tunnelling microscopy, Surface X-ray diffraction at synchrotron, Low Energy Electron Diffraction
Applicant skills: Scientific curiosity, knowledge of condensed matter physics
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Internship location: Campus Pierre et Marie Curie, Tower 22 – 4th floor, 22-12, 403
Possibility for a Doctoral thesis: Yes