The growth and characterization of 2D-materials beyond graphene: silicene, germanene and hexagonal boron-nitride

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Abstract:

Since the beginning of this decade several research groups have focussed on 2D-materials beyond graphene. Group-IV elements as silicon and germanium are intuitively suitable candidates. Silicene and germanene are in many aspects very similar to graphene, but in contrast to the planar graphene lattice, the silicene and germanene honeycomb lattices are buckled and composed of two vertically displaced sub-lattices. We have used low energy electron microscopy to directly visualize the formation and stability of silicene layers on a Ag(111) substrate. Theoretical calculations call into question the stability of this graphene-like analog of silicon. We find that silicene layers are intrinsically unstable against the formation of an "sp3-like" hybridized, bulklike silicon structure. The irreversible formation of this bulk-like structure is triggered by thermal Si adatoms that are created by the silicene layer itself. To add injury to insult, this same instability prevents the formation of a fully closed silicene layer or a thicker bilayer, rendering the future large-scale fabrication of silicene layers on Ag substrates unlikely. In this talk we will (1) address the various methods to synthesize germanene (2) provide a brief overview of the key results that have been obtained by density functional theory calculations and (3) discuss the potential of germanene for future applications as well for fundamentally oriented studies. However, the growth of the 2D-materials does not always lead to the freestanding properties that are rather desired. To overcome this problem, one needs an approach to electronically decouple the 2D-material from the substrate. One approach is to use a two-dimensional insulating material like hexagonal boron-nitride. The growth of hexagonal boron-nitride on Ir(111) has been studied by LEEM and are addressed in this presentation.