Black-phosphorous-like bismuthene and antimonene in topological van der Waals heterostructures

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The experimental investigation of topological materials has been a highly active research field for more than a decade. One of the earliest confirmed topological materials was the $Bi_{1-x}Sb_x$ alloy [1]. Subsequently, bismuth-(111) bilayers [2] were reported to be topologically nontrivial, as well as atomically thin black phosphorous-like (110)-oriented alpha-bismuthene [3] and even bulk bismuth [4]. The (111)-oriented antimonene, on the other hand, is a trivial semiconductor that potentially becomes nontrivial only under substantial strain [5].

There is significant interest in these 2-dimensional topological materials as they could be combined with other functional materials in specifically tailored van der Waals heterostructures in which they retain their characteristic properties due to the weak interaction. Moreover, when combining these ultrathin sheets of material moiré patterns can arise due to different lattices and rotation angles. Such moiré patterns can have a marked effect on the electronic band structure [6] and constitute yet another way to tune the properties of the heterostructure.

When growing atomically thin Sb on top of alpha-bismuthene nano-islands [7,8], it forms the known (111) phase, as well as (110)-antimonene which has not been experimentally studied before. Also, moiré patterns emerge inevitably on both antimonene phases. We present our joint study [9] of alpha-antimonene, in which we combined scanning tunnelling microscopy experiments and DFT calculations. Our results show that this new material is topologically nontrivial. Geometric modelling of the layers is used to understand the moiré patterns and support the determination of the lattice parameters.

References:
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