Morphology control and electrical characterization of free-standing InSb nanostructures

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Research interest in indium antimonide (InSb) has increased in recent years thanks to the possibility to overcome the limitation of its integration with lattice-mismatched materials in nano-heterostructures and the consequent opportunities to realize novel quantum devices. Hence, the precise control over morphology and crystalline quality becomes of paramount importance for applications in quantum technology. Here, we show the growth of InSb nanostructures on InAs and InP nanowire stems without any pre-growth effort (patterning). InSb nanostructures such as nanowires (1D), nanoflags (2D), and nanocubes (3D) have been realized by means of Au-assisted chemical beam epitaxy by tailoring the growth parameters like growth temperature, precursor fluxes, sample rotation, and substrate orientation[1]. Through morphological and crystallographic characterization, all the as-grown InSb 2D nanostructures are found to be single-crystalline with zinc blende structure. The existence of two families of 2D nanostructures, characterized by an aperture angle at the base of 145° and 160°, is observed and modelled. Furthermore, we have optimized the morphology of these free-standing 2D InSb nanoflakes. In particular, using tapered nanowire stems and precisely orienting the substrate with the help of reflection of high-energy electron diffraction (RHEED) patterns, we could maximize length and width and minimize the thickness of these nanoflakes[2]. The resulting flakes are large enough to precisely study their electrical characteristics. An electron mobility of ~29,500 cm^2/Vs is measured at 4 K, which is the highest reported value for InSb flakes in literature[3-5]. This study provides useful guidelines for the controlled growth of high-quality InSb nanostructures with different shape and envisions the use of 2D InSb flakes for fabrication of novel quantum devices.

References

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