# Free-standing InSb nanoflags for quantum device applications

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Indium antimonide (InSb) offers a narrow band gap, high carrier mobility, and a small effective mass, and has attracted tremendous attention in recent years for the implementation of topological superconducting states. However, high quality heteroepitaxial two-dimensional (2D) InSb layers are difficult to realize owing to the large lattice mismatch with other widespread semiconductor substrates. A solution to this problem is to grow free-standing single-crystalline 2D InSb nanostructures, so-called nanoflags (NFs) [1, 2]. In this contribution, we show the growth of free-standing InSb NFs on InP nanowire (NW) stems by means of Au-assisted chemical beam epitaxy. By employing tapered NW stems and precisely orienting the substrate with the help of reflection high-energy electron diffraction (RHEED) patterns, we could maximize length and width, and minimize the thickness of the NFs, as shown in Fig. 1a [1]. In fact, the InSb shape evolution is a result of the interplay between the axial vapor-liquid-solid growth and a directional vapor-solid radial growth [2]. By employing regular arrays of Au islands deposited on pre-patterned substrates covered with a $SiO_2$ mask, we could also analyze more in detail and model the growth mechanisms.

The optimized InSb NFs have been used to make Hall-bar devices from which we measured an electron mobility of 29,500 $cm^2/Vs$ and a mean free path of 500 nm at 4.2 K (see Fig. 1b), which is the highest value reported for free-standing 2D InSb NFs in literature. We have also successfully fabricated ballistic Josephson junction devices with 10/150 nm Ti/Nb contacts that show gate-tunable proximity-induced supercurrent (∼ 50 nA at 250 mK at 30 $V_{bg}$, see Fig. 1c) [3]. The devices also show clear signatures of subharmonic gap structures, indicating phase-coherent transport in the junction and a high transparency of the interfaces. Our study places InSb NFs in the spotlight as a versatile and convenient 2D platform for advanced quantum technologies.

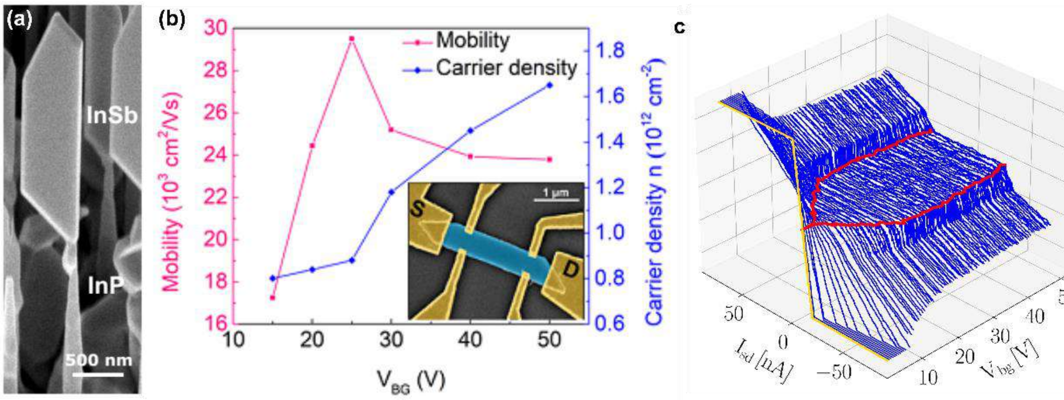

*Fig. 1: (a) 45° SEM image of free-standing InSb NF. (b) Hall mobility and carrier density obtained from Hall measurements. Inset shows the SEM image of an InSb NF Hall-bar device. (c) Voltage drop $V_{sd}$ across an InSb-based Josephson junction versus current bias $I_{sd}$ and back gate voltage $V_{bg}$. The red line indicates the critical current.*

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