Elucidating the Structural and Electronic Properties of Solution-Synthesized 2D SnS Crystals

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The vast majority of nanoscale 2D materials are synthesized by exfoliation or gas phase deposition techniques. Alternatively, bottom-up colloidal solution syntheses offer a scalable and cost-efficient means of producing 2D nanomaterials in high yield. However, routinely characterizing solution-based nanomaterials properties remain a substantial challenge due to their dimensions and the pervasive presence of surface-adsorbed stabilizing ligands. Here we present the synthesis of 2D tin sulfide (SnS) nanomaterials and a thorough spectroscopic investigation of the inherent structural and electronic properties of the crystals. First, we detail the development of a novel bottom-up, solution-based synthetic approach to produce nearly-monodisperse colloidal 2D metal chalcogenides of varying size and morphology (Fig 1) that can be fabricated into solid state devices (Fig 2). We then employ a variety of spectroscopies, ranging across the electromagnetic spectrum from X-ray to terahertz, to probe the crystallographic and electronic structure of the crystals, as well as carrier transport phenomena. These studies allow us to develop structure-property relationships among 2D materials of disparate size, morphology, and surface ligand composition when considering variances in measured band energies, interatomic vibrations, oxidation states, photoconductivity, and charge carrier mobility.

References


Figures

Figure 1: SEM image of solution-synthesized 2D SnS semiconductor nanoribbons.

Figure 2: Optical image of a device fabricated from a single solution-synthesized nanoribbon.