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.[1,2] 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

[1] Biacchi, A.J.; Vaughn, D.D.; Schaak, R.E., J. Am. Chem. Soc., 135 (2013) 11634-11644.
[2] Alberding, B.G.; Biacchi, A.J.; Hight Walker, A.R.; Heilweil, E.J., J. Phys. Chem. C, 120 (2016) 15395-15406.

Figures

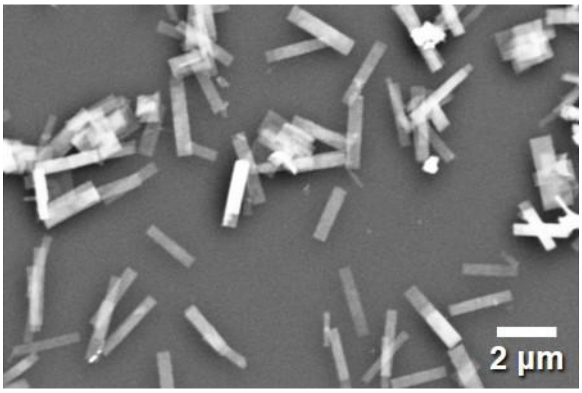

Figure 1: SEM image of solution-synthesized 2D SnS semiconductor nanoribbons.

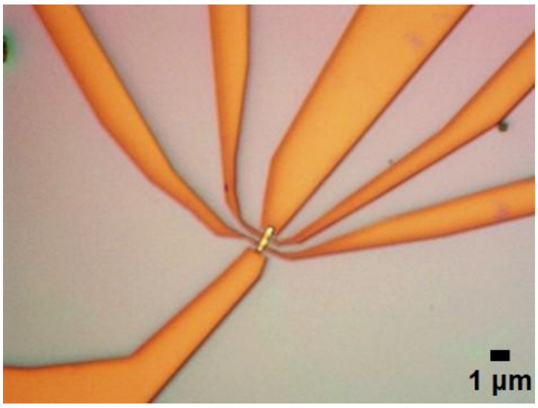

Figure 2: Optical image of a device fabricated from a single solution-synthesized nanoribbon.