

Thioglycolic acid assisted hydrothermal growth of SnS 2D nanosheets as catalysts for photodegradation of industrial dyes

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Abstract

We present our work on the rapid hydrothermal synthesis of highly crystalline 2D SnS nanostructures. An innovative idea is used in which thioglycolic acid is the sulfur precursor source. Structural studies indicate the material has grown in a single-phase orthorhombic structure. The single-phase formation of the material is also confirmed from the rietveld refinement of the experimental XRD data and by raman spectroscopic analysis. Morphological studies show the formation of 2D sheets having thickness in the nanoscale (100–150 nm) dimensions. Optical absorbance studies show the material is visible-light active exhibiting an indirect bandgap of 1.1 eV and direct band gap ~ 1.7 eV. Density functional theory calculations support the experimental bandgap results. Photocatalytic activity of the nanosheets was investigated against methylene blue (MB), rhodamine B (RhB) and methyl orange (MO) dyes employing a solar simulator as the source of photons (light source). The nanosheets were found to photodegrade 80% of MB, 77% of RhB and 60% of MO in 120 min of light illumination. Reusability and post catalytic properties affirm the durability and stability of the nanosheets, which is very important in the context of waste water treatment considering the toxic nature of the effluents from dye industries.

Keywords: thioglycolic acid, 2D sheets, single orthorhombic phase, hydrothermal synthesis, rietveld refinement, photodegradation

(Some figures may appear in colour only in the online journal)

Introduction

Efficient utilization of solar energy has always been a challenge and nanotechnology has provided better solutions. Nanotechnology is an interdisciplinary area of research involving synthesis, characterization and applications of nanomaterials. As far as the efficient use of solar energy is concerned, metal chalcogenide nanostructures are playing a leading role serving as promising absorbing materials for solar cell applications and as photocatalysts [1–11]. Due to their unique electrical, optical and mechanical properties, such nanostructures are being studied intensively for diverse applications in photovoltaics [1, 2, 8, 10–14], photocatalysis

[3, 5, 7, 9], supercapacitors [13], light emitting diodes [14], spintronics [15], etc. When it comes to conversion of solar energy into more usable energy forms by the nanostructures, the shape and size of the nanostructures play an important role. With the discovery of grapheme, 2D nanostructures received lots of attention due to their exceptional physical properties and numerous promising applications, including those of photocatalysis [16–21]. The enhanced catalytic nature of the 2D materials is verified by the presence of numerous active edges and inert basal planes [19]. The atoms present at the edges behave differently than the atoms present at the basal planes and hence show better tendency for coordination. 2D metal chalcogenides are emerging as an