Title:	Defect-rich, negatively-charged SnS2 nanosheets for efficient photocatalytic Cr(VI) reduction and organic dye adsorption in water
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Abstract:	Nanostructures of layered materials have gained increasing attention in photocatalytic and water-treatment processes. Herein, we report on sub-30 nm SnS2 nanosheets (NSs) which can perform photocatalytic reduction of Cr(VI) to Cr(III) quite efficiently on one hand, while removes large quantities of toxic organic dye molecules by choosing an adsorption mode of operation over photo-degradation on the other hand, unlike most other SnS2 nanostructures. The NSs have a highly extended crystallinity growing perpendicular to the (0 0 1) lattice direction but exhibit poor X-ray diffraction for the 10 l (1 = 1,2,3…) lattice planes. With such defects, the NSs have a narrow bandgap of 2.21 eV and exhibit a significant photocurrent density at near band-edge illumination. Cr(VI) photo-reduction using the SnS2 NSs follows a first-order reaction kinetics (rate constant of 0.10 min-1), five-fold higher than commercial TiO2 (P-25). Furthermore, the NSs adsorb Rhodamine B dye molecules from an aqueous solution by forming a monolayer of dye molecules following a pseudo-second-order kinetic model and exhibit an adsorption capacity of ~ 53.28 mg/g. We show that the NSs have a Zeta potential of ~ –22 eV and preferably adsorb cationic dyes only. Thus the SnS2 NSs can be effective for Cr(VI) contaminated waste-water treatment in a photocatalytic manner and can also act as a potential adsorbent for polluting dye molecules either in the presence or absence of sunlight. While both these activities are known for SnS2 as well as other materials, the competitive nature of the two mechanisms while each of them is a possibility has never been investigated. Therefore, besides the high activities, the study highlights the presence of different active sites on the material surface that can respond preferentially to either inorganic or organic impurities.
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