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Editorial

Nanostructured Crystalline Semiconductors: Structure, Morphology and Functional Properties

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Nanotechnology has contributed a lot to the development of the semiconductor industry. Downsizing semiconductor materials toward nanoscale gives rise to the advent of intriguing physical and chemical properties that are not observable in the bulk state. The most compelling issue in this regard is the improvement of functional properties on the fine tuning of the nanoscale structure and morphology. This special issue aimed at compiling the state-of-the-art advancements, in terms of controllable synthesis methods, characterization techniques, and functional properties of crystalline nanostructured materials.

One of the strategies used to downsize bulk materials to nanoscale is exfoliation. It works for layered materials. Not all crystals form atomic bonds in three dimensions; there are families of materials with layered structures. This means that the in-plane atoms are connected via strong chemical bonding, and the stacking layers are combined via a weak van der Waals interaction. These weak interactions are easily exfoliated. C. D. Berardino et al. [1] reported controlled liquid exfoliation of 3D graphite to 2D graphene nanosheets through a mixed approach of shear mixing and tip sonication. Through such a mixed approach, the average lateral size was controllably tuned without considerable damage. Another 2D material that caught copious attention is MoS_2. The work by G. Solomon et al. [2] compares the synthesis methods for crystalline MoS_2 nanosheets. Two synthesis methods (hydrothermal and microwave) were considered. The comparison was made in terms of morphology, crystal structure, and catalytic activity toward a hydrogen evolution reaction (HER) in 0.5 M H_2SO_4. Accordingly, the microwave method delivers nanosheets of MoS_2 within 30 min, while the hydrothermal method takes 24 h. The nanosheets obtained by the microwave method show thin and uniform morphology, whereas those obtained by the hydrothermal method exhibit a more crumpled structure with a short-range order. Owing to the presence of defects in the crumpled structure, the hydrothermally grown MoS_2 outperforms that of the MoS_2 grown by the microwave method in catalyzing HER.

Controllable synthesis of nanostructured materials greatly helps in tuning photon absorption properties, and, hence, designing any relevant application. M.Liue et al. [3] described a solution-based synthesis of sulvanit (Cu_3TaS_4 and Cu_3TaSe_4) nanocrystals with optical band gaps of 2.54 and 2.32 eV, respectively. They optimized the reaction conditions to down-size the crystals toward nanoscale while preserving the parent cubic feature. It is worth noting another band gap of engineering work by R. Carcione et al. [4]. They synthesized CdTe quantum dots (QDs) by decomposing cadmium isostearate in the presence of trioctylphosphine telluride. The obtained QDs exhibited tunable photoluminescent properties in the range of 70 nm (from green to red).

Moreover, the computational work reported by Taoreed O. Owolabi et al. [5] is also stunning. This work focuses on developing a model to simulate the effect of doping on the band gap of bismuth ferrite ($BiFeO_3$). It showed that doping results in lattice distortion. Hence, they employed a support vector regression algorithm that was hybridized with a gravitational search algorithm, using crystal lattice distortion as a predictor. This algo-

Citation: Shifa, T.A. Nanostructured Crystalline Semiconductors: Structure, Morphology and Functional Properties. *Crystals* **2021**, *11*, 736. https://doi.org/10.3390/cryst11070736

Academic Editor: Shujun Zhang

Received: 18 June 2021
Accepted: 21 June 2021
Published: 25 June 2021

rithm predicts the energy band gap of doped bismuth ferrite with excellent accuracy and estimation capacity.

This special issue, therefore, covers intriguing research fields encompassing both experimental and theoretical works in the area of controllable synthesis, and the characterizations and functional properties of nano structured crystalline materials. It not only summarizes the current development in the field, but also paves the way for future research.

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