2D colloidal semiconductor nanomaterials: structure design and applications

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During the last decade two dimensional (2D) inorganic nanostructures have attracted a special attention owing to a number of unique properties which can make a valuable addition to those discovered in graphene. Among different preparation routes to 2D nanomaterials, wet chemical colloidal synthesis offers several advantages, such as a simplicity of the synthesis setup, a possibility of formation of free standing nanosheets which makes them easy to be processed into solids via common solution-based techniques (spin (dip)-coating, drop-casting, inkjet printing, etc.) [1]. Hence, these structures can find a range of commercial applications as building blocks for inexpensive manufacturing of low cost and large area electronic and optoelectronic devices.

In this work we present three main 2D nanomaterials synthesized using a facile colloidal approach. Among them CdSe nanoplatelets, which currently are being intensively investigated due to their unique optical properties. Since it is not a trivial task to tune their photoluminescence because of their well-defined thickness, we have employed a precise shell engineering by means of colloidal atomic layer deposition. This design allowed not only for a precise control of the optical properties in a wide range, but also for a diverse surface functionalization of the particles. Another member of the selenide family studied in this work is CuSe which crystallized into the klockmannite phase. These as-synthesized nanosheets have been processed into thin films via a simple drop-casting yielding conducting flexible coatings [2]. We demonstrated advantages of these films compared to reference films prepared from spherical nanoparticles made of a similar material. In addition, 2D nano-$Bi_2Te(Se)_3$ obtained in the framework of this study was characterized as a thermoelectric material being sintered into bulk pellets. These thermoelectrics exhibited excellent performance owing to their shape and structure design. Overall, this work provides additional values of semiconductor nanomaterials possessing 2D shape.

1) M. Nasilowski *et al.*, *Chem. Rev.* **2016,** *116*, 10934.
2) S. Vikulov *et al.*, *Adv. Funct. Mater.*, **2016**, *26*, 3670.