SEEDED GROWTH APPROACH FOR SYNTHESIS OF SEMICONDUCTOR NANOTETRAPODS

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A step forward in the shape control of colloidal nanocrystals is the generation of inorganic nanostructures with deliberately designed branching. The most basic branched crystal is a tetrapod that is formed when four wurtzite-phase arms grow out of four equivalent facets of a zinc blende nanocrystal core. The formation of tetrapods has recently been reported for several II–VI semiconductors,[1-10] because they exhibit zinc blende–wurtzite polytypism. Indeed, their lattice has a common crystal plane, which can be used to achieve branching. The [111] plane of the cubic zinc blende lattice structure is atomically identical to the ±[0001] plane of the wurtzite structure.
In order to form the tetrapods it is possible to separate the nucleation and growth processes by seeded growth approach. According this method preformed nuclei in zinc blende phase are added to the reaction mixture, followed by the growth of the arms in wurtzite structure. In fact the balance of the nucleation and growth processes in a one-pot reaction is hardly achieved and leads to high sensitivity on small variations in reaction conditions.
Talapin and co-workers[11] demonstrated that seeded growth of nanocrystals offers a convenient way to design nanoheterostructures with complex shapes and morphologies by changing the crystalline structure of the seed.
In this contribution, we present a step in this field, demostrating that the seeded growth approach is easily extendible to other combinations of materials. Here, we demonstrate its viability to the synthesis of tetrapod-shaped heterostructures with ZnTe core and CdX (X=S, Te, Se) arms. In addition, by the same approach, we are able to synthetize tetrapods nanocrystals with CdSe as core and CdTe arms. These strategies of synthesis permit to obtain tetrapods with significantly narrow distribution of arm lengths and diameters; in addition, it is possible to tune the size of nanocrystals by changing several reaction parameters.
These heterostructures present a type II character (staggered band), that leads to the formation of an indirect exciton. The relative energy offset can be tuned by controlling the size of the core and the arms, which should allow the further exploitation of these nanocrystals in potential application such as photovoltaic devices.

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Figure: TEM images of tetrapod shaped nanocrystals formed by seeded growth approach.