Cation exchange reactions enabled efficient heterovalent-doping: the novel strategy for dopant induced optical and electronical properties tailoring in nanocrystals

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Substitutional heterovalent doping represents an effective method to control the optical and electronic properties of colloidal nanocrystals (CNCs). Recently, cation exchange reactions became a good way to introduce the dopant into CNCs matrix. Even so, different cation exchange processes also lead to different dopant-related behaviours. Herein, we take a new cation exchange process (Figure 1) to get M^+ doping in CdX NCs, namely the cation exchange between M^+ in an amorphous/crystalline M_2X matrix (where M is a metal and X means chalcogen) and Cd^{2+} in solution. Taking advantage of different kinds of phosphine initialized such cation exchange reactions, the heterovalent dopant engineering with controllable, deep substitutional monovalent dopants have been realized successfully.

Steady-state UV-NIR absorption, PL spectra, and time-resolved carrier kinetics characterizations have verified the stable, dominant, and strong dopant fluorescence. The control of n- and p-type electronic impurities in CdX NCs has been realized. Large-scale bottom-up superlattices of the resultant NCs and their dispersion into PMMA bulk solid will hasten their subsequent device applications.

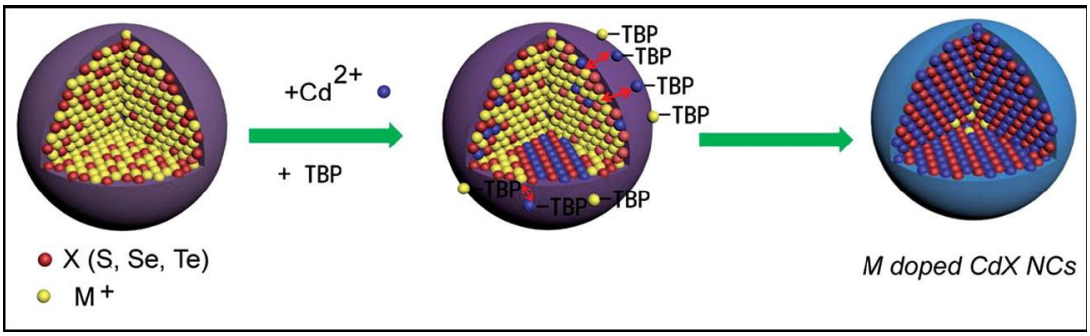

Fig. 1 Schematic illustration of the preparation process to achieve deep monovalent doping in II−VI NCs.

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