

Nanocrystals free of toxic elements are being pushed to the forefront of nanoscience research because of their environmentally friendly advantages and attractive photophysical properties on recent advances in colloidal synthesis, excellent optical properties, optoelectronic device applications, and biological applications. In this context, the first topic in this paper introduces group IV semiconductors. In particular, the unique light emitting properties generated in silicon nanocrystals of diameters smaller than Bulk exciton Bohr radius are highlighted. Next the topic turns to the nanocrystals of group III-V semiconductors. After that, attentions are paid to the lead-free perovskite nanocrystals with double perovskite structures. Recent efforts on how to control nanostructures to enhance photoluminescence quantum yields is highlighted for each semiconductor nanocrystal. Finally, the remaining challenges that must be overcome to realize nontoxic optoelectronic devices will be discussed.