Nonlinear optical properties of colloidal quantum dots for luminescence-based sensor applications

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Quantum dots (QDs) are widely used in research and industrial fields due to their exceptional optical and electronic properties, which can be tailored by adjusting size (resulting in size-dependent optical and electronic properties due to quantum confinement) and chemical composition of these nanomaterials. Over the years, many research groups have focused on discovering improved third-order nonlinear optical (NLO) materials that could support developing applications in laser technology, telecommunications, and biophotonics [1]. In this work, we quantitatively demonstrate that colloidal QDs are capable of exhibiting a nonlinear optical response across a broad spectral wavelength range [2,3]. Our findings highlight the potential of this nanomaterial for use as a two-photon–excited luminescence sensor for detecting metal ions, including heavy metal ions [4]. The nonlinear absorption properties are present as appropriate cross sections (σ_2), given in Goeppert-Mayer unit (GM) normalized per molecular weight which allows comparison of the NLO properties of the studied QDs with various nanosystems or organic dyes.

All investigated nanomaterials exhibit notable optical properties suitable for optical sensing applications in both one- and two-photon regime. The findings of the study also underscore the promising outlook for employing novel and emerging cadmium-free QDs in various fields, including bio-related ones, as they could be an interesting alternative to nonlinear absorbers currently used, for example, as markers for nonlinear microscopy.

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