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Synthesis and bioanalytical applications of nanostructures multiloaded with quantum dots

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HIGHLIGHTS

- Nanostructures loaded with multiple quantum dots improve sensitivity
- Assembling multiple quantum dots in one label simplifies their bioconjugation
- We summarize strategies to create multiloaded labels and to control their properties
- The review includes examples of applications for each multiloaded label

ABSTRACT

This review focuses on selected examples of multiloaded quantum-dot (QD) nanocomposites as novel concepts and promising labels for bioimaging and analysis. As bright, excellent, 10-nm-sized labels, providing high-intensity signal, QDs can reach higher levels when multiloaded into a single biocompatible nanocontainer. QD-containing nanocomposites combine the properties of both materials (i.e., luminescent and electrochemical characteristics of the entrapped QDs and permeability, solubility, reactivity or biocompatibility of the carrier). Approaches described include multiple QD-containing nanocomposites with different carriers – organic (dendrimers and layer-by-layer hollow microcapsules), inorganic (carbon nanotubes and silica nanoparticles) and of a combined nature. We also consider and discuss promising applications in bioanalysis.

Keywords:

Bioanalysis
Bioimaging
Biolabeling
Enhanced label
Immunoassay
Multifunctional particle
Nanoparticle
Nanostructure
Quantum dot
Synthesis

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1. Introduction

Nanotechnology, one of the cutting-edge technologies of the twenty-first century, is multidisciplinary and interdisciplinary and covers many fields, including chemistry, physics, material sciences, engineering, biology, and even medicine. One major merit of using nanotechnology is that one can control and tailor properties in a very predictable manner to meet the needs of specific applications. A huge effort has been expended in assay development, particularly immunoassay development, to simplify the assay process while preserving the essential benefits of sensitivity, robustness, broad applicability, and suitability for automation.

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