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Functional Coatings for X-ray Fluorescent Nanoparticles

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Extended Abstract

In recent years, the design and synthesis of bio-compatible coatings leading to hybrid nanoparticles (NPs) as the contrast agents have gained substantial relevance. Furthermore, the addition of several functionalities for bio-imaging applications represents a key step for non-invasive bio-diagnostics. In this context, we design and utilize hybrid nanostructures for X-ray fluorescence computed tomography (XFCT). The combination of a ceramic or metallic core – based on MoO_2, Rh or Ru – with a protective shell allows the generation of bio-compatible nanohybrids for dual mode bio-imaging, where the core NPs constitute the X-ray fluorescence (XRF) contrast agents [1]–[3]. Core NPs are synthesized *via* polyol, hydrothermal or microwave-assisted hydrothermal methods, yielding uniform shape and high dispersibility in aqueous media.

Different approaches have been pursued for the fabrication of a bio-compatible shell coating. A modified sol-gel based silica coating process, doped with a commercial fluorophore (Cy5.5), was developed and shown to be applicable to both ceramic and metallic NPs [4], forming core-shell NPs with both optical and X-ray fluorescence properties.

Alternatively, carbon quantum dots (CQDs) were synthesized *via* citrate pyrolysis using microwave-assisted hydrothermal method, exhibiting uniform size distribution (1.6 ± 0.4 nm) and excitation-independent emission (440 nm). Conjugation of these CQDs, *via* cross-linking, with Rh NPs led to excitation-independent hybrid NPs, with a red-shifted emission wavelength (520 nm), attributed to the reduction of pyrrolic nitrogen on CQDs [5].

These hybrid NPs exhibit improved *in vitro* biocompatibility in comparison with bare XRF contrast agents. Furthermore, the optical fluorescence – provided by Cy5.5 or CQDs – allows the localization of the NPs in the intracellular environment while the XRF signal from the core NPs is utilized for XFCT, in small animals, leading to both a microscopic and macroscopic bio-imaging contrast agent.

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