Metal-doped luminescent Quantum Dots for multimodal bioimaging

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Nanotechnology is a scientific discipline with great potential to contribute to the development of new advantageous imaging nanoprobes. The use of nanoparticles (NPs) as imaging probes offers several advantages over conventional molecular-scale contrast agents, such as: (1) high loading capacity, where the concentration of the imaging agents can be controlled within each nanoparticle during the synthesis process; (2) tunable surface that can potentially extend the circulation time of the contrast agents in the blood, or target them to specific locations in the body; or (3) provide multimodal imaging capacities because NPs can combine two or more contrast properties, which can be used in multiple imaging techniques simultaneously[1].

The development of NPs combining different functionalities (e.g. photoluminescent and magnetic resonance) is nowadays an attractive area of research due to their great potential for the advance of biomedical imaging technologies. Colloidal metal semiconductor nanocrystals (quantum dots, QDs) constitute an attractive new class of optical contrast agents, which exhibit excellent properties: broad absorption bands, tunable emission colors, high resistance against photobleaching and large surface area for further functionalization[2]. However, tissue auto-fluorescence also imposes a limitation to the application of fluorescent QDs like these for in vivo imaging, as it leads to low signal-to-noise ratios that complicate their detection in biological environments, reducing contrast and the clarity of the resulting image.

There are different ways to overcome this limitation. One possibility is the development of metal nanoparticles with excitation/emission in the NIR spectral area. Such type of novel fluorescent labels are very promising in bioanalysis as combine their binary advantages of both QDs and NIR light. Another approach consists in the introduction of transition metals (e.g. Mn, which is also an essential chemical element in living organisms) in nanocrystals, as this confers them characteristics typical of phosphorescent emitters, which exhibit longer Stokes shift between excitation and emission wavelengths, and longer luminescent lifetime. The advantage of this is that the resulting phosphorescent emission allows simple discrimination between the luminescent emission from Mn doped QDs from the background fluorescence of the sample using time-resolved photoluminescence (PL) measurements[3]. Additionally, some of the possible doping ions (e.g. Mn) can be paramagnetic, and therefore act as excellent MRI contrast agents. Therefore, doping with such elements the photoluminescent nanocrystals confers additional MRI contrast capabilities to the QDs. The development of NPs combining both optical and magnetic resonance functionalities is an attractive area of research due to their great potential for the advance of biomedical imaging technologies[4].

In this presentation, an overview will be offered showing some of the novel developments on such new type of QDs for biomedical applications.

Bibliography

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