Influence of encapsulation process on the optical properties of up-converting $NaYF_4$ nanoparticles and photosensitizing dyes

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The use of up-converting, lanthanide doped nanoparticles (NPs) as luminescent labels in bioimaging provides the unique possibility to obtain visible luminescence after low power laser diode excitation from nearinfrared region. This lowers the autofluorescence background noise and allows for deep penetration of excitation light into biological tissues [1]. However, as the most commonly used for colloidal NPs synthesis wet chemistry techniques usually yield hydrophobic NPs, the efficient and straightforward NPs surface hydrophilization for bio-related applications remains the main challenge [2]. Recently the encapsulation of multiple inorganic NPs within the various types of polymeric nanocarriers with sizes below 200 nm have received increasing attention, because of the improved solubility, high long-term colloidal stability and biocompatibility of the obtained vehicles, with simultaneous possibility of co-encapsulation with other photoactive compound (i.e. organic photosensitizers) with simultaneous preservation of the optical properties of the hybrid cargo loaded inside the liquid core.

Encouraged by our recent results regarding the encapsulation of different types of inorganic NPs [3-4], we have obtained novel lanthanide-doped $NaYF_4$ NPs, designed for co-encapsulation with organic photosensitizing dyes via a new nanoemulsion-templated approach. For the synthesis of $NaYF_4$ NPs we used trioctylphosphine oxide ligands, what allowed us to obtain NPs with sizes ~5 nm, what further facilitated the encapsulation process. The selection of the type of lanthanide ions doping (Er^{3+}/Yb^{3+} or Tm^{3+}/Yb^{3+}) and photosensitizers was made based on the overlap of their emission and absorption spectra, respectively. The physico-chemical properties of the obtained nanostructures were characterized, with the special emphasis put on the measurements of the up-converted emission spectra and luminescence lifetimes. All of the studied systems showed intense, narrow band emission in the visible part of the spectra under 980 nm laser diode excitation, with long luminescence lifetimes in the sub-millisecond range. The investigation of optical properties of the nanocarriers loaded with different concentration of photosensitizers and constant amounts of lanthanide doped $NaYF_4$ NPs allowed also to study the interaction between $NaYF_4$ NPs and organic dyes. This in further step allowed for the observation of energy transfer processes between optically active components of the systems, and for showing their potential application as multifunctional agents for simultaneous bioimaging and photodynamic based cancer treatments.

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References

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