Luminescent Rare Earth Doped Nanoparticles – Light Based Theranostics

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Since first reported, luminescent rare earth doped nanoparticles have attracted a great deal of interest. In the last decade, however, the field has rapidly taken off, progressing from the basic understanding of the photophysical properties governing their nanoscale luminescence, in particular upconversion, to their use in a plethora of applications, with considerable focus in biology and medicine. This interest stems primarily from the ability to stimulate these luminescent nanoparticles with near-infrared (NIR) light as well as their diverse emission wavelengths spanning the UV to the NIR. Therefore, with a single NIR excitation wavelength, it is possible to observe higher energy luminescence, known as upconversion, or single photon NIR emission (known as down-shifted luminescence). The former upconversion process proceeds through the sequential absorption of multiple NIR photons through the long-lived $4f$ electronic energy states of the tri-positive rare earth ions. As a result, upconversion is several of orders more efficient than conventional multiphoton absorption processes. This is especially interesting for applications in theranostics (**thera**py + diag**nostics** on the same platform) where the upconverted light can be used to trigger another light activated modality (therapy) while the NIR luminescence can be used for bioimaging and nanothermometry (diagnostics). Here, we present our work on the synthesis and development of various NIR excited (and emitting) core/shell rare earth doped nanostructures/nanoplatforms and demonstrate how their various emissions could be harnessed for applications in biology and nanomedicine.