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ARTICLE TYPE

Luminescent latex particles loaded with anionic lanthanide complexes: versatile platforms for multicolour optical coding

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ABSTRACT: Luminescent polymer latexes based on lanthanide complexes have been synthesized by miniemulsion polymerization. A self-assembled europium complex was embedded into poly(methyl methacrylate) nanoparticles without covalent linking and compared to a commercially-available neutral chelate. The nature of the surfactant was found to have a great impact on the incorporation process for the europium complex and only the latexes stabilized by a cationic surfactant exhibited a luminescence signal. A maximum doping level of about 2% in weight in the final monodispersed particles was obtained. The resulting polymeric luminescent nanoparticles showed good stability over leakage. The described synthetic method was used to incorporate multiple lanthanide complexes into latexes nanoparticles affording multicolour nanolabels. Two series of polymeric latexes bearing codes are presented.

SUPPORTING INFORMATION

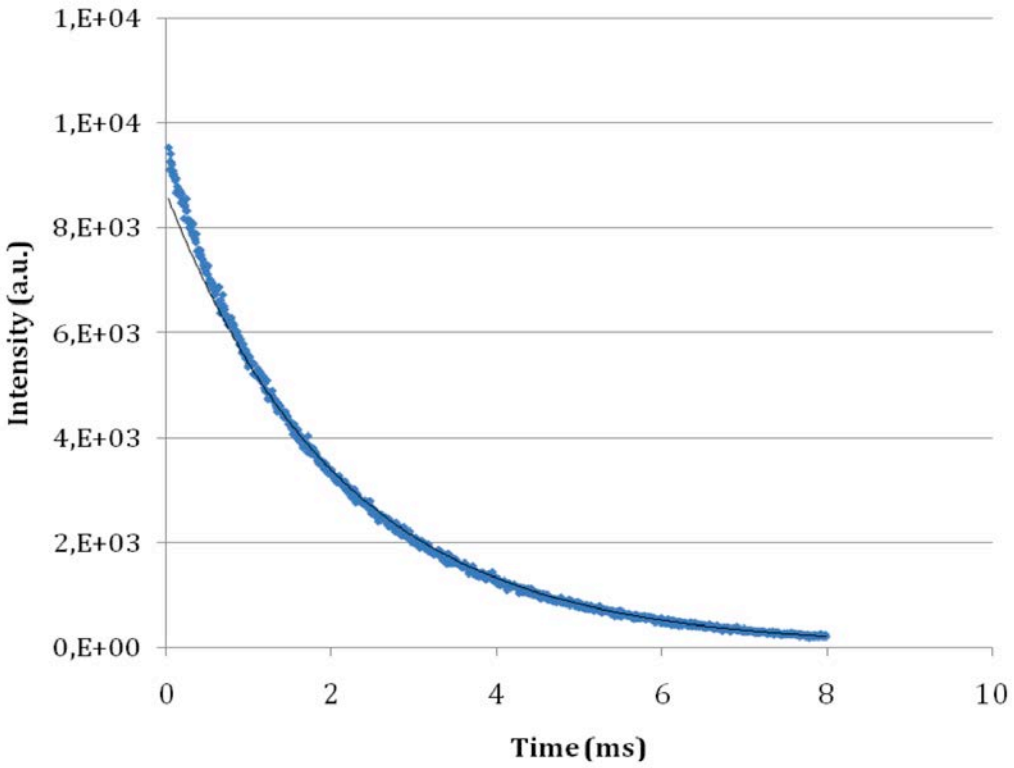

Figure S1. Experimental lifetime of $Eu(pytz)_3(NHOct_3)_3$-loaded PMMA latex particles at 617 nm. λ (excitation) = 300 nm (blue curve) and fitting curve (black).

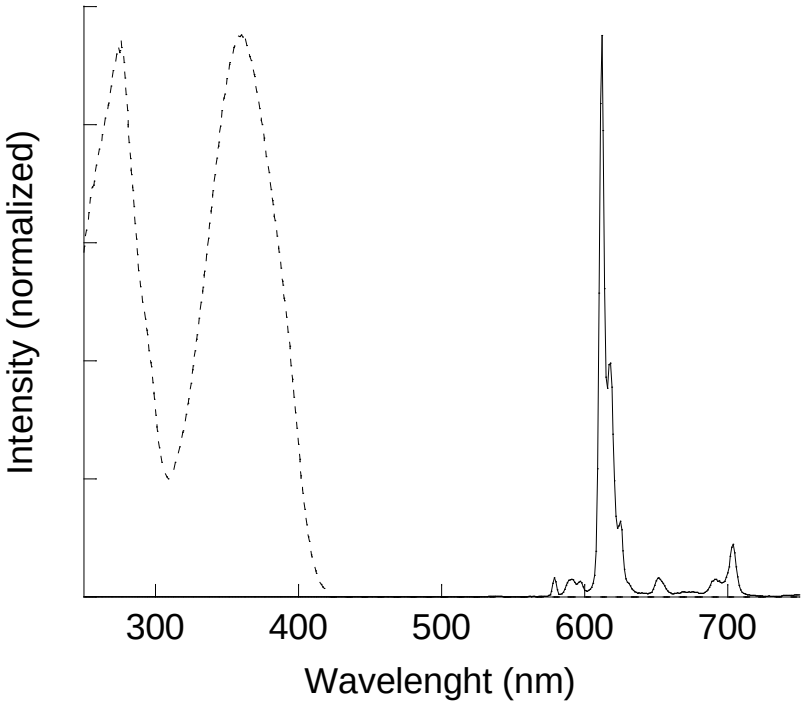

Figure S2. Excitation (dashed line) and emission (full lines) spectra of $Eu(dbm)_3(phen)$-loaded PMMA latex particles stabilized by SDS (λex = 612 nm and λem = 360 nm). Similar excitation and emission spectra were recorded for the latexes stabilized by CTAB.

Determination of the incorporation efficiency

The incorporation efficiency was calculated as follows:

$$Incorporation\ efficiency\ (\%) = \frac{n_{initial} - n_{serum}}{n_{initial}} \times 100$$

where:

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$n_{initial}$ is the quantity of lanthanide complexes initially introduced (mol) and,

n_{serum} is the quantity of lanthanide complexes in the water phase (not incorporated) determined by ICPMS after filtration (mol).

Determination of the number of lanthanide complexes per particle

The number of latex particles is given by the following equation:

$$N_p = \frac{\left(\frac{m_m \times C}{d_m} + \frac{m_m(1-C)}{d_p}\right) \times 6 \times 10^{21}}{\Pi \times D_p^3}$$

where

m_m is the amount of monomer introduced (g)

d_m is the monomer density (g.cm^{-3})

d_p is the polymer density (g.cm^{-3})

D_p is the DLS particle diameter (nm)

C is the monomer to polymer conversion

The number of lanthanide complexes per particle was then calculated according to:

$$Lanthanide\ complexes\ per\ particle = \frac{n_{L_n} \times N_A}{N_p}$$

where N_p is the particle number, N_A is the Avogadro number (mol^{-1}) and n_{L_n} is the quantity of incorporated lanthanide complexes (mol) determined by ICPMS.

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The luminescence emission spectra of the Lnpytz)$_3$(NHOct$_3$)$_3$ complexes reported in Figures S3-S6 were recorded using different slit parameters in order to obtain higher quality spectra for all complexes independently of their luminescence quantum yields.

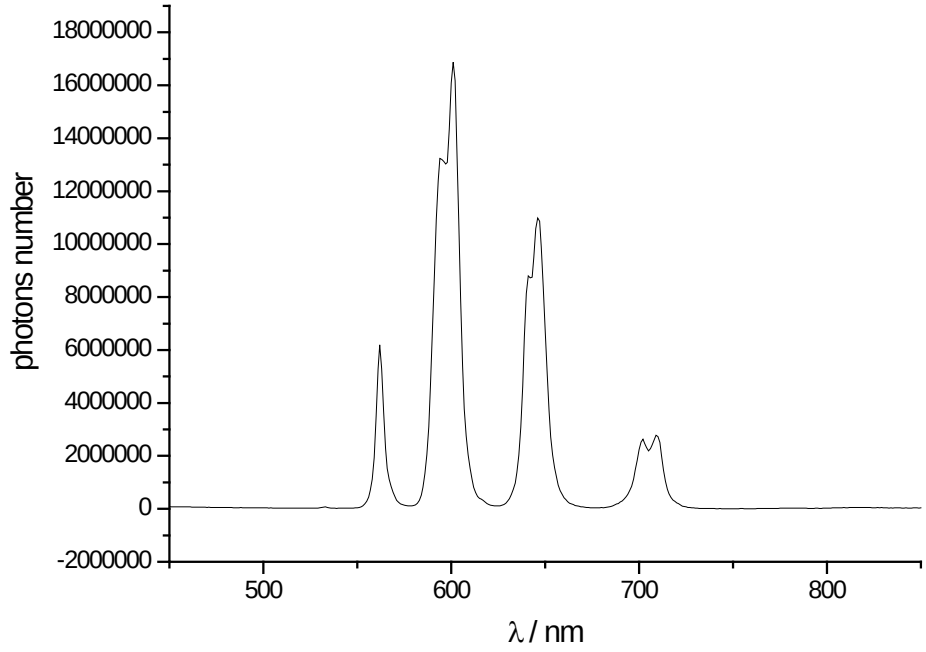

Figure S3. Emission spectrum of Sm(pytz)$_3$(NHOct$_3$)$_3$ in methanol at $2.3 \cdot 10^{-3}$ M.

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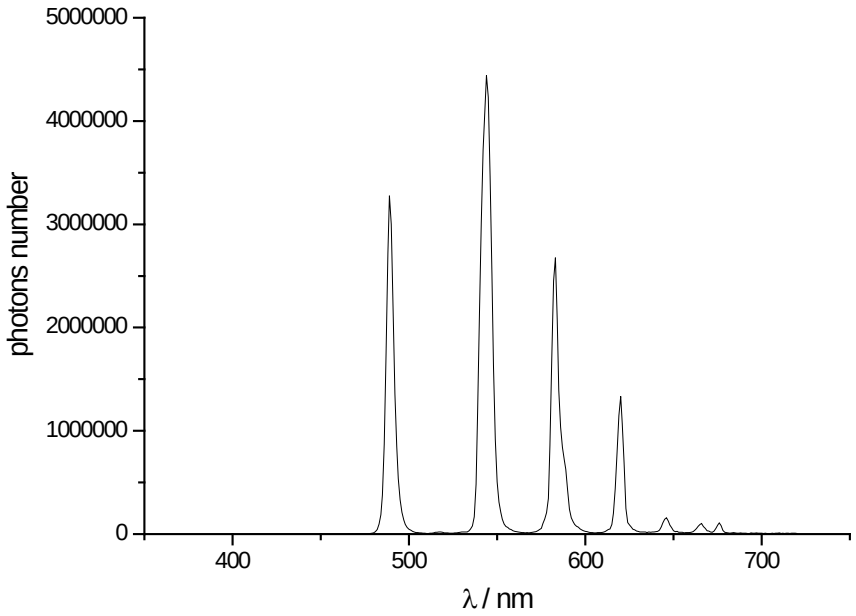

Figure S4. Emission spectrum of $Tb(pytz)_3(NHOct_3)_3$ in methanol at $2.3 \cdot 10^{-3}$ M.

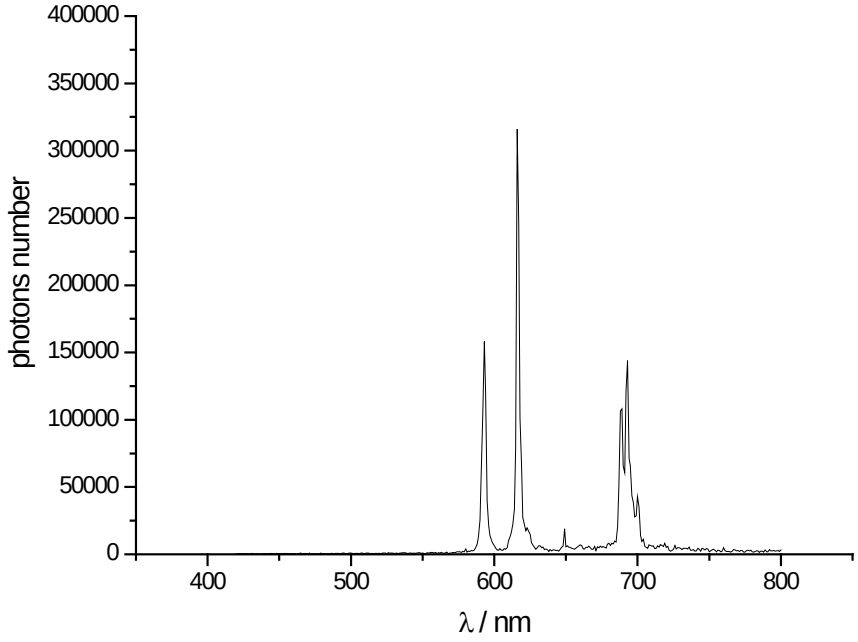

Figure S5. Emission spectrum of $Eu(pytz)_3(NHOct_3)_3$ in methanol at $2.3 \cdot 10^{-3}$ M.

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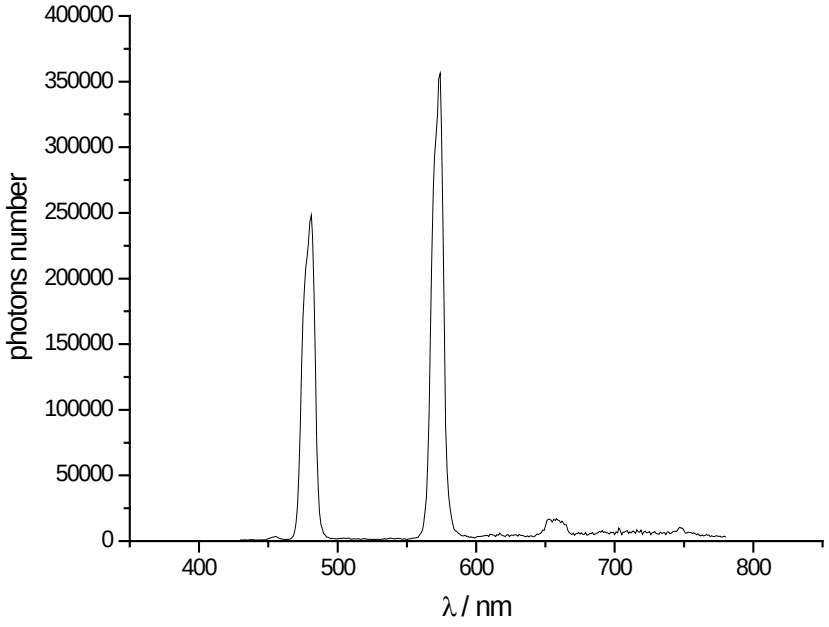

Figure S6. Emission spectrum of $Dy(pytz)_3(NHOct_3)_3$ in methanol at $2.3 \cdot 10^{-3}$ M.