Combination of UV-C and Red Emission in Pr^{3+} and Eu^{3+} Co-doped $LuPO_4$ Nanoparticles for Application in Theranostics

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Background

Recent research showed that $LuPO_4$:Pr^{3+},Nd^{3+} nanoparticles lead to an significantly inactivation of cancer cells [1-5]. The ionizing radiation is absorbed by $LuPO_4$ (ϱ= 6.53 g/cm^3 and Z_{eff} = 63.7) and the Pr^{3+} doping causes UV-C emission in the range from 230 to 285 nm. However, it is also important for particle insertion in the human body that these nanoscale scintillators can be detected during their migration. For cancer detection, a novel approach is the imaging of cancer cells with Eu^{3+} co-doped $LuPO_4$ nanoparticles. The intensive red emission of Eu^{3+} between 592 and 704 nm due to intraconfigurational transitions ($^5D_0 \rightarrow {}^7F_J$) is well suitable for detection purposes.
In this study, nanoscale scintillator samples, viz. $LuPO_4$ co-doped with Pr^{3+} and Eu^{3+}. Under X-ray excitation, these nanoparticles emit efficiently UV-C radiation (230-285 nm) and intense red emission for cancer cells detection (592-705 nm).

Synthesis

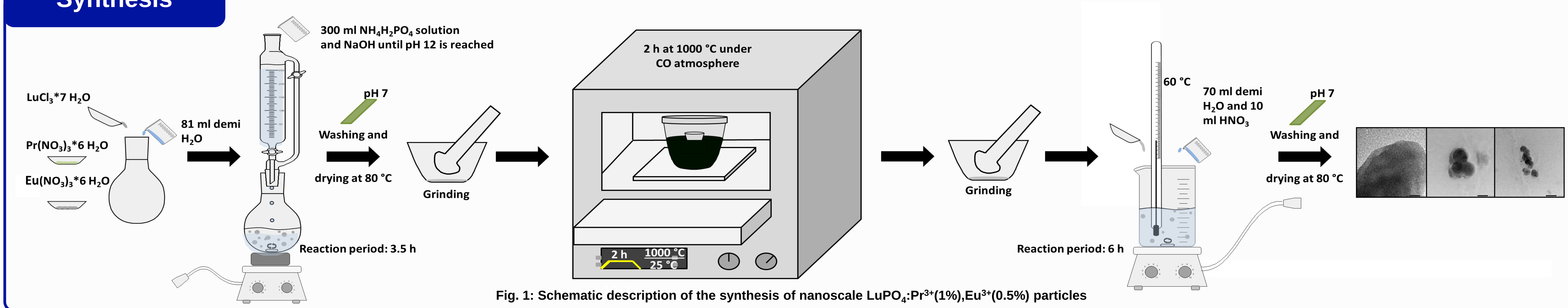

Fig. 1: Schematic description of the synthesis of nanoscale $LuPO_4$:Pr^{3+}(1%),Eu^{3+}(0.5%) particles

Results / Measurements

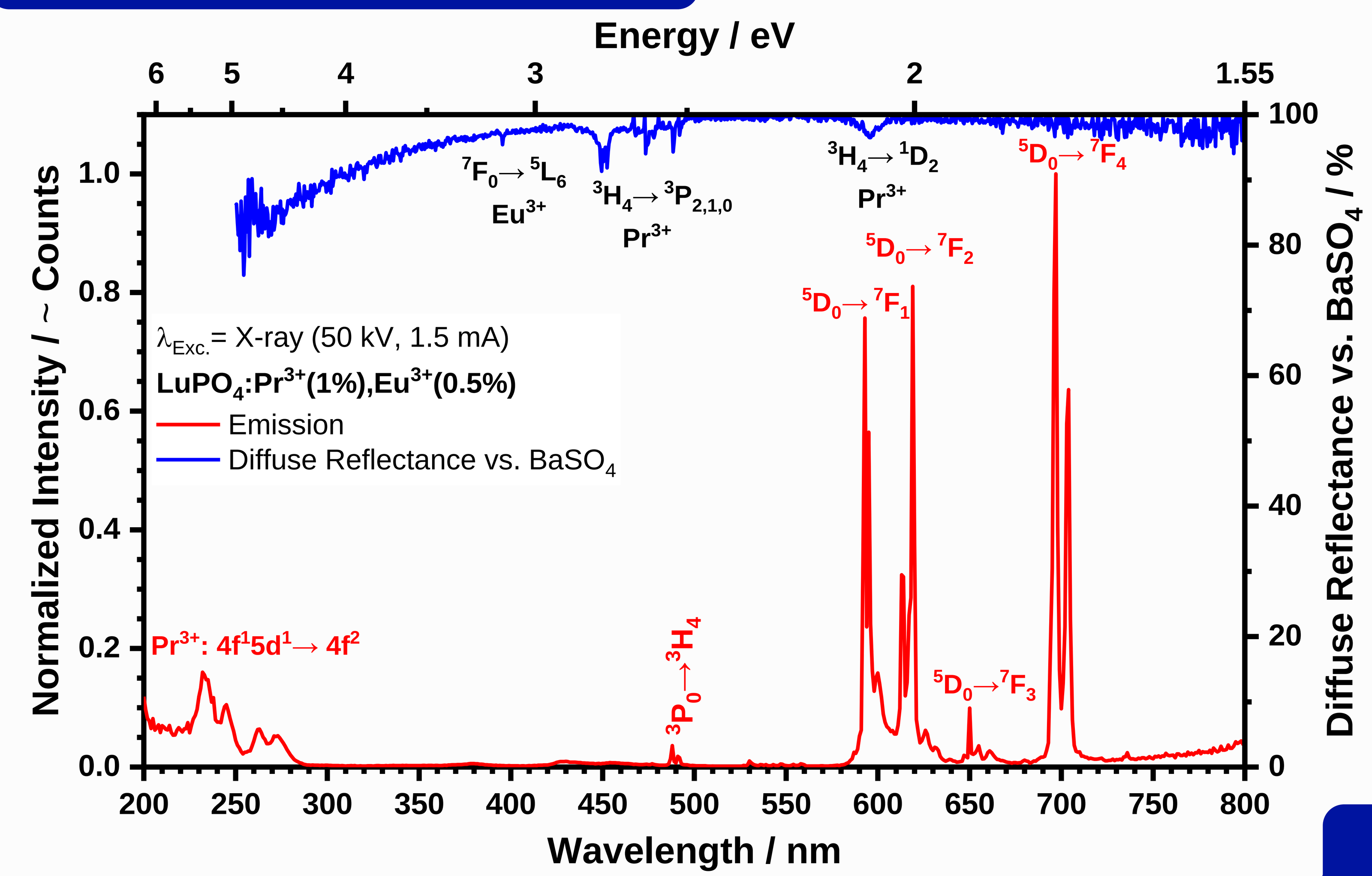

Fig. 2: X-ray excited emission spectra of $LuPO_4$:Pr^{3+}(1%),Eu^{3+}(0.5%)

Optical Imaging

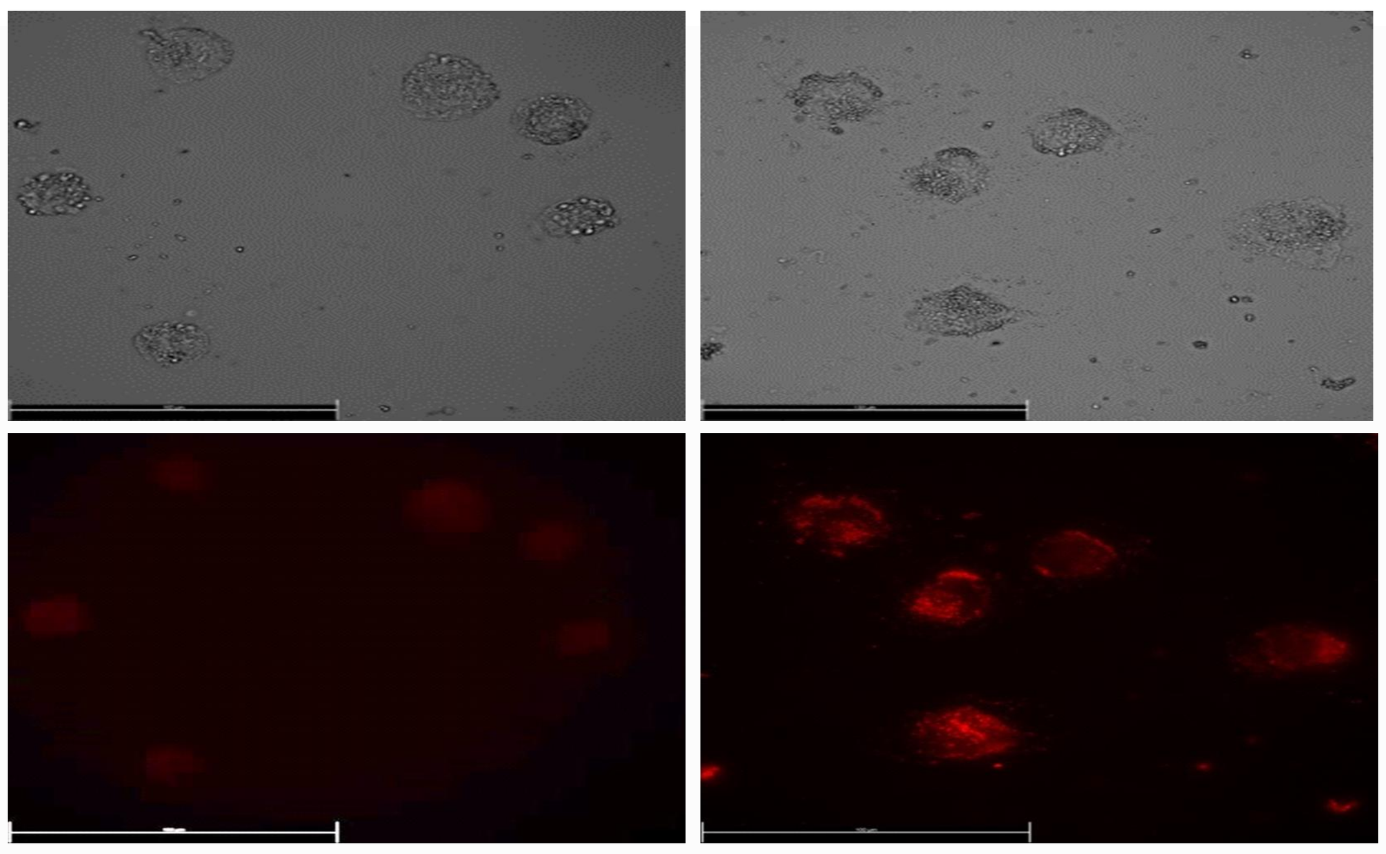

Fig. 4: Microscopy images show $LuPO_4$:Eu^{3+}(5%) nanoparticles (after 24 h incubation) before and after excitation with a 365 nm UV-LED

Cancer therapy

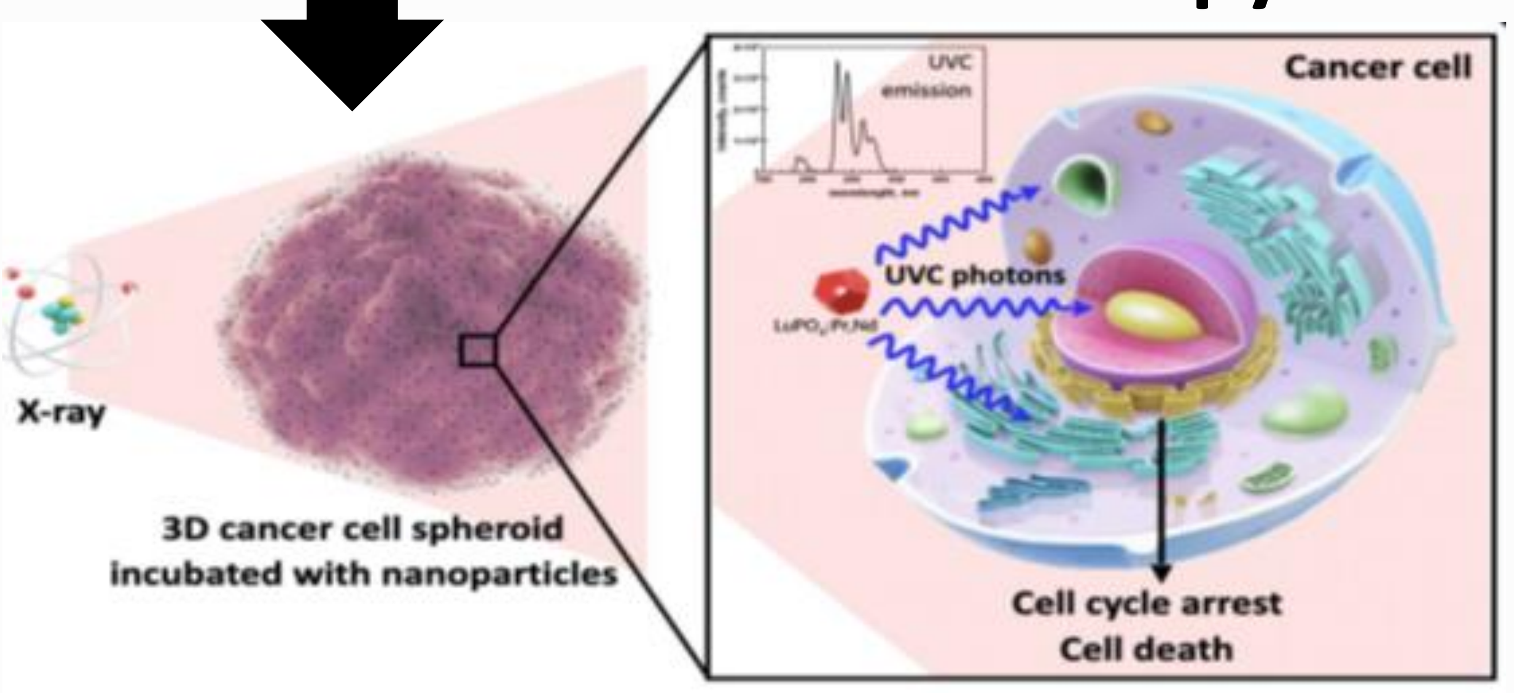

Fig. 3: Schematic description and the result how the $LuPO_4$:Pr^{3+}(1%) nanoparticles interact with A 549 cancer cells [6]

Conclusions

- High quality $LuPO_4$:Pr^{3+},Eu^{3+} nanoparticles with a crystallite size of 20-30 nm were synthesized via homogeneous precipitation reaction.
- Four UV emission bands between 230 and 280 (intraconfigurational transitions) of Pr^{3+} in addition to the red emission in the range between 590 and 705 nm (interconfigurational transitions) of Eu^{3+}.
- Application in theranostics – Therapeutic (Cancer therapy) and diagnostic(Imaging) combined at the “Point of use”.
- Well known host material for the use as scintillator and excitation with high energy radiation

References

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