**Supporting Information**

**A spectroscopic investigation of Eu3+ incorporation in *Ln*PO4 (*Ln* = Tb, Gd1–xLux, x = 0.3, 0.5, 0.7, 1) ceramics**

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SI 1: PXRD patterns of Eu3+–doped TbPO4 and the solid solution series Gd1–xLuxPO4 (x = 0.3, 0.5, 0.7, 1) after synthesis.



SI 2: Comparison of emission spectra of Eu3+–doped CaSO4 anhydrite, λex = 245nm (replot from (Junot *et al.*, 2014)) and Eu3+–doped TbPO4 in the anhydrite–like structure.



SI 3: Emission spectra of Eu3+‒doped TbPO4 after one year of aging, excited at 17268 cm–1.



SI 4: Emission spectra of Eu3+ doped Gd0.7Lu0.3PO4 (λex = 17265 cm–1, delay = 10 μs or 2.5 ms) compared with a) Eu3+ incorporation in an anhydrite–like phase and b) Eu3+ incorporation in monazite (black traces) and xenotime (green traces) phase. The red box indicates Eu3+‒emission signals that cannot be ascribed to any of the *Ln*PO4 phases.



SI 5: Lifetimes of Eu3+–doped TbPO4 after synthesis (gray) and after one year of aging (black).



SI 6: Lifetimes of different Gd,Lu–solid solutions in a) Region I and b) Region II (right) after one year aging.



SI 7: Lifetimes of Eu3+‒doped LuPO4 single crystals direct after the synthesis (gray) and after 9 months of aging (black).



SI 8: Comparison of excitation spectra of LuPO4 powder and single crystal samples measured directly after synthesis. The single crystal data are taken from (Xiao *et al.*, 2018).

**References**

Junot, D.O., dos Santos, M.A.C., Antonio, P.L., Caldas, L.V., and Souza, D.N. (2014), Feasibility study of CaSO4: Eu, CaSO4:Eu, Ag and CaSO4:Eu, Ag (NP) as thermoluminescent dosimeters, Radiation Measurements, 71, 99-103, doi: 10.1016/j.jcis.2016.08.027.

Xiao, B., Lösch, H., Huittinen, N., and Schmidt, M. (2018), Local structural effects of Eu3+ incorporation into xenotime-type solid solutions with different host cations, Chemistry – A European Journal, 24(50), 13368-13377, doi: 10.1002/chem.201802841.