Long optical coherence in $Eu_xLa_{1-x}PO_4$ crystals, a new synthetic material for quantum technologies.

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For several years now, rare-earth-doped crystals have been identified as promising candidates for solid-state quantum memories [1], single photon emitters [2] and scalable quantum computing [3]. In the bulk state, these materials show extremely long optical and spin coherence times, around the millisecond [4] and several hours respectively [5]. They are in addition adapted to multi-mode storage [1]. In addition, recent promising demonstrations of long optical and spin coherence times in oxide nanoparticles doped with rare-earth ions [6,7] have opened the way to new functionalities for these materials [8].

In the present work we introduce a new family of rare-earth crystals in view of their use for quantum technologies applications: the phosphates. We synthesized a series of $Eu_xLa_{1-x}PO_4$ microcrystalline powders with x varying from 0.01 to 1 and characterized their structural (**Figure 1**) and optical properties. Optical coherence times (T_2) (**Figure 2**) and spin population lifetimes (T_1) of Eu^{3+} ions were also assessed at cryogenic temperature. Finally, we discuss approaches for obtaining this material at the nanoscale with preserved optical coherence properties.

References

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Figures

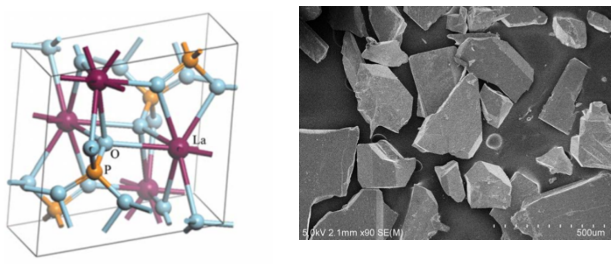

Figure 1: Left – $LaPO_4$ crystal lattice (monoclinic monazite). Right – SEM image of $Eu_{0.05}La_{0.95}PO_4$ single crystals obtained by flux method.

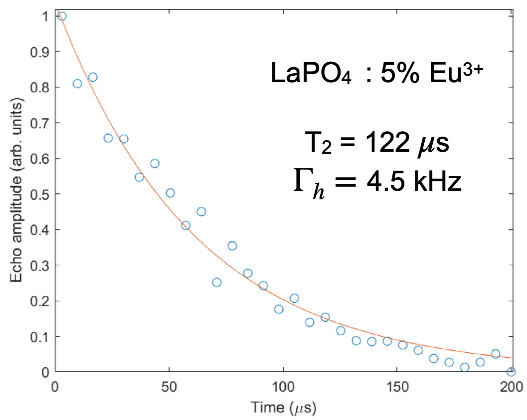

Figure 2: Photon echo decay for the $^5D_0 \leftrightarrow {}^7F_0$ transition of Eu^{3+} at 578.63 nm in $Eu_{0.05}La_{0.95}PO_4$ microcrystals yielding an optical coherence time of 122 μs. T = 1.3 K