Electronic Supplementary Material (ESI) for Nanoscale Advances.

Engineering efficient upconverting nanothermometers using Eu^{3+} ions

Giacomo Lucchini[a], Adolfo Speghini[a*] , Patrizia Canton[b], Fiorenzo Vetrone[c,d*],

Marta Quintanilla[c,1]

[a] Nanomaterials Research Group, Dipartimento di Biotecnologie, Università di Verona and INSTM, UdR Verona, Strada Le Grazie 15, I-37314 Verona (Italy)

[d] Centro di Microscopia Elettronica "Giovanni Stevanato", Dipartimento di Scienze Molecolari e Nanosistemi, Università Ca' Foscari Venezia, Via Torino 155/B, Venezia-Mestre, Italy

[c] Institut National de la Recherche Scientifique, Centre Énergie, Matériaux et Télécommunications (INRS - EMT), Université du Québec, 1650 Boul. Lionel-Boulet, Varennes, QC, J3X 1S2 (Canada)

[d] Centre for Self-Assembled Chemical Structures, McGill University, Montreal, QC, H3A 2K6 (Canada)

[1] Current Address: BioNanoPlasmonics Laboratory, CIC biomaGUNE, Paseo de Miramón 182, Donostia – San Sebastián (Spain)

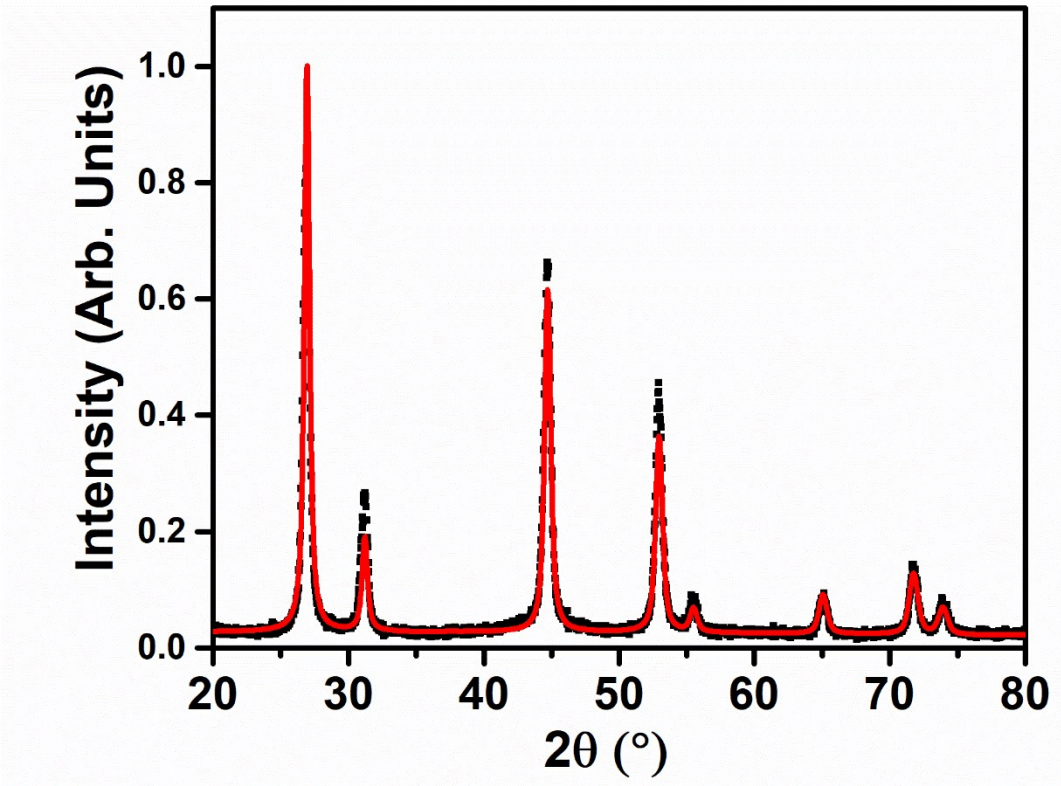

Figure S1. XRPD pattern of SrF_2:Yb^{3+}, Tm^{3+}, Eu^{3+} UCNPs (black squares). Rietveld refinement, using MAUD software (red line) (lattice parameter: 5.734 ± 0.002).

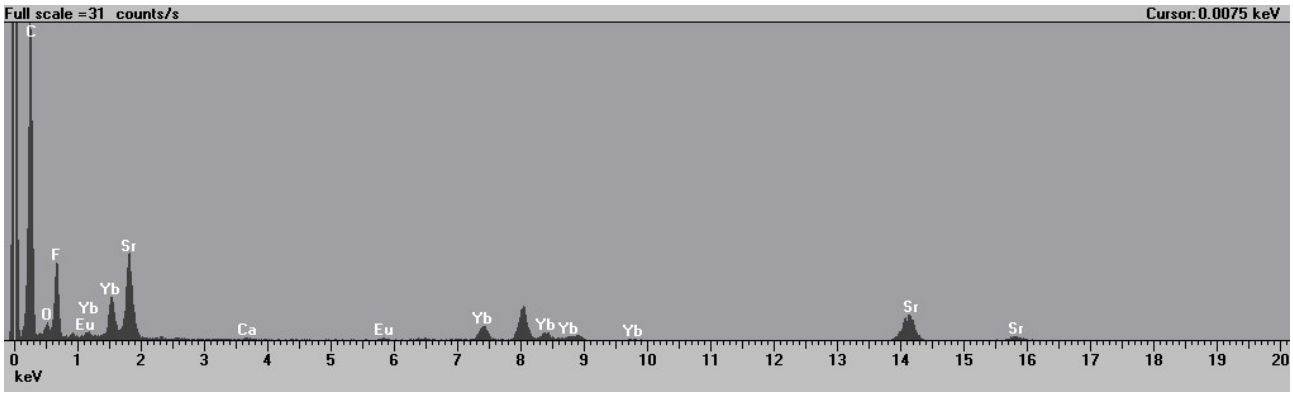

Figure S2. EDX spectra for the SrF_2:Yb^{3+},Tm^{3+},Eu^{3+} UCNPs.

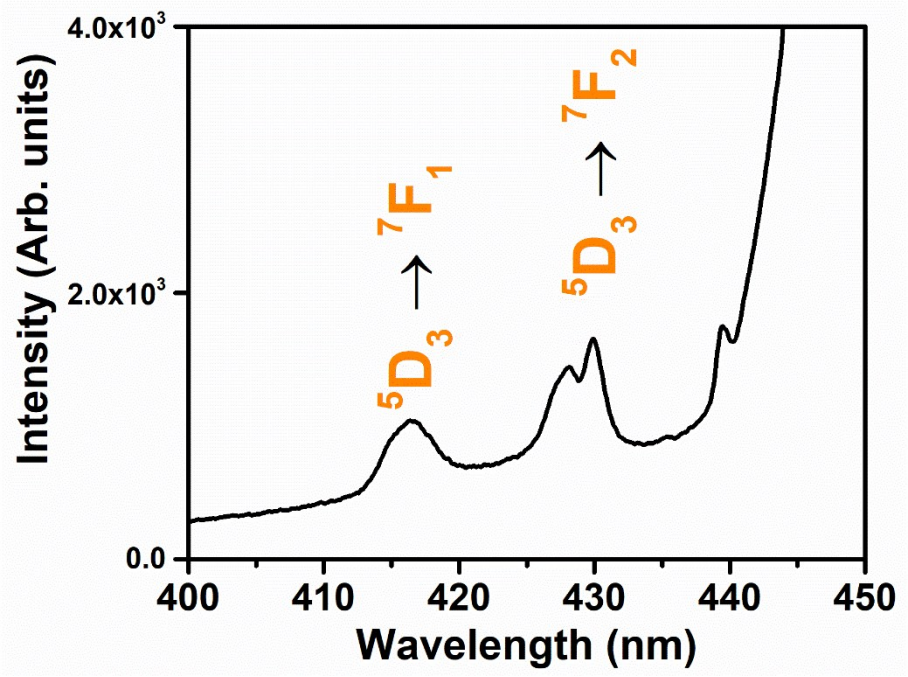

Figure S3. Upconversion spectrum of a water colloidal dispersion of the SrF_2:Yb^{3+},Tm^{3+},Eu^{3+} UCNPs (1 wt %) after excitation at 980 nm (laser power density of 450 mW/mm^2) in the blue region, showing emission from $^5D_3$ level of the Eu^{3+} ions.

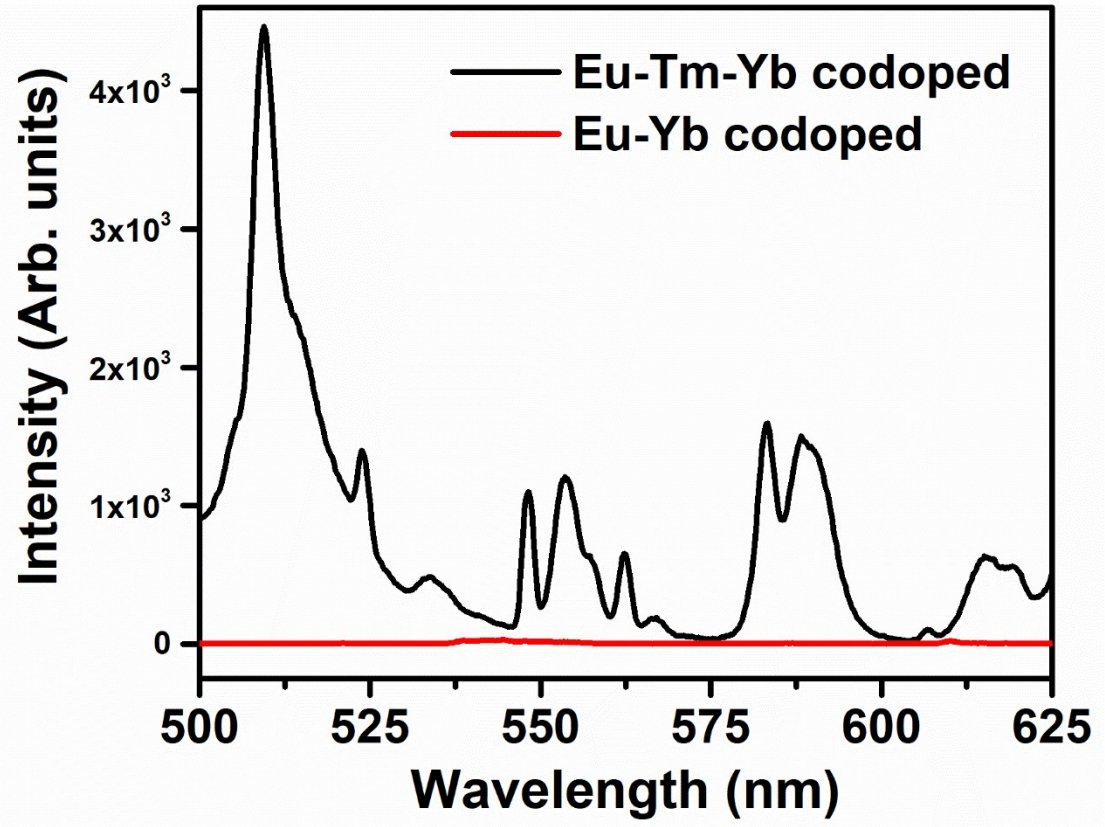

Figure S4. Comparison of the upconversion spectra of water colloidal dispersions of the SrF_2:Yb^{3+},Tm^{3+},Eu^{3+} UCNPs (1 wt %) after excitation at 980 nm (laser power density of 450 mW/mm^2) (black line) and SrF_2:Yb^{3+},Eu^{3+} nanoparticles (red line) in the same experimental conditions.

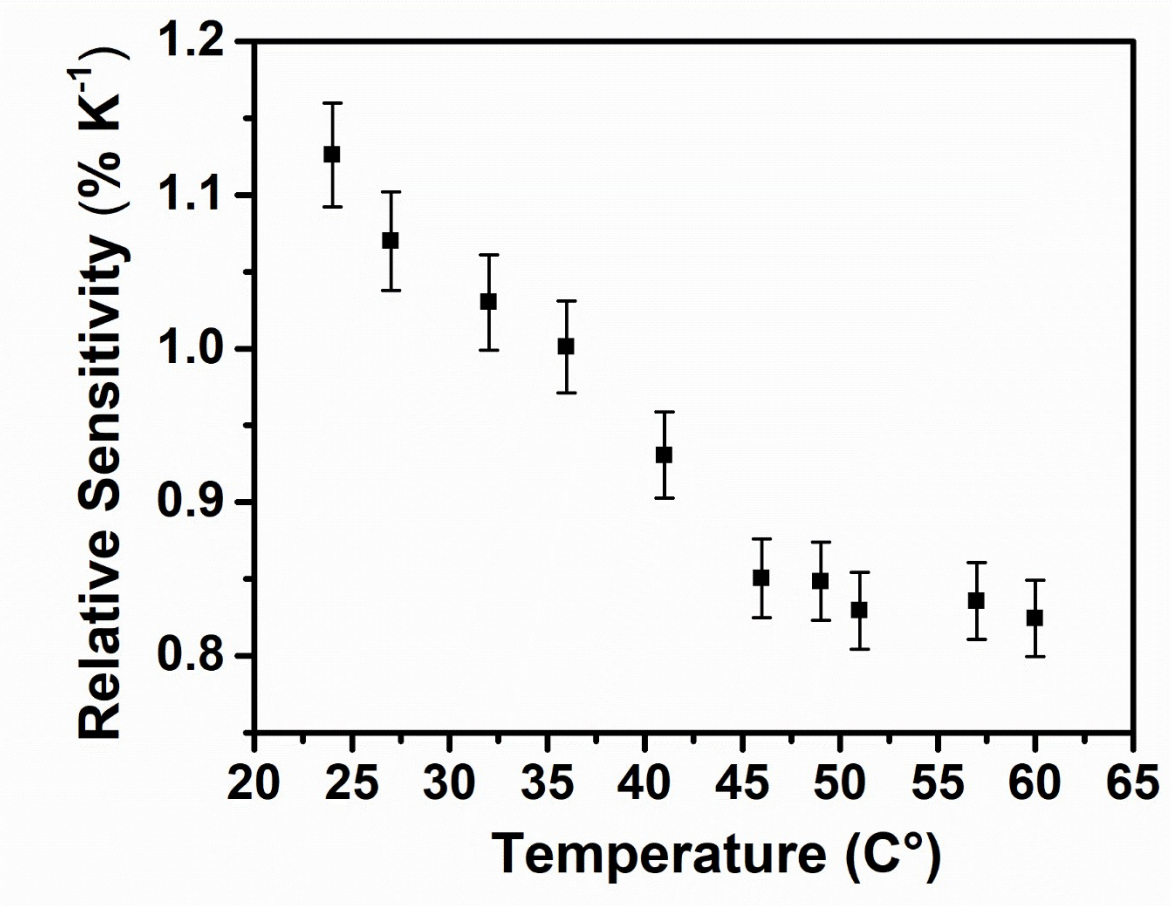

Figure S5. Relative sensitivity of water colloidal dispersions of the SrF_2:Yb^{3+}, Tm^{3+}, Eu^{3+} UCNPs (1 wt %) as a function of temperature.

Figure S6. Picture of D_2O colloidal dispersion of the SrF_2:Yb^{3+}, Tm^{3+}, Eu^{3+} UCNPs (1 wt %).

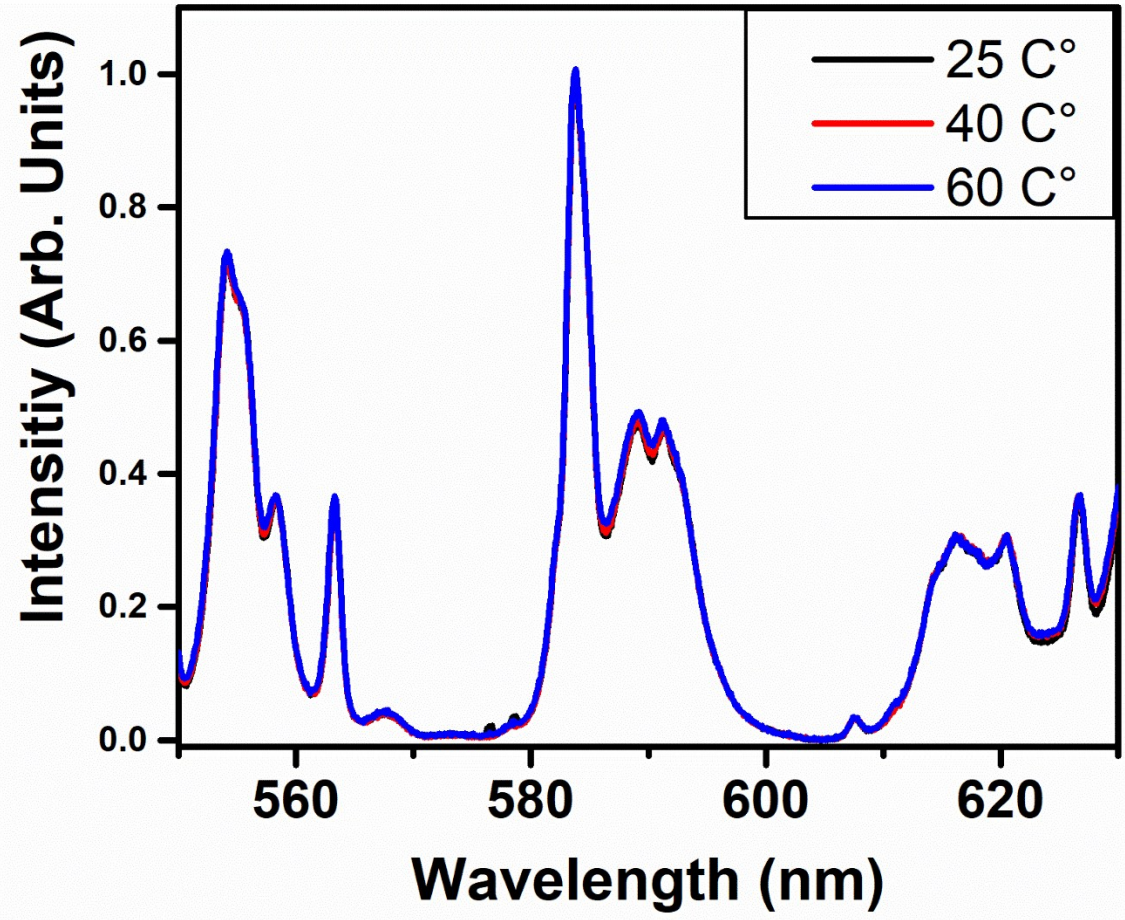

Figure S7. Upconversion spectra at three different temperatures (intensity normalized to the 585 nm band) upon 980 nm excitation of the SrF_2:Yb^{3+},Tm^{3+},Eu^{3+} UCNPs (1 wt %) in D_2O.