Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Time-Resolved Luminescence Spectroscopy for Monitoring the Stability and Dissolution Behaviour of Upconverting Nanocrystals with Different Surface Coatings

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1. Characterization of all Particle Systems: TEM, TGA, Zeta potential, FT-IR and Optical Spectroscopy

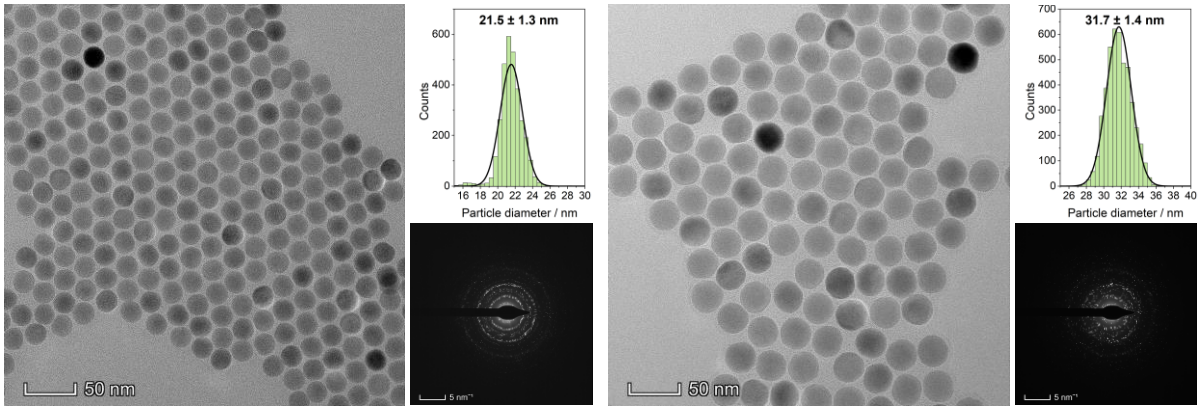


Figure S1: TEM images from as-synthesized oleate-$NaYF_4$:Yb,Er with size of 21.5 ± 1.3 nm (left) and 31.7 ± 1.4 nm (right) with the corresponding size histograms derived from TEM data (size distribution was fitted applying a Gaussian normal distribution) and the SAED (selected area electron diffraction) pattern of the particles showing a high crystallinity and typical β-phase reflexes.

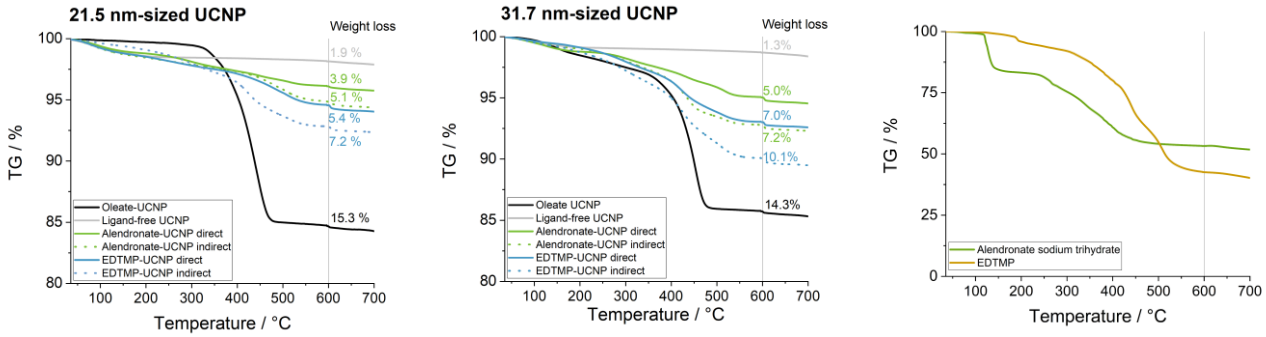


Figure S2: Thermogravimetric analysis (TGA) curves of 21.5 nm- and 31.7 nm-sized $NaYF_4$: Yb,Er particles with different coatings and TGA curves of the ligands.

Table S1: Summarized results of the calculated amount of ligand per 1 mg particle and absolute number of ligand molecules on one single particle.

Ligand	Coating procedure	Particle Size nm	Surface area nm^2	Weight loss at 600°C %	Calculated amount ligand µmol/mg	Calculated amount ligand molecule/nm^2
Oleate	as synthesized	21.5	1256	15.3	0.54	4.0
Alendronate	direct method	21.5	1256	3.9	0.29	2.9
Alendronate	indirect method	21.5	1256	5.1	0.37	3.9
EDTMP	direct method	21.5	1256	5.4	0.21	2.1
EDTMP	indirect method	21.5	1256	7.2	0.28	2.9
Oleate	as synthesized	31.7	2826	14.3	0.50	3.9
Alendronate	direct method	31.7	2826	5	0.38	2.2
Alendronate	indirect method	31.7	2826	7.2	0.54	3.1
EDTMP	direct method	31.7	2826	7	0.28	1.5
EDTMP	indirect method	31.7	2826	10.1	0.39	2.3

For oleate capped UCNPs, the amount of ligand was calculated according the reported procedure from Wilhelm et al.[1] For phosphonate coated particles, it was considered that the phosphonate ligands don´t decompose completely. Based on the TGA analysis of the ligands, the relative mass loss was estimated to 38 % (weight loss without water) and 58 % for alendronate and EDTMP, respectively, and the amount of ligand was calculated for the ideal case that the coating consists of only the desired phosphonate ligand.

Table S2: Zeta potential (ζ) of ligand free, alendronate-, and EDTMP-coated $NaYF_4$: Yb, Er particles measured in water at pH 7.4.

Ligand	Coating procedure	Particle Size / nm	Zeta potential (ζ) / mV
Ligand free	acid treatment	21.5	– 47.0 ± 0.7
Alendronate	direct method	21.5	– 18.0 ± 0.5
Alendronate	indirect method	21.5	– 19.8 ± 0.2
EDTMP	direct method	21.5	– 48.8 ± 0.3
EDTMP	indirect method	21.5	– 45.5 ± 2.0
Ligand free	acid treatment	31.7	– 43.9 ± 1.6
Alendronate	direct method	31.7	– 19.1 ± 1.2
Alendronate	indirect method	31.7	– 17.0 ± 0.4
EDTMP	direct method	31.7	– 44.7 ± 1.2
EDTMP	indirect method	31.7	– 44.8 ± 1.9

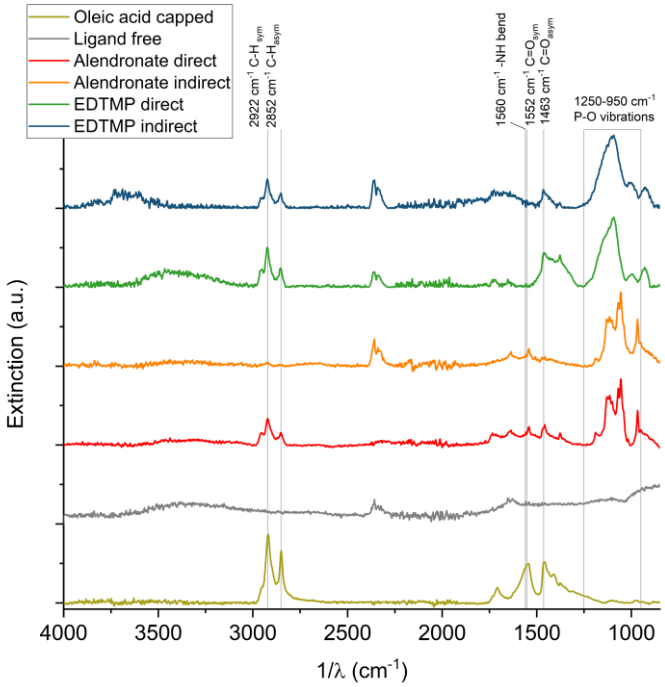


Figure S3: ATR-FTIR spectra of 21.5 nm sized ligand free, alendronate-, and EDTMP-coated $NaYF_4$: Yb, Er particles

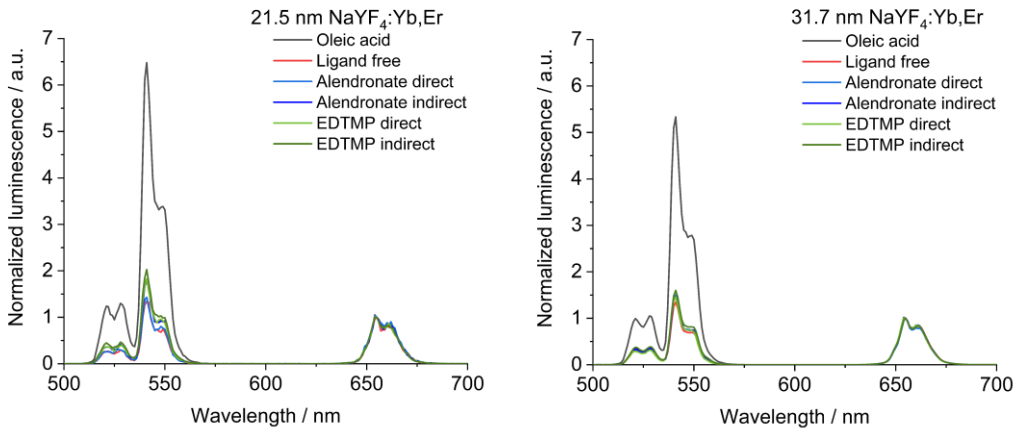


Figure S4: Normalized luminescence spectra of as-synthesized oleate-$NaYF_4$:Yb,Er in cyclohexane and differently coated $NaYF_4$:Yb,Er in water.

2. Potentiometric Quantification of Particle Dissolution

Table S3: Fluoride released during coating procedure with organophoshonate ligand for the 21.5 nm sized UCNPs

Ligand	Coating procedure	Released fluoride [mol%]
Alendronic acid	INDIRECT ROUTE: Water, RT, 24 h, c (particle)= 1 mg/mL n (ligand)=20 µmol/nm² particle	1.8
EDTMP	INDIRECT ROUTE: Water, RT, 24h, c (particle)= 1 mg/mL n (ligand)=20 µmol/nm² particle	2.1
Alendronic acid	DIRECT ROUTE: Cyclohexane/water, RT, 24h, c (particle)= 1 mg/mL n (ligand)=20 µmol/nm² particle	2.3
EDTMP	DIRECT ROUTE: Cyclohexane/water, RT, 24h, c (particle)= 1 mg/mL n (ligand)=20 µmol/nm² particle	2.7

Table S4: Molar fraction of released fluoride calculated per total fluoride in $NaY_{0.78}Yb_{0.20}Er_{0.02}F_4$ for 21.5 nm sized particles (indirect route). The relative standard deviations were derived from triplicate measurements.

Aging time /h	Molar fraction of released fluoride /mol.%					
	AA-UCNP at rt	AA-UCNP at 37°C	EDTMP-UCNP at rt	EDTMP-UCNP at 37°C	Ligandfree-UCNP at rt	Ligandfree-UCNP at 37°C
1	7.9 ± 0.8	6.6 ± 0.5	7.7 ± 0.4	7.4 ± 0.1	16.1 ± 1.2	30.7 ± 1.1
2	6.8 ± 0.4	10.7 ± 0.8	9.6 ± 0.2	9.9 ± 0.4	20.3 ± 1.0	41.9 ± 0.8
4	7.1 ± 0.2	29.0 ± 0.6	15.3 ± 0.8	18.6 ± 0.2	29.6 ± 0.7	63.2 ± 0.5
6	7.9 ± 0.1	48.4 ± 0.4	9.6 ± 0.7	26.3 ± 0.1	37.8 ± 0.5	82.4 ± 0.4
8	10.1 ± 0.1	57.1 ± 0.2	12.0 ± 0.3	33.4 ± 0.3	47.3 ± 0.4	93.6 ± 0.6
10	13.4 ± 0.3	74.2 ± 0.4	14.2 ± 0.1	39.4 ± 0.6	50.1 ± 0.4	100.4 ± 0.7
12	17.5 ± 0.5	87.6 ± 0.9	15.3 ± 0.5	50.1 ± 0.8	57.7 ± 0.3	101 ± 1.3
18	31.5 ± 0.6	92.8 ± 0.1	22.4 ± 0.2	69.2 ± 1.1	65.4 ± 0.3	100.0 ± 0.7
24	37.5 ± 0.8	99.4 ± 0.7	29.0 ± 0.7	84.3 ± 1.2	75.0 ± 0.3	99.7 ± 1.4

3. Visual Detection of Structural Integrity with TEM and EDX

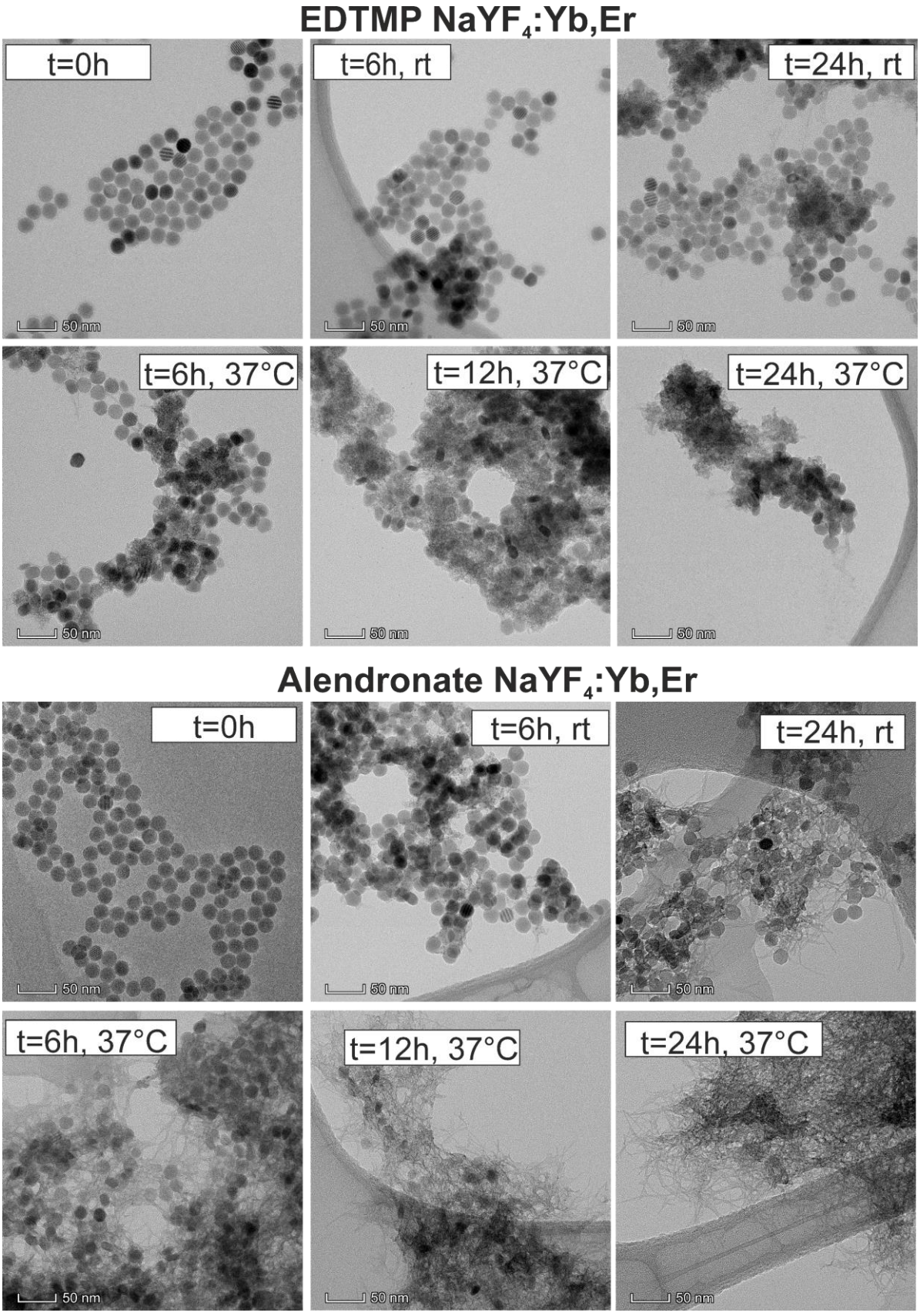


Figure S5: TEM images from organophosphonate-capped 21.5 nm sized UCNP (indirect route) incubated at 0.1 mg/mL concentration in PBS. Insert gives aging time and temperature.

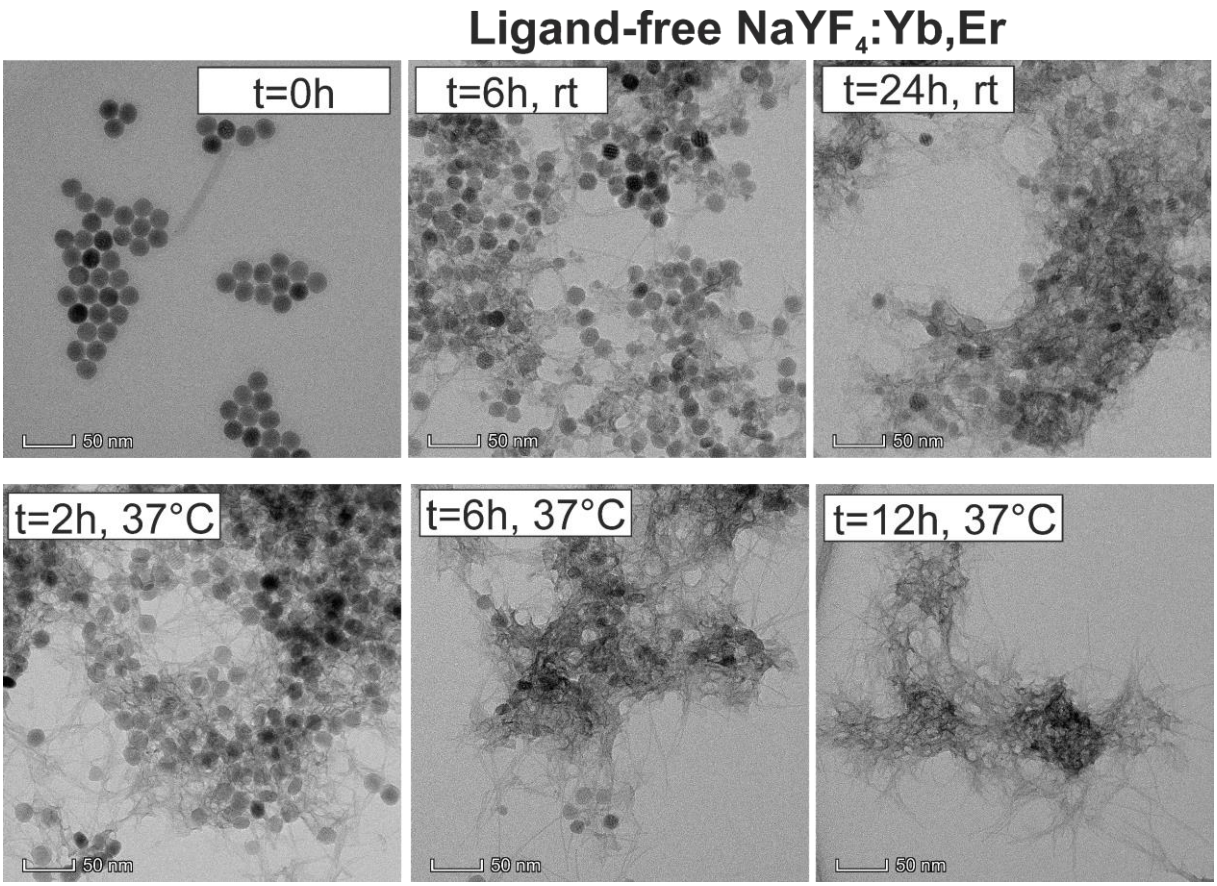


Figure S6: TEM images from ligand-free 21.5 nm sized UCNP incubated at 0.1 mg/mL concentration in PBS. Insert gives aging time and temperature.

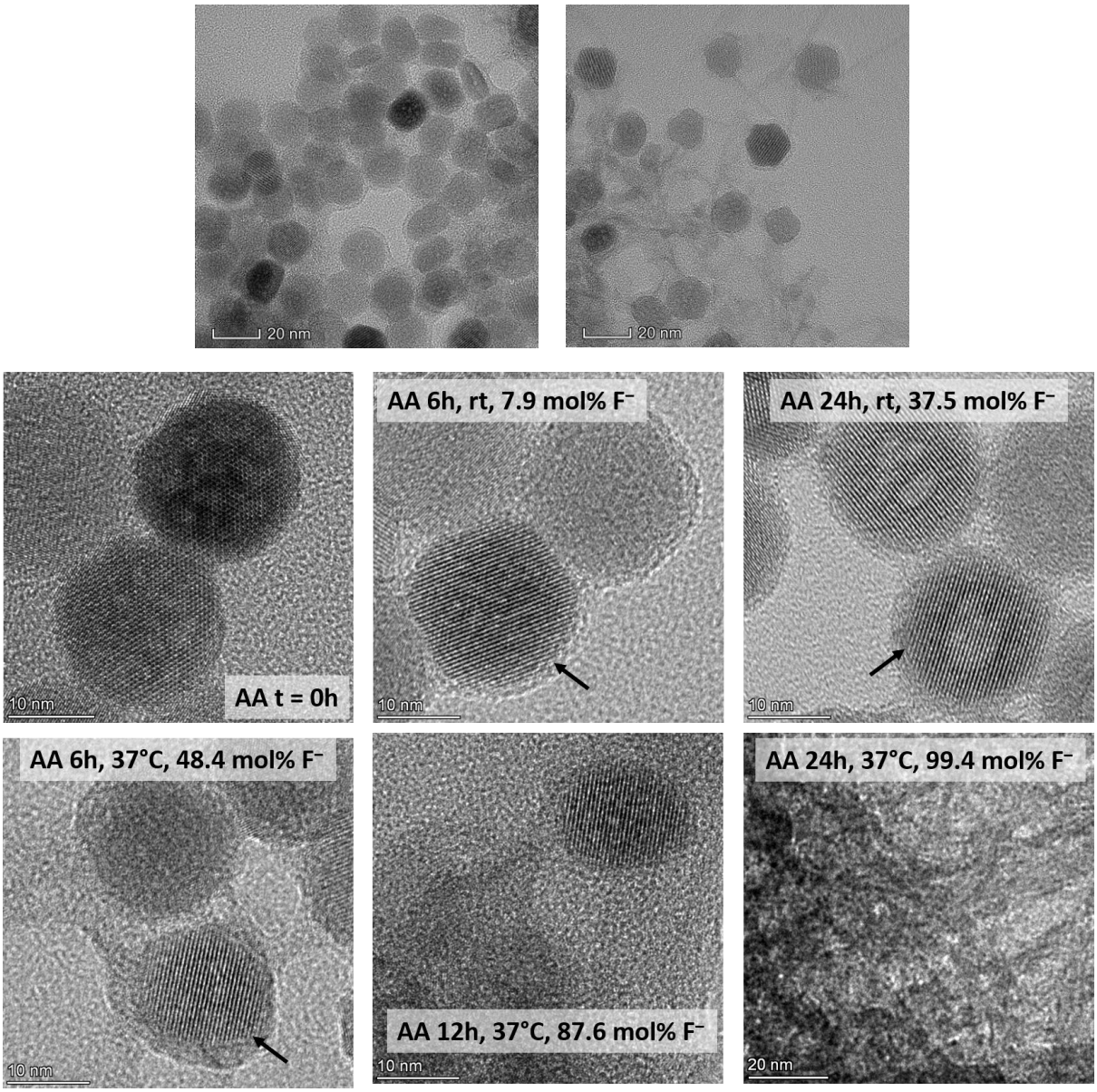
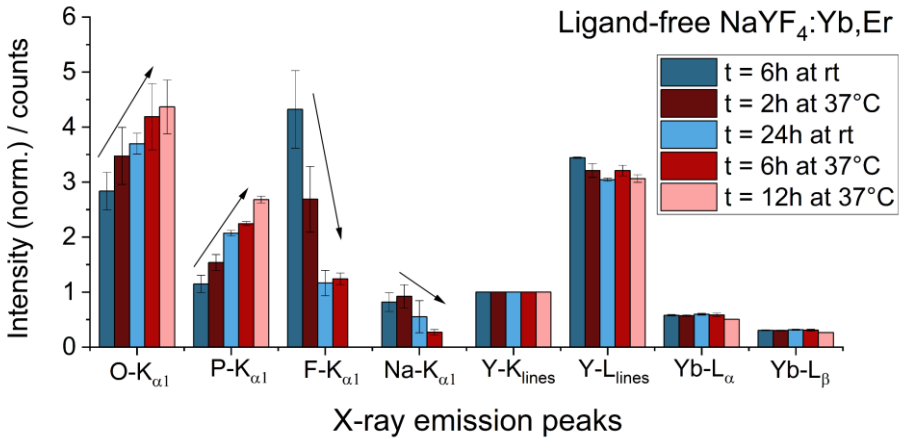


Figure S7: Upper panel: TEM images (390 kx magnification) from EDTMP-capped 21.5 nm sized UCNP incubated for 6h at 37°C (left) and ligand-free 21.5 nm sized UCNP incubated for 6h at rt (right) at 0.1 mg/mL concentration in PBS illustrating the different dissolution behaviour depending on the surface coating; lower panel: Selected area of TEM images (390kx magnification, 3-fold enlargement) from alendronate-coated UCNP visualizing the formation of amorphous layer on the particles surface and decrease in particle size during dissolution.

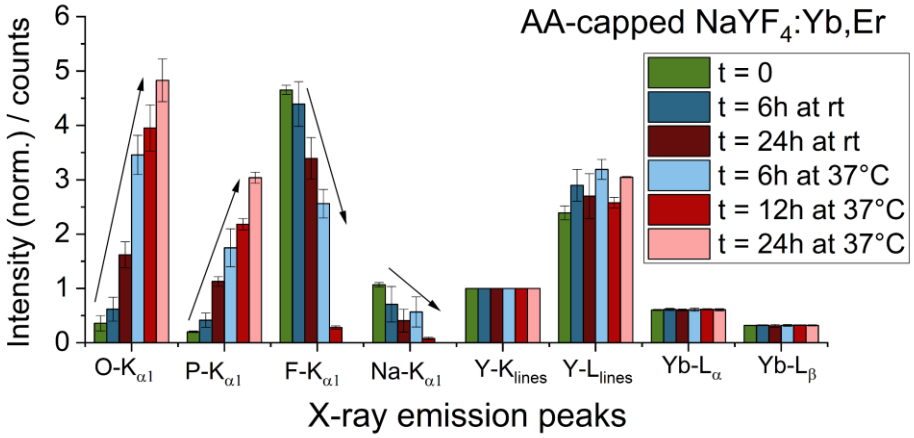
Energy Dispersive X-ray (EDX) Analysis



	t = 6 h at rt	t = 24 h at rt	t = 2 h at 37 °C	t = 6 h at 37 °C	t = 12 h at 37 °C
O-$K_{\alpha1}$	2.84 ± 0.34	3.70 ± 0.19	3.47 ± 0.52	4.19 ± 0.60	4.37 ± 0.49
P- $K_{\alpha1}$	1.15 ± 0.16	2.07 ± 0.05	1.54 ± 0.14	2.25 ± 0.04	2.68 ± 0.06
F- $K_{\alpha1}$	4.32 ± 0.70	1.16 ± 0.23	2.69 ± 0.59	1.24 ± 0.11	0.00 ± 0.01
Na- $K_{\alpha1}$	0.82 ± 0.17	0.55 ± 0.29	0.92 ± 0.21	0.27 ± 0.05	0.00 ± 0.00
Y-K_{lines}	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Y-L	3.44 ± 0.01	3.04 ± 0.03	3.21 ± 0.13	3.21 ± 0.10	3.06 ± 0.07
Yb-L_{α}	0.58 ± 0.01	0.60 ± 0.02	0.57 ± 0.02	0.59 ± 0.03	0.51 ± 0.00
Yb-L_{β}	0.30 ± 0.01	0.31 ± 0.01	0.30 ± 0.01	0.31 ± 0.02	0.27 ± 0.00

Figure S8: Changes in the elemental composition of the analysed ligand-free 21.5 nm-sized UCNP upon aging in PBS.

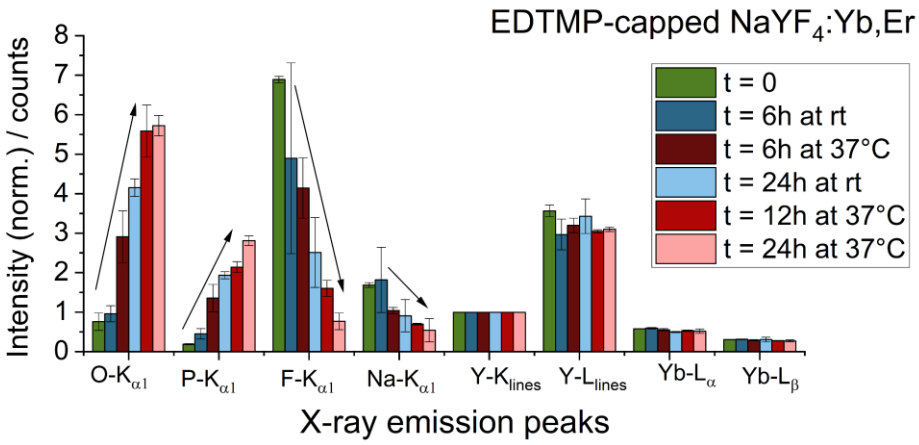
Energy Dispersive X-ray (EDX) Analysis



	t = 0 h	t = 6 h at rt	t = 24 h at rt	t = 6 h at 37 °C	t = 12 h at 37 °C	t = 24 h at 37 °C
O-$K_{\alpha1}$	0.36 ± 0.14	0.62 ± 0.22	1.62 ± 0.24	3.46 ± 0.36	3.95 ± 0.42	4.83 ± 0.39
P- $K_{\alpha1}$	0.20 ± 0.01	0.41 ± 0.13	1.13 ± 0.09	1.75 ± 0.35	2.18 ± 0.10	3.04 ± 0.10
F- $K_{\alpha1}$	4.65 ± 0.09	4.39 ± 0.41	3.39 ± 0.38	2.56 ± 0.26	0.28 ± 0.03	0.00 ± 0.00
Na- $K_{\alpha1}$	1.07 ± 0.04	0.71 ± 0.33	0.41 ± 0.21	0.57 ± 0.20	0.08 ± 0.02	0.01 ± 0.03
Y-K_{lines}	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Y-L	2.39 ± 0.13	2.90 ± 0.29	2.70 ± 0.41	3.19 ± 0.18	2.58 ± 0.10	3.05 ± 0.01
Yb-L_{α}	0.60 ± 0.01	0.61 ± 0.02	0.60 ± 0.02	0.61 ± 0.03	0.62 ± 0.01	0.61 ± 0.02
Yb-L_{β}	0.32 ± 0.00	0.32 ± 0.01	0.31 ± 0.03	0.32 ± 0.01	0.33 ± 0.00	0.32 ± 0.01

Figure S9: Changes in the elemental composition of the analysed alendronate-coated 21.5 nm-sized UCNP upon aging in PBS.

Energy Dispersive X-ray (EDX) Analysis



	t = 0 h	t = 6 h at rt	t = 6 h at 37 °C	t = 24 h at rt	t = 12 h at 37 °C	t = 24 h at 37 °C
O-$K_{\alpha1}$	0.76 ± 0.22	0.96 ± 0.20	2.91 ± 0.66	4.15 ± 0.22	5.59 ± 0.65	5.72 ± 0.26
P- $K_{\alpha1}$	0.19 ± 0.01	0.46 ± 0.13	1.35 ± 0.34	1.93 ± 0.09	2.14 ± 0.14	2.81 ± 0.12
F- $K_{\alpha1}$	6.89 ± 0.08	4.89 ± 2.41	4.14 ± 0.76	2.51 ± 0.88	1.61 ± 0.20	0.77 ± 0.21
Na- $K_{\alpha1}$	1.69 ± 0.06	1.82 ± 0.83	1.04 ± 0.08	0.91 ± 0.41	0.69 ± 0.02	0.55 ± 0.29
Y-K_{lines}	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Y-L	3.57 ± 0.15	2.97 ± 0.39	3.20 ± 0.18	3.43 ± 0.44	3.05 ± 0.04	3.10 ± 0.06
Yb-L_{α}	0.58 ± 0.01	0.60 ± 0.02	0.56 ± 0.03	0.50 ± 0.02	0.54 ± 0.02	0.52 ± 0.05
Yb-L_{β}	0.31 ± 0.00	0.32 ± 0.01	0.29 ± 0.01	0.31 ± 0.06	0.28 ± 0.01	0.27 ± 0.03

Figure S10: Changes in the elemental composition of the analysed EDTMP-coated 21.5 nm-sized UCNP upon aging in PBS.

4. Excitation Power Dependence of the Optical Measurements

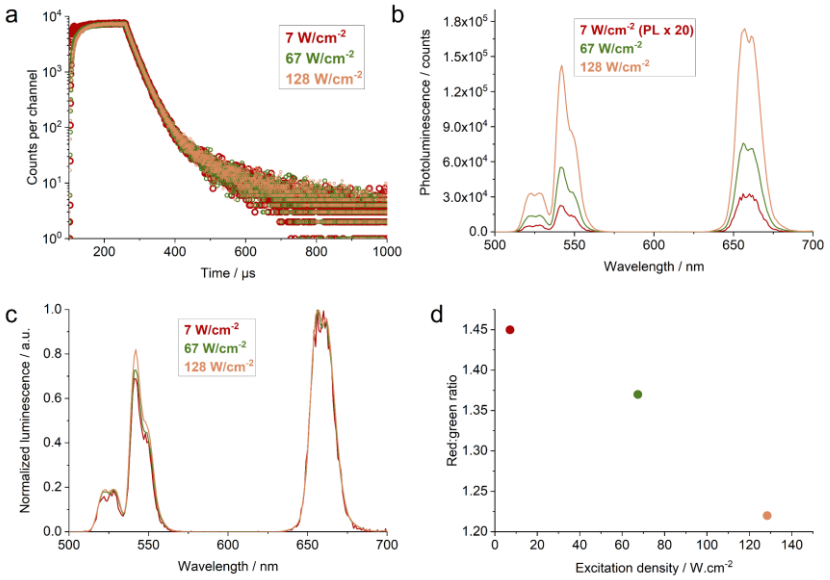


Figure S11: a) Decay at 1000 nm (pulse width 150 at 200 Hz); b-c) photoluminescence and d) red:green ratio of EDTMP-coated 21.5 nm sized UCNP under 978 nm excitation for different excitation power density.

5. Luminescence Lifetime Measurements: Decay curves, Quenching efficiency, Lifetime Components

Ligand-free UCNP in PBS at room temperature (21.5 nm)

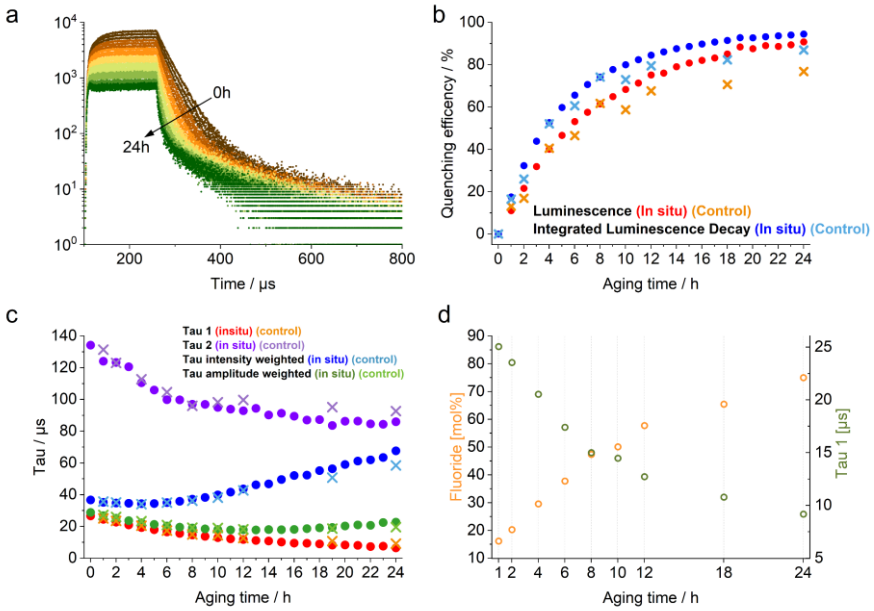


Figure S12: a) Luminescence lifetime of ligand-free UCNP measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz). The particles were incubated at 0.1 mg/mL concentration for 24 h in PBS at 20 °C. The decay spectra were collected hourly for 900 s; b) Quenching efficiency delivered from integrated decay curves (blue) and from the luminescence intensity at 250 µs (red) and the corresponding control measurements (crosses); c) Lifetime components derived from a second-order exponential fitting (circles) and the corresponding control; d) Fraction of released fluoride from UCNP in PBS at room temperature (orange circles) and the corresponding short lifetime component τ_1 (green circles).

Ligand-free UCNP in PBS at 37 °C (21.5 nm)

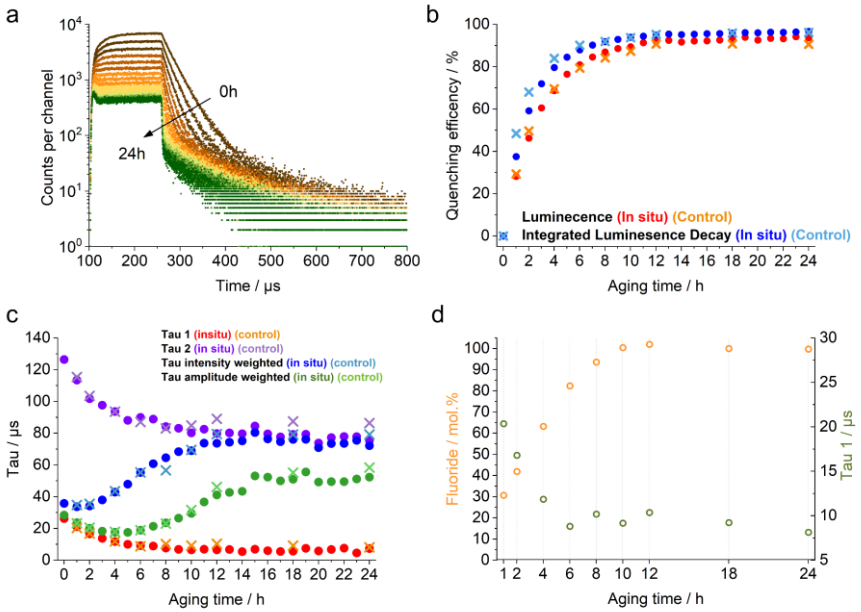


Figure S13: a) Luminescence lifetime of ligand-free UCNP measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz). The particles were incubated at 0.1 mg/mL concentration for 24 h in PBS at 37 °C. The decay spectra were collected hourly for 900 s; b) Quenching efficiency delivered from integrated decay curves (blue) and from the luminescence intensity at 250 µs (red) and the corresponding control measurements (crosses); c) Lifetime components derived from a second-order exponential fitting (circles) and the corresponding control measurements (crosses); d) Fraction of released fluoride from UCNP in PBS at room temperature (orange circles) and the corresponding short lifetime component τ_1 (green circles).

EDTMP-capped UCNP in PBS at room temperature (21.5 nm, indirect route)

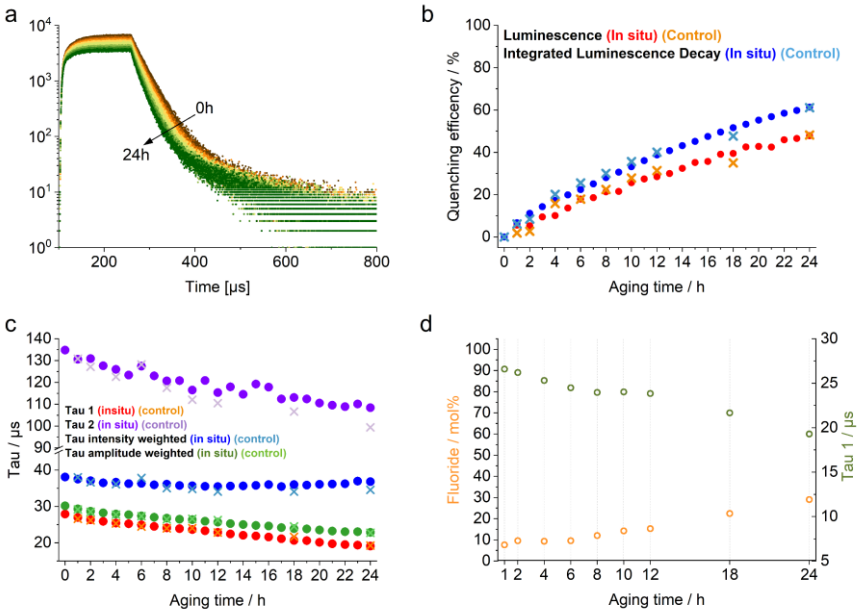


Figure S14: a) Luminescence lifetime of EDTMP-capped UCNP measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz). The particles were incubated at 0.1 mg/mL concentration for 24 h in PBS at 20 °C. The decay spectra were collected hourly for 900 s; b) Quenching efficiency delivered from integrated decay curves (blue) and from the luminescence intensity at 250 µs (red) and the corresponding control measurements (crosses); c) Lifetime components derived from a second-order exponential fitting (circles) and the corresponding control measurements (crosses); d) Fraction of released fluoride from UCNP in PBS at room temperature (orange circles) and the corresponding short lifetime component τ_1 (green circles).

EDTMP-capped UCNP in PBS at 37 °C (21.5 nm, indirect route)

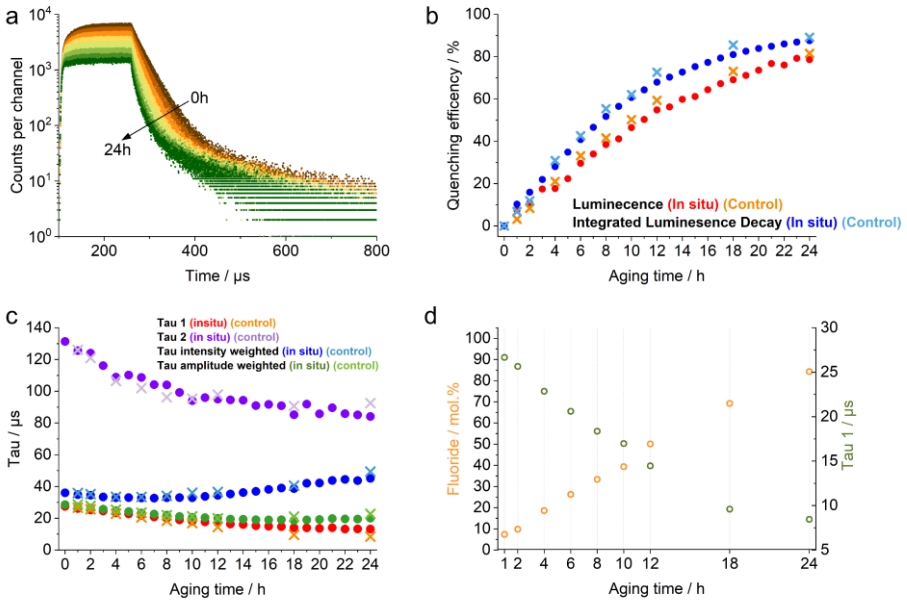


Figure S15: a) Luminescence lifetime of EDTMP-capped UCNP measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz). The particles were incubated at 0.1 mg/mL concentration for 24 h in PBS at 37 °C. The decay spectra were collected hourly for 900 s; b) Quenching efficiency delivered from integrated decay curves (blue) and from the luminescence intensity at 250 µs (red) and the corresponding control measurements (crosses); c) Lifetime components derived from a second-order exponential fitting (circles) and the corresponding control measurements (crosses); d) Fraction of released fluoride from UCNP in PBS at room temperature (orange circles) and the corresponding short lifetime component τ_1 (green circles).

Alendronate-capped UCNP in PBS at 37 °C (21.5 nm, indirect route)

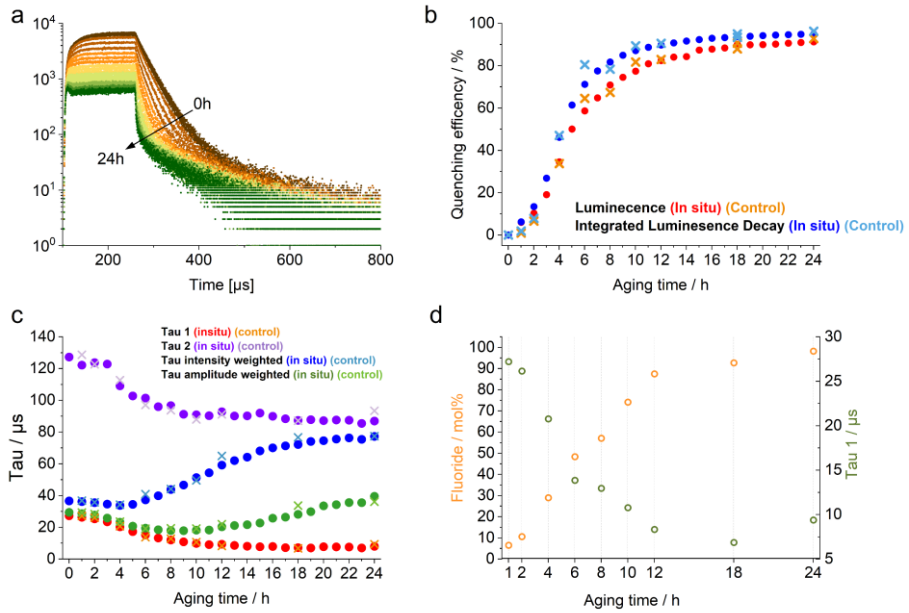


Figure S16: a) Luminescence lifetime of AA capped UCNP measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz). The particles were incubated at 0.1 mg/mL concentration for 24 h in PBS at 37 °C. The decay spectra were collected hourly for 900 s; b) Quenching efficiency delivered from integrated decay curves (blue) and from the luminescence intensity at 250µs (red) and the corresponding control measurements (crosses); c) Lifetime components derived from a second-order exponential fitting (circles) and the corresponding control measurements (crosses); d) Fraction of released fluoride from UCNP in PBS at room temperature (orange circles) and the corresponding short lifetime component τ_1 (green circles).

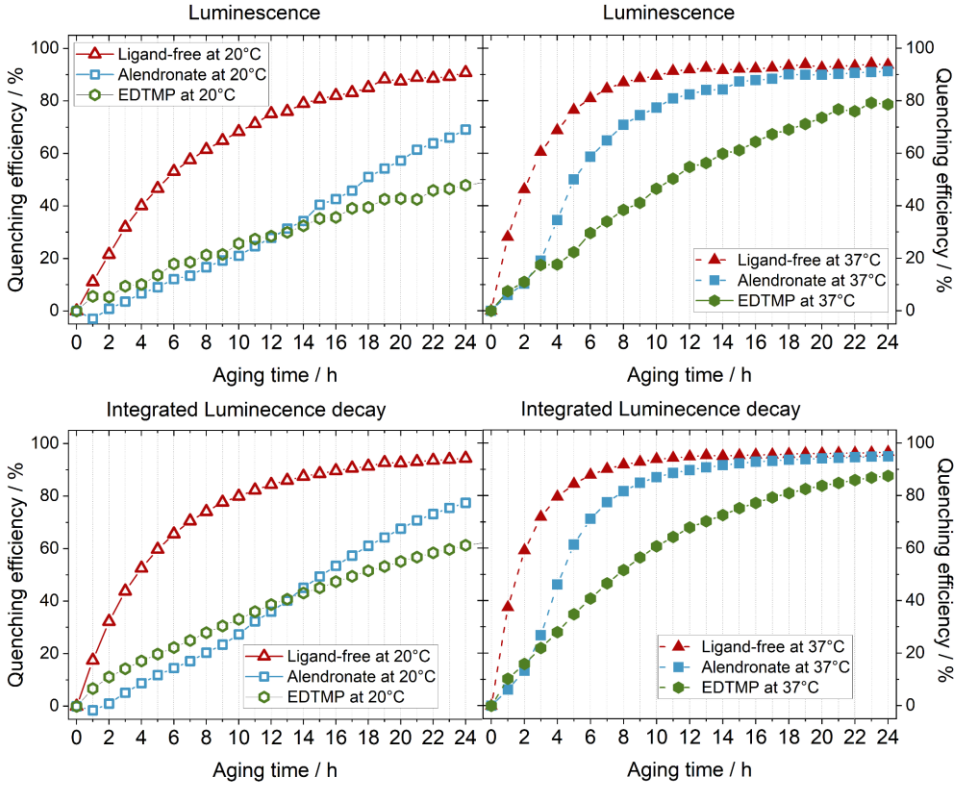


Figure S17: Quenching efficiencies calculated from in situ lifetime measurements for 21.5 nm sized UCNP (indirect route) aged in PBS at 20 °C or 37 °C. The luminescence intensity was observed at 250 µs and for the integrated luminescence decay the curve were integrated in the range from 255 µs to 1000 µs.

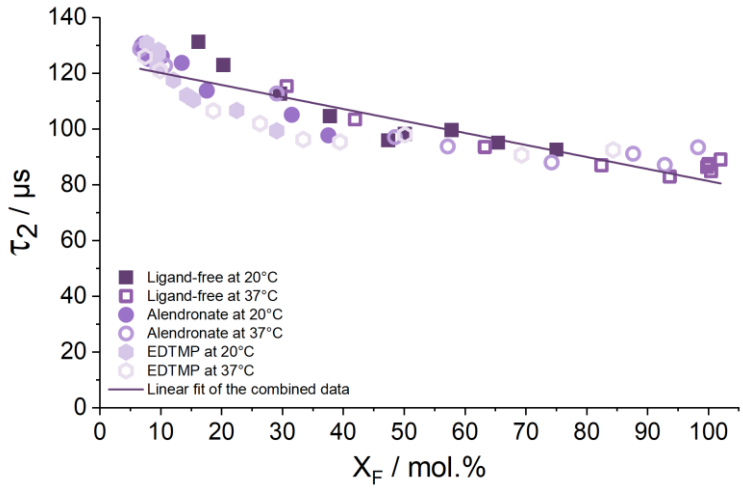


Figure S18: Long lifetimes components of the Yb^{3+} DC emission band (excited at 978 nm and detected at 1000 nm) as function of measured released fluoride for the 21.5 nm particles (indirect route) with various coatings.

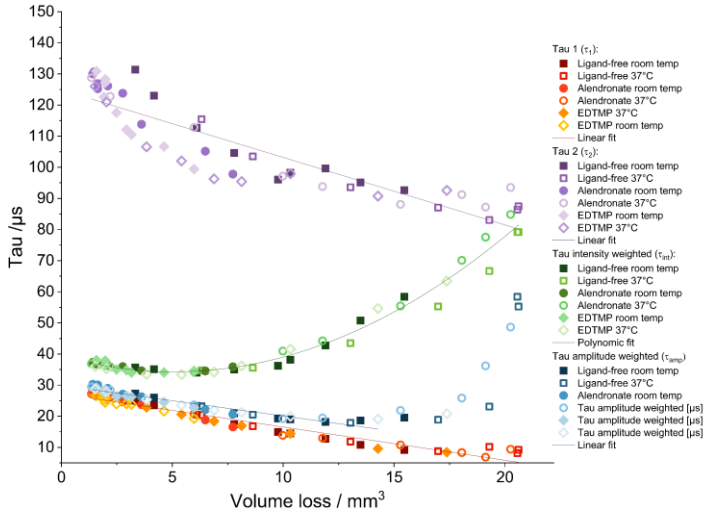


Figure S19: Calculated lifetimes components of the Yb^{3+} DC emission band (excited at 978 nm and detected at 1000 nm) as function of fraction of remaining UCNPs for the 21.5 nm particles (indirect route) with various coatings. The fraction of UCNP was calculated according to the method of Mackenzie et al.[1] using Eq. S5-S8.

EDTMP-capped UCNP in PBS at 37°C (20.5 nm, direct route)

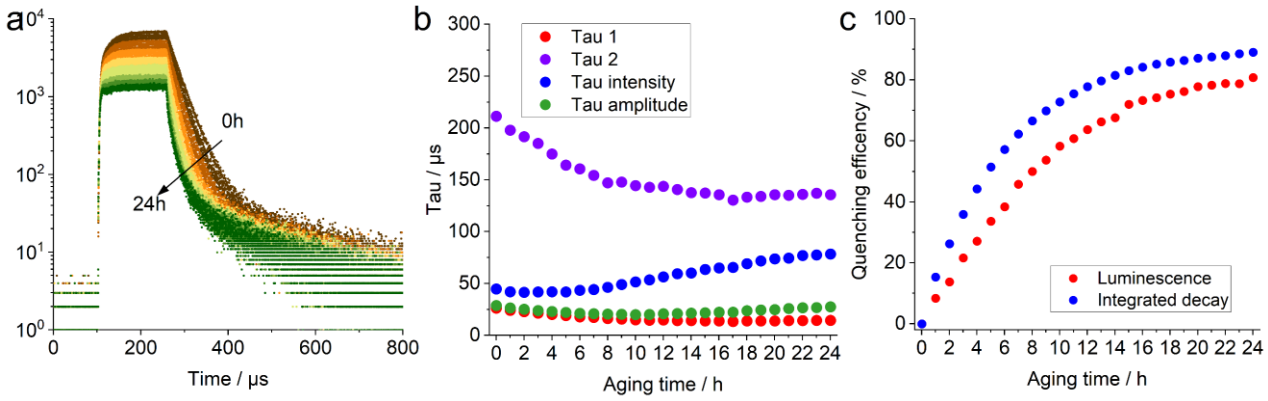


Figure S20: Luminescence lifetime of phosphonate-capped 21.5 nm-sized UCNP (direct route) measured at 1000 nm after excitation at 978 nm (150 µs pulse width at 200 Hz) and calculated lifetimes components.

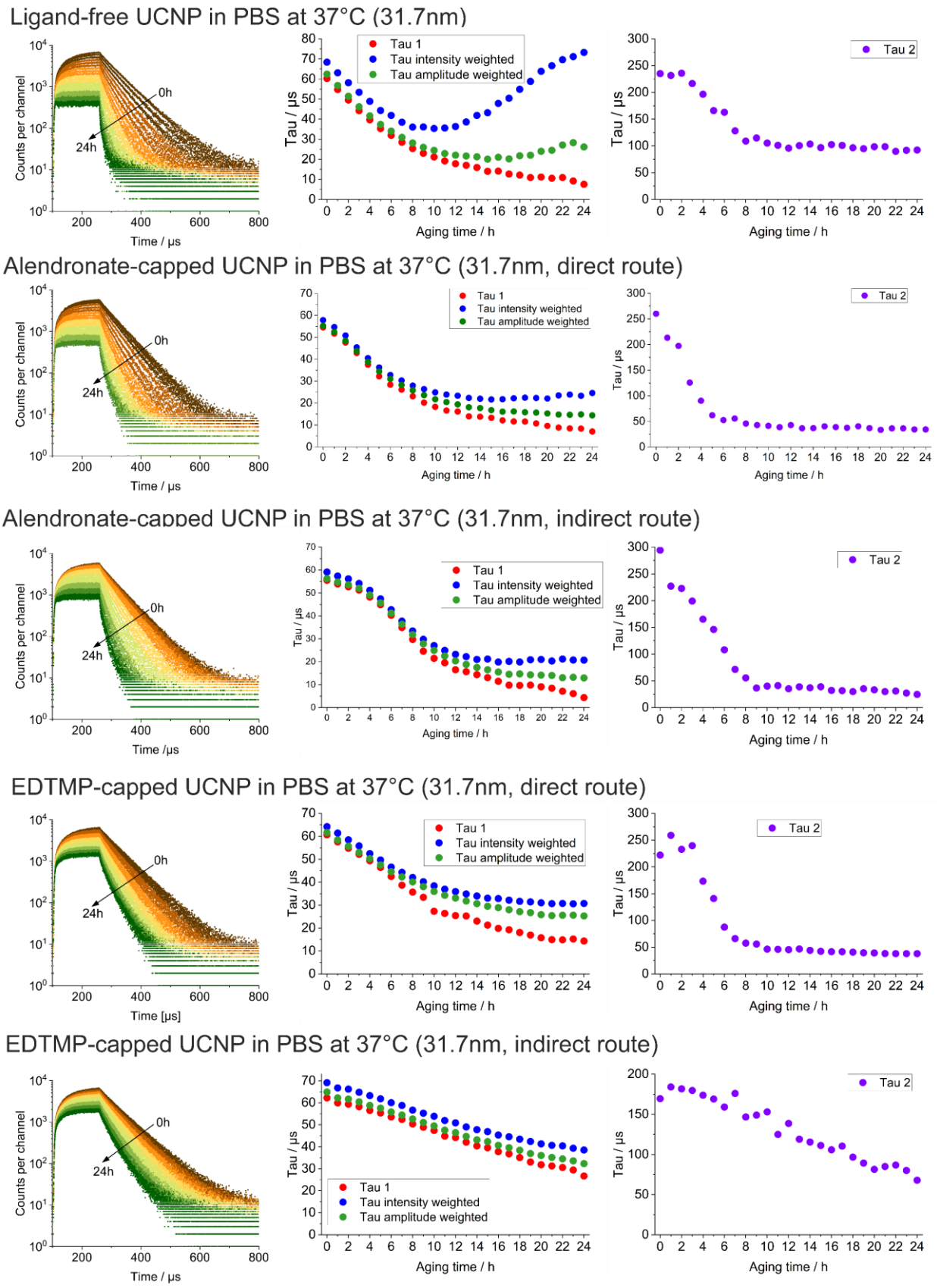


Figure S21: Luminescence lifetime of various 31.7 nm sized UCNP measured at 1000nm after excitation at 978 nm (150 µs pulse width at 200 Hz) and calculated lifetimes components.

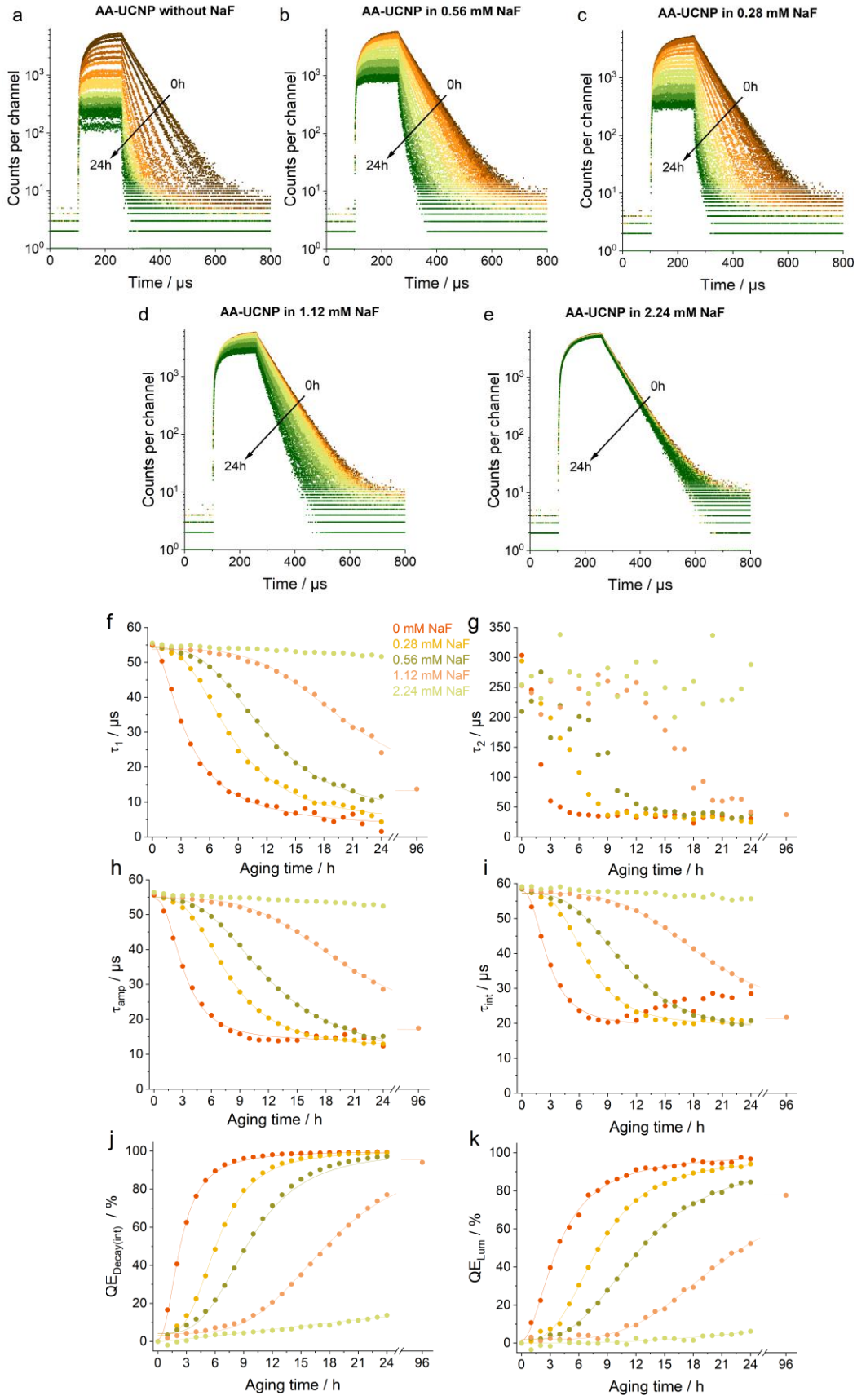


Figure S22: (a-e) Luminescence lifetime of 31.7 nm-sized alendronate coated UCNP in the presence of different amount of NaF measured at 1000nm after excitation at 978 nm (150 µs pulse width at 200 Hz), (f-i) lifetimes components and (j-k) quenching efficiencies calculated from in situ lifetime measurements. Logistic fits according to Eq. 4 were performed for c (NaF) of 0, 0.28, 0.56 and 1.12 mM and are presented in the graphs. Fitting parameters are summarized in Table S7.

6. Equations and Calculations

Calculation of quenching efficiency $\eta_a = \left(1 - \frac{I_a}{I_0}\right) x\ 100\%$ **(Eq. S1)**

with I_0 = initially measured luminescence intensity / integrated luminescence decay curve

I_a = luminescence intensity / integrated luminescence decay curve obtained in the presence of a quenching process

Biexponential function for decay fitting $R(t) = A_1 e^{-\frac{t}{\tau_1}} + A_2 e^{-\frac{t}{\tau_2}}$ **(Eq. S2)**

Intensity weighted lifetime $\tau_{int} = \frac{A_1\tau_1^2 + A_2\tau_2^2}{A_1\tau_1 + A_2\tau_2}$ **(Eq. S3)**

Amplitude weighted lifetime $\tau_{amp} = \frac{A_1\tau_1 + A_2\tau_2}{A_1 + A_2}$ **(Eq. S4)**

with A_1 and A_2 = Amplitudes of the exponential term

τ_1 and τ_2 = Lifetime components

Calculation of volume loss of $NaYF_4$:Yb,Er during dissolution according to Mackenzie et al.:[2]

Estimating the number of unit cells in a hexagonal UCNP

Number of released fluoride atoms: $N(F)_{released} = n(F)_{released} \times N_A$ **(Eq. S5)**

Number of released unit cells: $uN_{released} = N(F)_{released} / 6$ **(Eq. S6)**

(because 1 hexagonal unit cell contains 6 fluoride atoms)

Volume of a hexagonal unit cell: $uV_{hexagonal} = \frac{2\sqrt{3}}{4} a_h^2 c_h$ **(Eq. S7)**

$uV_{hexagonal} = 0.10678\ nm^3$

with a_h = 0.591 nm and c_h = 0.353 nm

Volume loss during dissolution: $uV_{loss} = uN_{released} \times uV_{hexagonal}$ **(Eq. S8)**

Calculation of total dissolution equilibrium constant K_{diss} of $NaYF_4$ nanoparticles in PBS:

$NaYF_4{:}Yb,Er_{(s)} + 137mM\ Na^+ + 2.7\ mM\ K^+ + 139.7mM\ Cl^- + 12\ mM\ {PO_4}^{3-}$
$\longleftrightarrow (137 + 0.65)mM\ Na^+ + 2.7mM\ K^+ + 139.7mM\ Cl^- + (12 - 0.65)\ mM\ {PO_4}^{3-} +$
$2.6\ mM\ F^- + 0.65\ mM\ LnPO_{4(s)} \downarrow$ **(Eq. S9)**

$$K_{diss} = \frac{[Na^+][PO_4^{3-}][F^-]^4}{[Na^+][PO_4^{3-}]} = 1.7\ x\ 10^{-11}$$ **(Eq. S10)**

7. Fitting Parameters of the Curve Fittings

Table S5: Fitting parameters for the logistic curve fitting of ($QE_{Decay(int)}$) in Figure 6.

	A1	A2	x0	p	R^2
Ligand-free 31.7 nm	1.95682 ± 2.58038	100 ± 1.60076	2.90676 ± 0.15033	1.6626 ± 0.13272	0.98983
Ligand-free 21.5 nm	0.25583 ± 0.7088	98.8032 ± 0.3435	1.46549 ± 0.02511	1.44594 ± 0.03363	0.999
EDTMP 31.7 nm direct	1.78636 ± 0.70847	104.7664 ± 1.2693	6.54626 ± 0.12244	1.58056 ± 0.04587	0.99914
EDTMP 31.7 nm indirect	4.80469 ± 1.35408	100 ± 4.347	10.1977 ± 0.5434	1.90588 ± 0.15105	0.99493
EDTMP 21.5 nm direct	1.64772 ± 0.85158	100 ± 1.29099	4.78649 ± 0.12163	1.30864 ± 0.04332	0.9987
EDTMP 21.5 nm indirect	4.49048 ± 1.17802	100 ± 2.7451	7.93352 ± 0.314	1.64067 ± 0.09539	0.99698
Alendronate 31.7 nm direct	1.67455 ± 1.97154	100 ± 1.7009	3.82918 ± 0.13802	1.94978 ± 0.13758	0.99459
Alendronate 31.7 nm indirect	3.3676 ± 0.796	100 ± 0.59782	6.1943 ± 0.06702	3.29396 ± 0.10891	0.9986
Alendronate 21.5 nm direct	1.73642 ± 0.60885	97.14841 ± 0.2225	2.78703 ± 0.02636	2.7479 ± 0.05711	0.99934
Alendronate 21.5 nm indirect	2.73045 ± 0.95931	99.4942 ± 0.46016	3.58827 ± 0.0534	2.55451 ± 0.08316	0.99839

Table S6: Fitting parameters linear correlation in Figure 7.

	Intercept	Slope	R^2
Tau 1	3.806 ± 0.17334	14.57959 ± 0.27018	0.99931
Tau (int)	3.78019 ± 0.16404	14.67673 ± 0.3803	0.99866
Tau (amp)	3.75346 ± 0.15718	15.02227 ± 0.39898	0.99859
QE (lum)	3.92451 ± 0.13337	14.68052 ± 0.20788	0.9996
QE (decay)	2.25466 ± 0.24174	13.70788 ± 0.37679	0.99849

Table S7: Fitting parameters for the logistic curve fitting of lifetimes components and quenching efficiencies calculated from in situ lifetime measurements for of 31.7 nm-sized alendronate coated UCNP in the presence of different amount of NaF in Figure S22.

	NaF	A1	A2	x0	p	R^2
Tau 1	0 mM	55.33995 ± 0.95425	2.40699 ± 0.75771	3.66442 ± 0.12716	1.71331 ± 0.101	0.99573
	0.28 mM	54.60392 ± 0.54568	4.17658 ± 0.77322	8.14735 ± 0.14666	2.73161 ± 0.13456	0.9976
	0.56 mM	54.06858 ± 0.32347	5.78993 ± 0.93776	11.86747 ± 0.1899	3.10411 ± 0.12783	0.99859
	1.12 mM	53.68929 ± 0.30169	13.23886 ± 0.8793	20.12185 ± 0.2869	3.98372 ± 0.18568	0.99454
Tau (amp)	0 mM	54.50033 ± 1.03054	13.72602 ± 0.47017	3.10778 ± 0.12291	2.41242 ± 0.19468	0.99155
	0.28 mM	54.99276 ± 0.24017	11.53416 ± 0.2742	7.64216 ± 0.06207	2.99861 ± 0.07253	0.99939
	0.56 mM	54.96633 ± 0.21323	9.46761 ± 0.63346	11.77401 ± 0.1388	2.96696 ± 0.08509	0.99933
	1.12 mM	54.63203 ± 0.21269	17.02674 ± 0.60153	19.90038 ± 0.2236	3.68544 ± 0.12569	0.99706
Tau (int)	0 mM	57.79473 ± 0.94633	18.86786 ± 0.88251	2.71822 ± 0.11407	2.32004 ± 0.22237	0.9955
	0.28 mM	57.27924 ± 0.47967	19.45248 ± 0.38508	6.74834 ± 0.10911	3.5378 ± 0.18838	0.99686
	0.56 mM	57.18743 ± 0.2736	16.90329 ± 0.56035	10.6471 ± 0.12984	3.3159 ± 0.12425	0.99872
	1.12 mM	57.29708 ± 0.20245	21.31167 ± 0.57176	18.96411 ± 0.20249	3.9463 ± 0.12947	0.99732
QE (Lum)	0 mM	1.37007 ± 1.19147	99.70595 ± 0.83418	3.84145 ± 0.08238	1.89355 ± 0.07433	0.99801
	0.28 mM	1.57672 ± 0.56943	97.02858 ± 0.71591	8.00852 ± 0.07267	2.96618 ± 0.07958	0.99926
	0.56 mM	1.76871 ± 0.40985	95.85324 ± 1.34656	12.35153 ± 0.1436	3.05553 ± 0.08545	0.99937
	1.12 mM	1.91993 ± 0.38452	77.86952 ± 1.13342	20.27036 ± 0.19408	4.08185 ± 0.13132	0.9974
QE (Decay)	0 mM	1.27989 ± 0.8383	100 ± 0.31249	2.36859 ± 0.0341	2.19723 ± 0.05512	0.99904
	0.28 mM	3.3676 ± 0.796	100 ± 0.59782	6.1943 ± 0.06702	3.29396 ± 0.10891	0.99878
	0.56 mM	4.30716 ± 1.14483	100 ± 1.83225	9.55106 ± 0.18022	3.30477 ± 0.19991	0.99664
	1.12 mM	4.17037 ± 0.53179	95.49767 ± 1.44003	17.56921 ± 0.18937	4.02426 ± 0.13011	0.99759

8. References:

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