Supporting Information

Sequential growth of CaF_2:Yb,Er@CaF_2:Gd nanoparticles for efficient magnetic resonance angiography and tumor diagnosis

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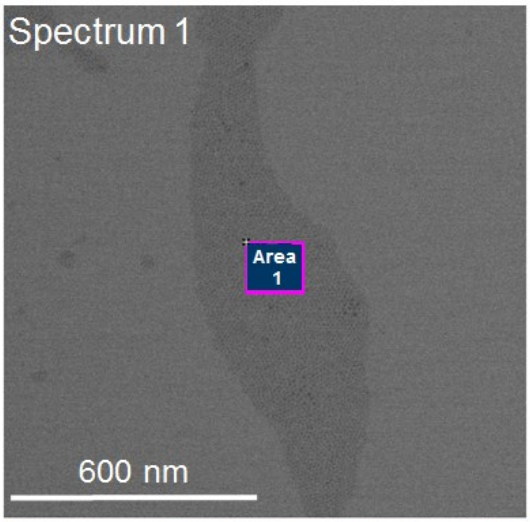
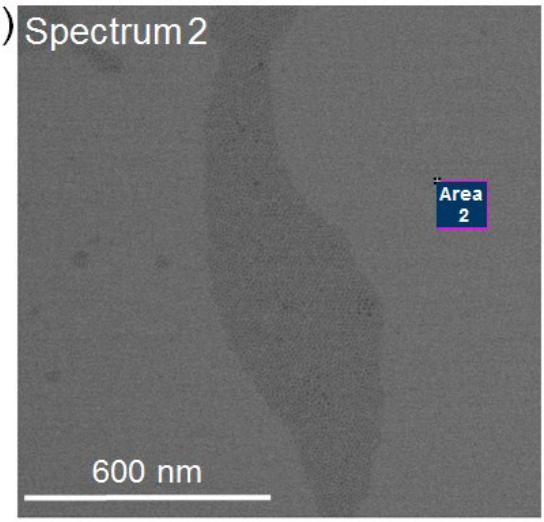
(a)



(b)

Element	Weight%	Atomic%
F	16.04	39.42
Ca	8.43	9.82
Cu	65.2	47.91
Gd	2.41	0.71
Er	0	0
Yb	7.93	2.14
Totals	100	100

(c)



(d)

Element	Weight%	Atomic%
F	0	0
Ca	0	0
Cu	100	100
Gd	0	0
Er	0	0
Yb	0	0
Totals	100	100

Fig. S1. The detailed elemental compositions of the as-prepared CaF_2:Yb,Er@CaF_2:Gd nanoparticles at different transmission electron microscopy (TEM) image area (a, b were at nanoparticles area 1 and c, d were at blank area 2).

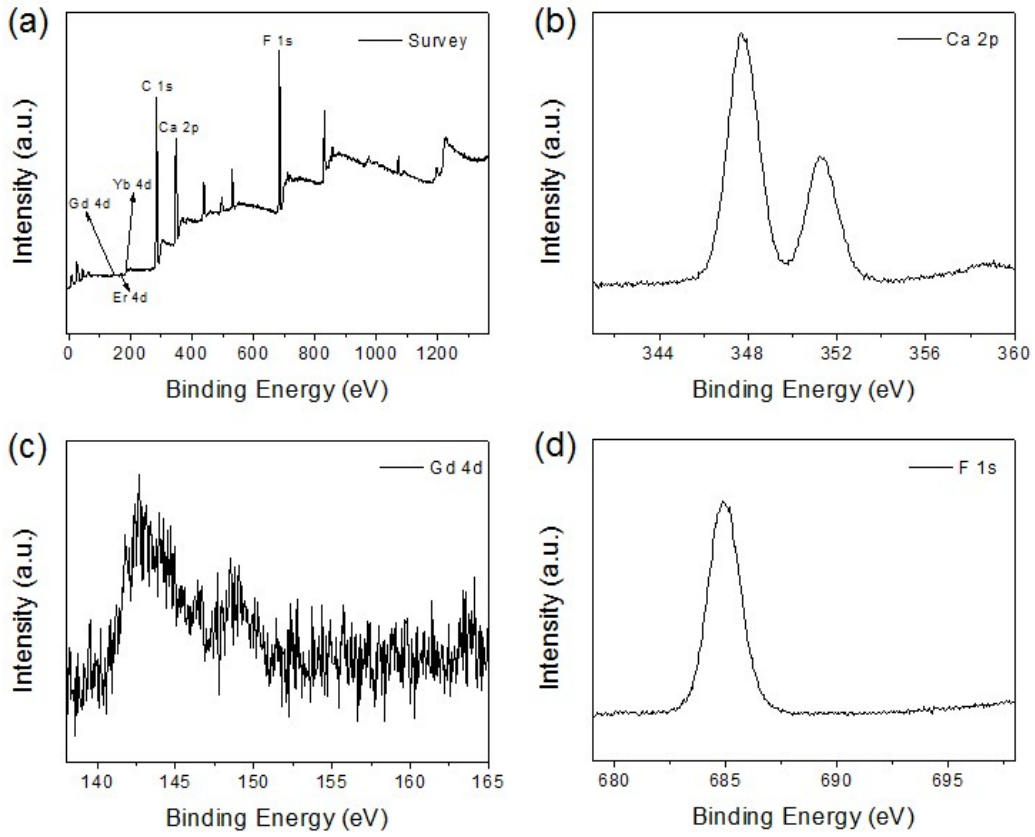


Fig. S2. The X-ray photoelectron spectra (XPS) of the as-prepared CaF_2:Yb,Er@CaF_2:Gd nanoparticles: (a) Survey spectrum, (b) Ca 2p spectrum, (c) Gd 4d spectrum, (d) F 1s spectrum.

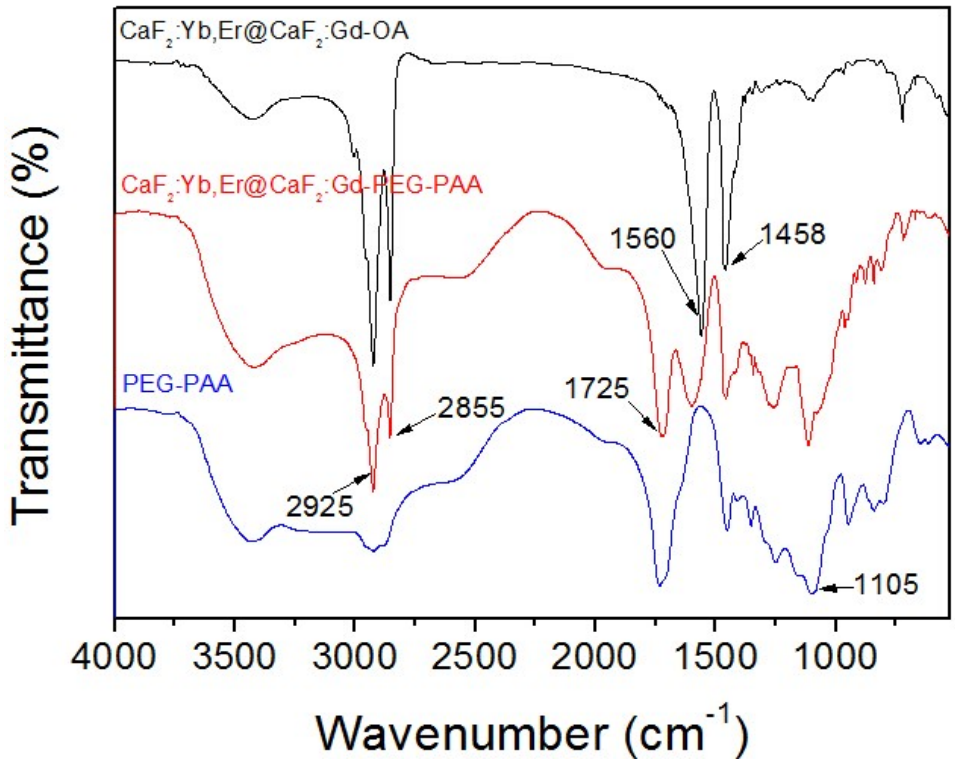


Fig. S3. FT-IR spectra of the CaF_2:Yb,Er@CaF_2:Gd-OA (black line), the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles(red line) and the PEG-PAA di-block copolymer (blue line).

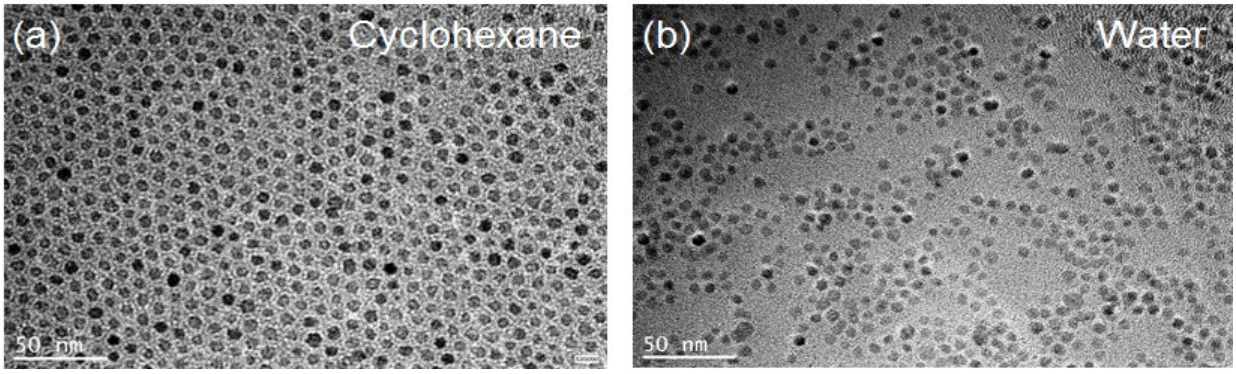


Fig. S4. TEM images of (a) the as-prepared CaF_2:Yb,Er@CaF_2:Gd-OA nanoparticles dispersed in cyclohexane and (b) the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles dissolved in water.

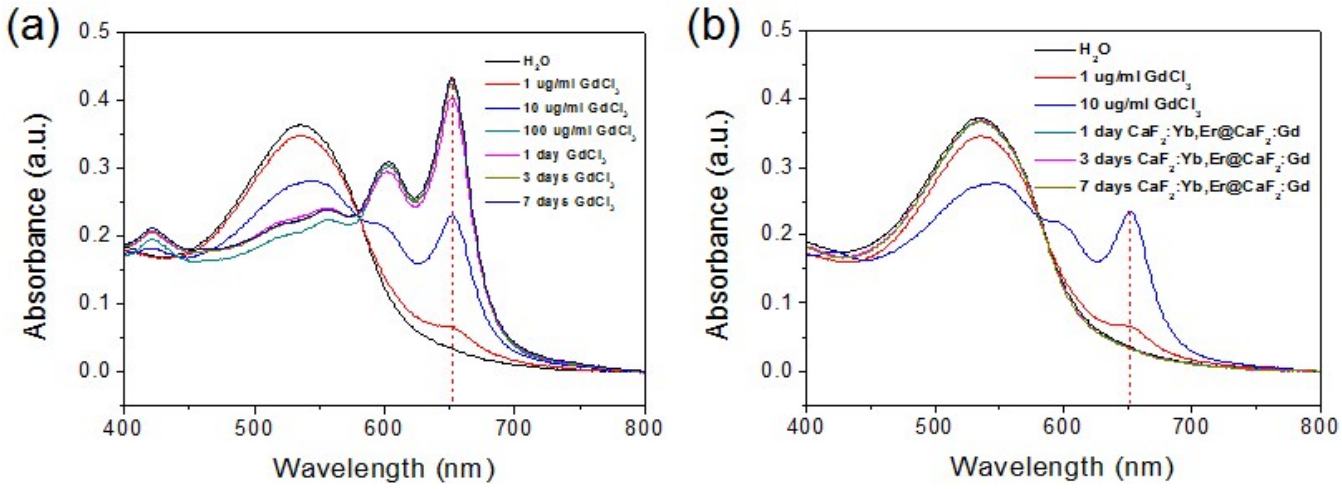


Fig. S5 Absorption spectra of arsenazo III at different filtrates time points obtained after dialysis of 1 mg Gd/mL (a) $GdCl_3$ aqueous solution and (b) the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles aqueous solution to study the leaching of Gd ions from the original aqueous solution .Water and $GdCl_3$ aqueous solution (1 μg Gd/mL, 10 μg Gd/mL and 100 μg Gd/mL)were used as negative and positive controls, respectively.

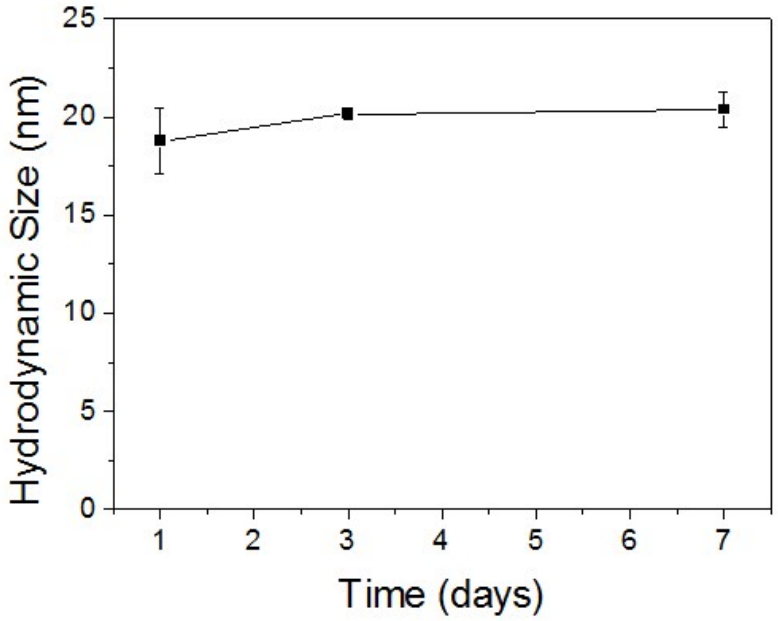


Fig. S6. Hydrodynamic size of the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles aqueous solution at different storage time points measured by dynamic light scattering (DLS).

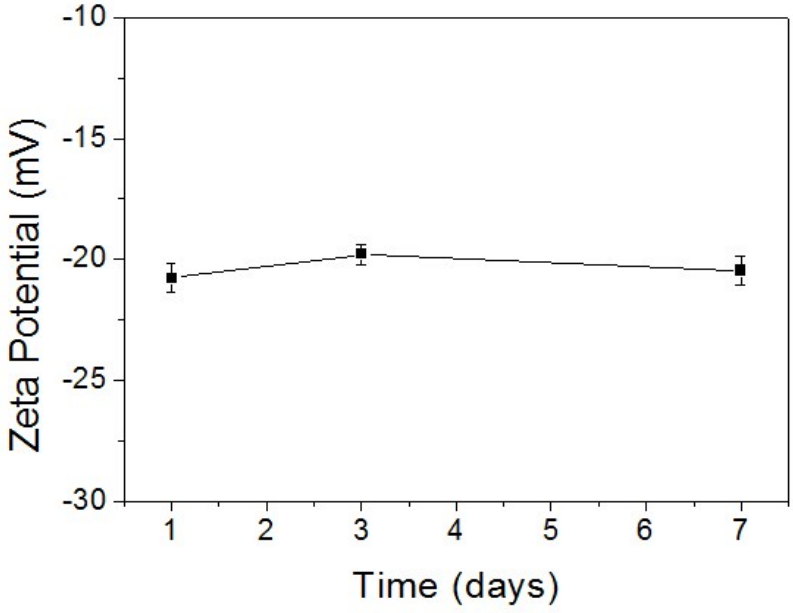
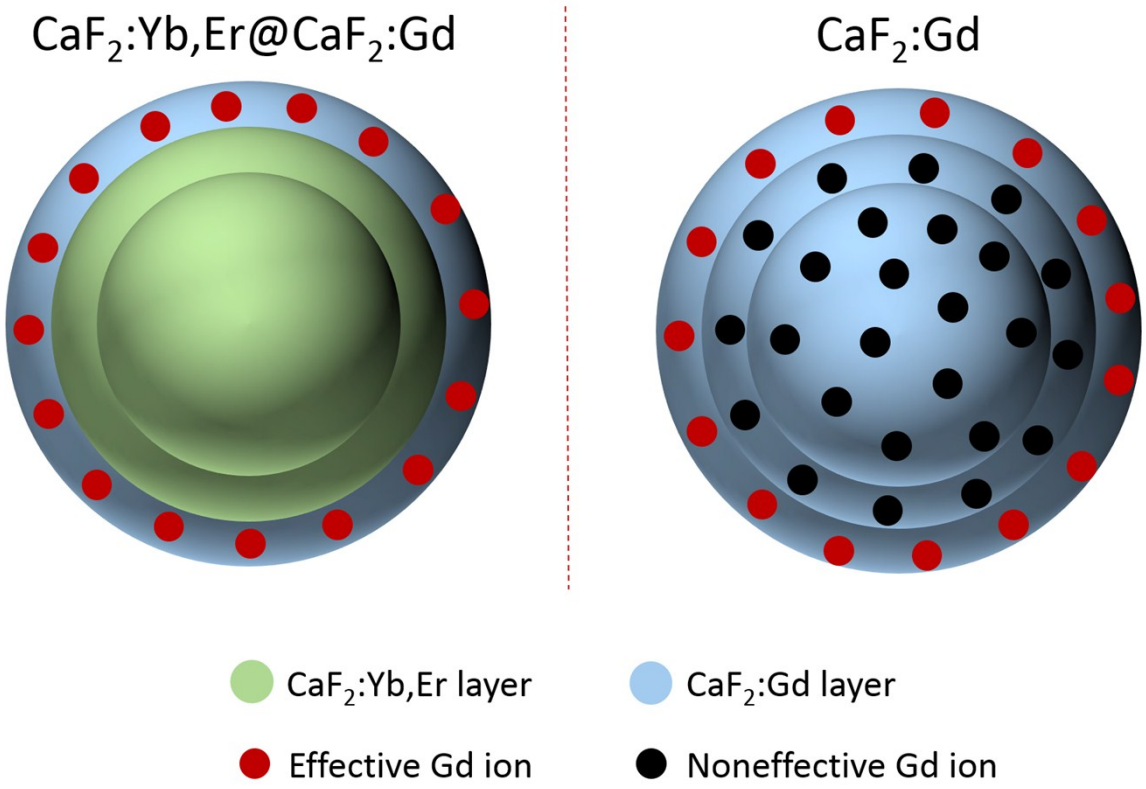


Fig. S7. Zeta potential of the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles aqueous solutions at different storage time points.



Scheme S1. Schematic illustration of the detail structure difference between as-prepared CaF_2:Yb,Er@CaF_2:Gd nanoparticles and CaF_2:Gd nanoparticles.

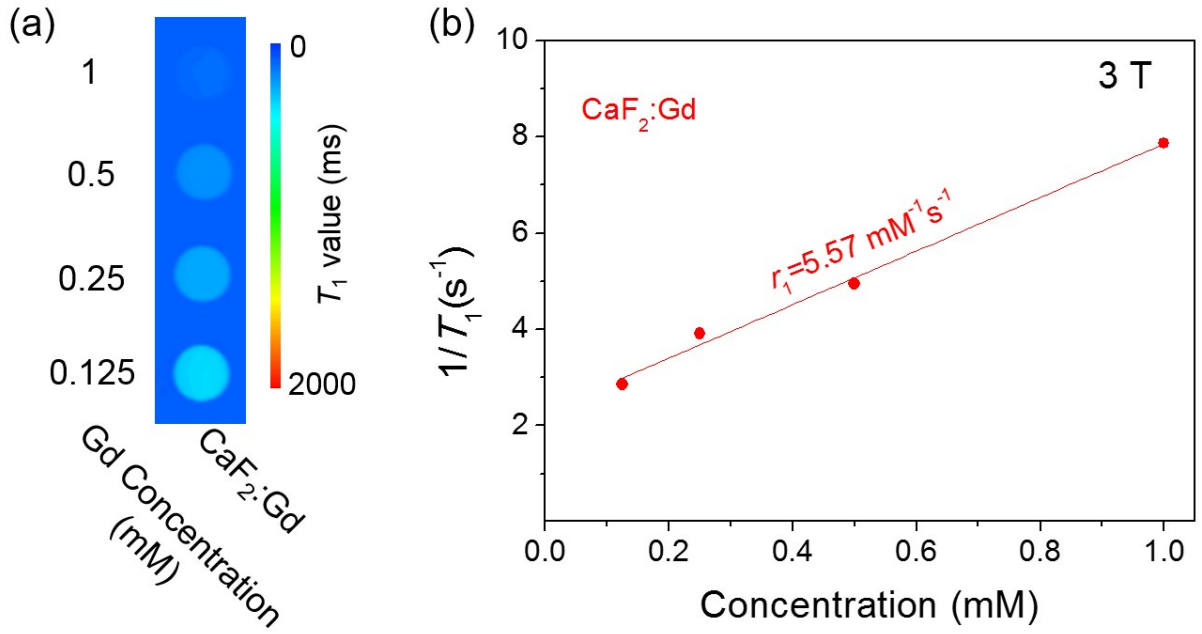


Fig. S8. (a) T_1 maps of the hydrophilic CaF_2:Gd nanoparticles; (b) Comparison of longitudinal relaxivity r_1 of the hydrophilic CaF_2:Gd nanoparticles under 3.0 T.

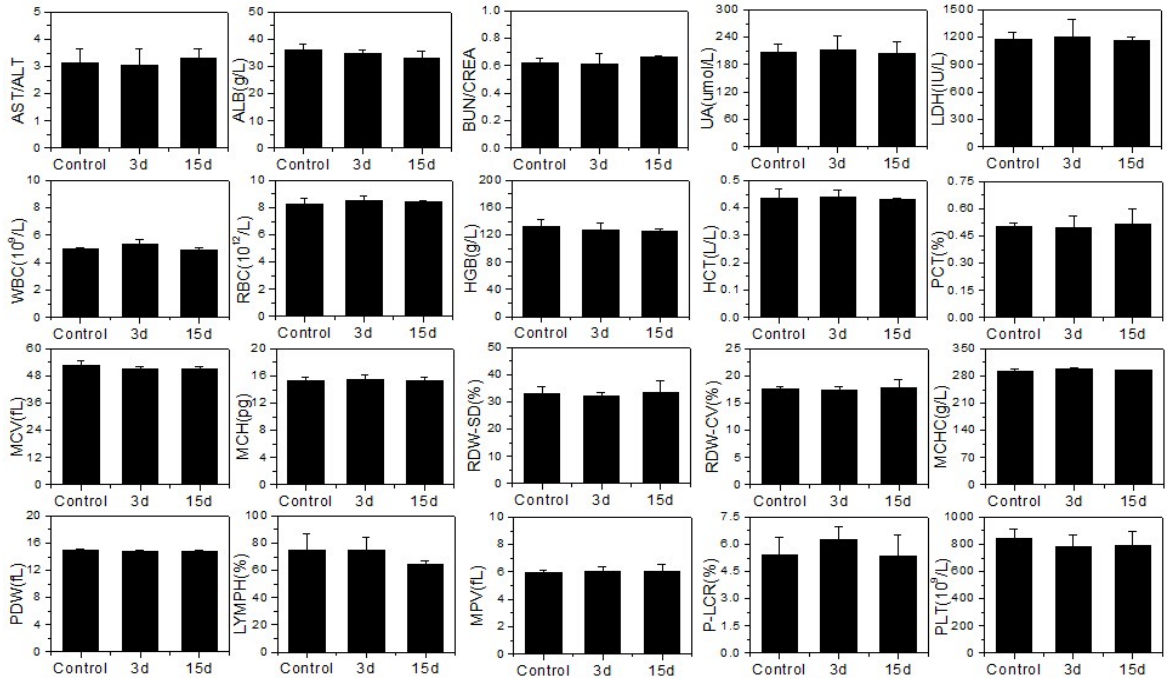


Fig. S9 The other variations of indices of hepatic function, renal function and blood routine tests (n=3), including aspartate transaminase / alanine transaminase ratio (AST/ALT), albumin (ALB), blood urea

nitrogen / creatinine ratio (BUN/CREA), uric acid (UA), lactate dehydrogenase (LDH), white blood cells (WBC), red blood cells (RBC), hemo-globin (HGB), hematocrit (HCT), plateletcrit (PCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), red blood cell distribution width measured by standard deviation (RDW-SD), red blood cell distribution width measured by variation coefficient (RDW-CV), mean corpuscular hemoglobin concentration (MCHC), platelet distribution width (PDW), lymphocyte (LYMPH), mean platelet volume (MPV), platelet-large contrast ratio(P-LCR), platelets (PLT).

Table S1. The detailed elements composition of the hydrophilic CaF_2:Yb,Er@CaF_2:Gd nanoparticles measured by means of ICP-AES.

Element	ICP-AES data (μg/mL)	Weight%	Atomic%
Ca	206.2	22.06	54.31
Yb	491.7	52.59	29.94
Er	34.5	3.69	2.17
Gd	202.5	21.66	13.57
Totals		100	100