

Supporting information for

Synthesize of lanthanide-doped GdVO₄ nanosheet with excellent optical and paramagnetic properties for FRET biodetection and targeting *in vivo* MRI

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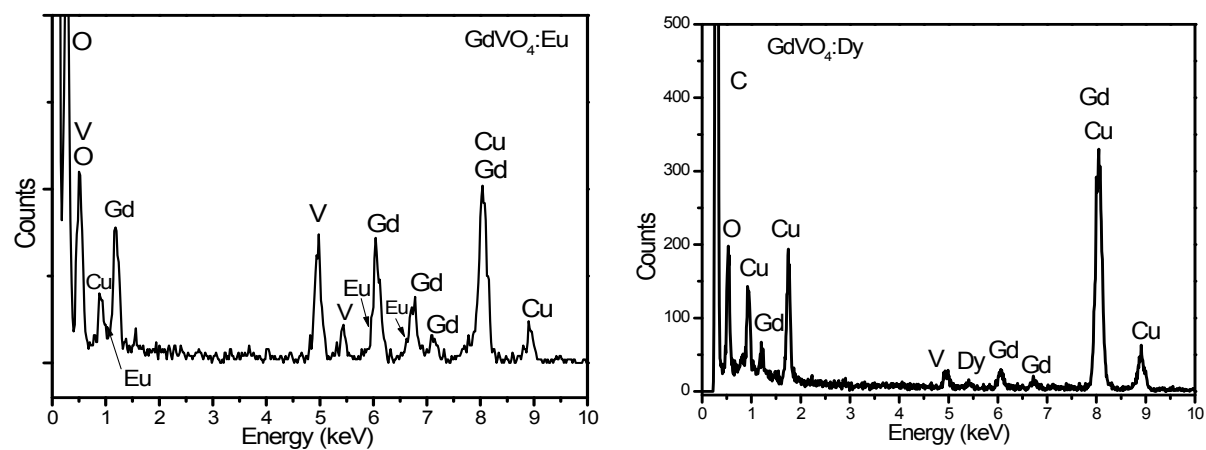


Figure S1. The Energy dispersive x-ray analysis (EDXA) spectrum of $\text{GdVO}_4:\text{Eu}$ and $\text{GdVO}_4:\text{Dy}$ NSs.

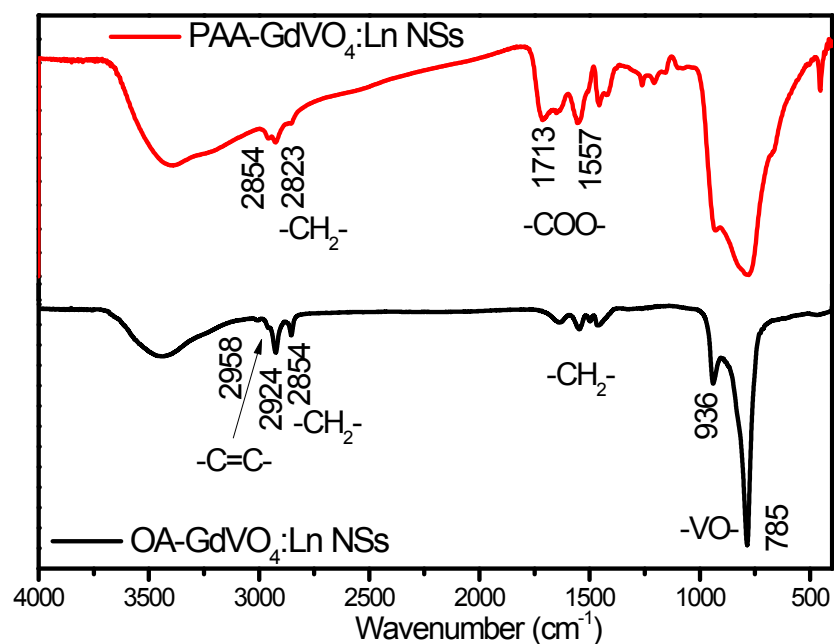


Figure S2. The FTIR of OA- and PAA- $\text{GdVO}_4:\text{Ln}$ NSs.

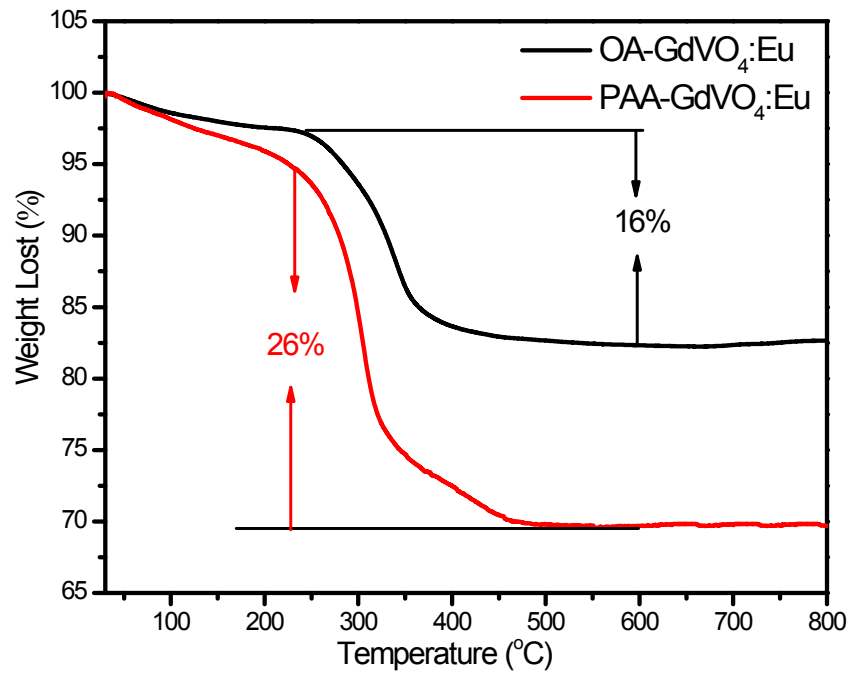


Figure S3. Thermogravimetric analysis (TGA) for NSs before and after ligand exchange.

Results

	Mean (mV)	Area (%)	Width (mV)
Zeta Potential (mV): -29.4	Peak 1: -29.4	100.0	5.49
Zeta Deviation (mV): 5.49	Peak 2: 0.00	0.0	0.00
Conductivity (mS/cm): 0.0107	Peak 3: 0.00	0.0	0.00
Result quality Good			

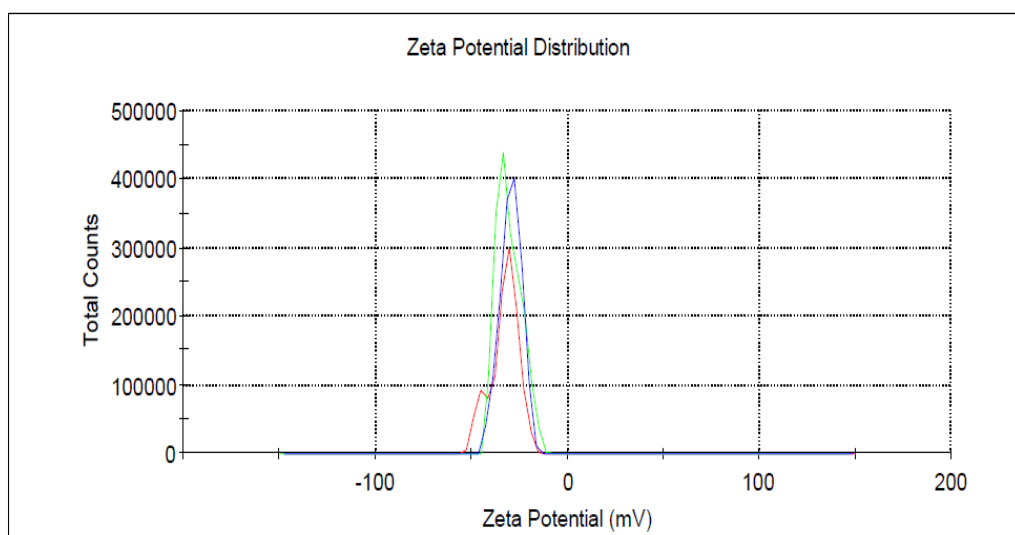


Figure S4. The zeta-potential of PAA-GdVO₄:Ln NSs colloidal aqueous solution.

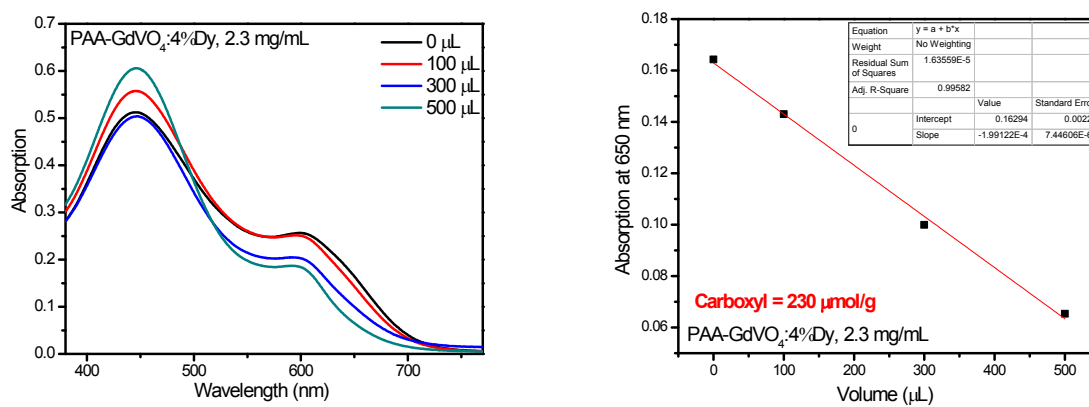


Figure S5. Determination of carboxyl surface concentrations of PAA-GdVO₄:Ln NSs. Left: 0–500 μL of NS aqueous solutions were incubated in 10 mM HEPES, pH 7.5, 200 μM Ni²⁺. Absorption spectra were taken after centrifugation, 2-fold dilution, and addition of 40 μM PV. Right: Plot of the absorbance at 650 nm versus the volume of NSs aqueous solution. The experiments were repeated at least 3 times.

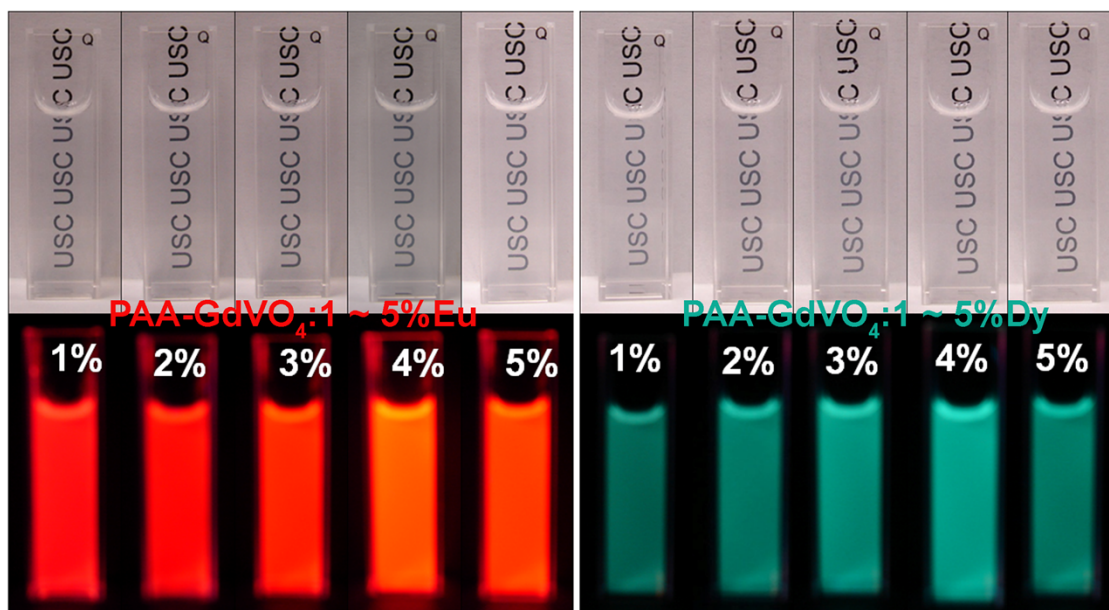


Figure S6. Photograph of PAA- GdVO₄:1-5%Eu and Dy NSs dispersed in aqueous solution with a concentration of 50 µg/mL, and their corresponding visual fluorescence photographs under excitation at 254 nm from a portable UV lamp.

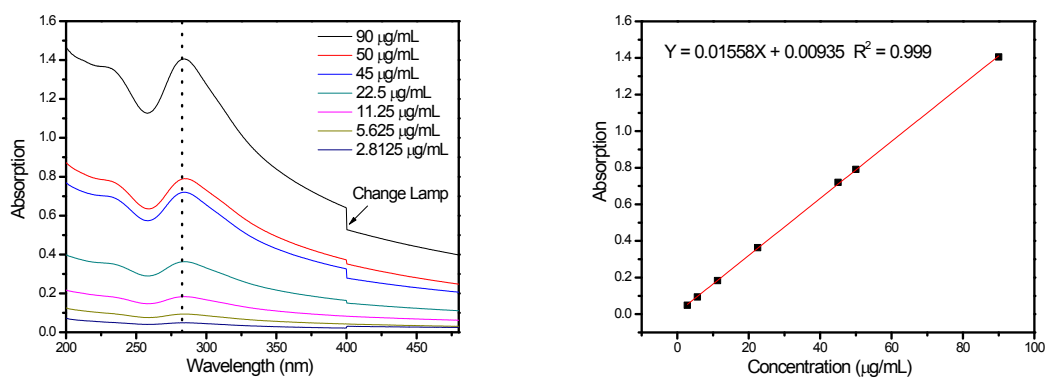


Figure S7. UV-Vis absorption spectra of PAA-GdVO₄:Ln NSs dispersed in aqueous solution with different concentrations, and the relationship of absorption value at 280 nm with different NS concentrations. The concentration of all samples was quantitatively determined by the Absorption-Concentration equation.

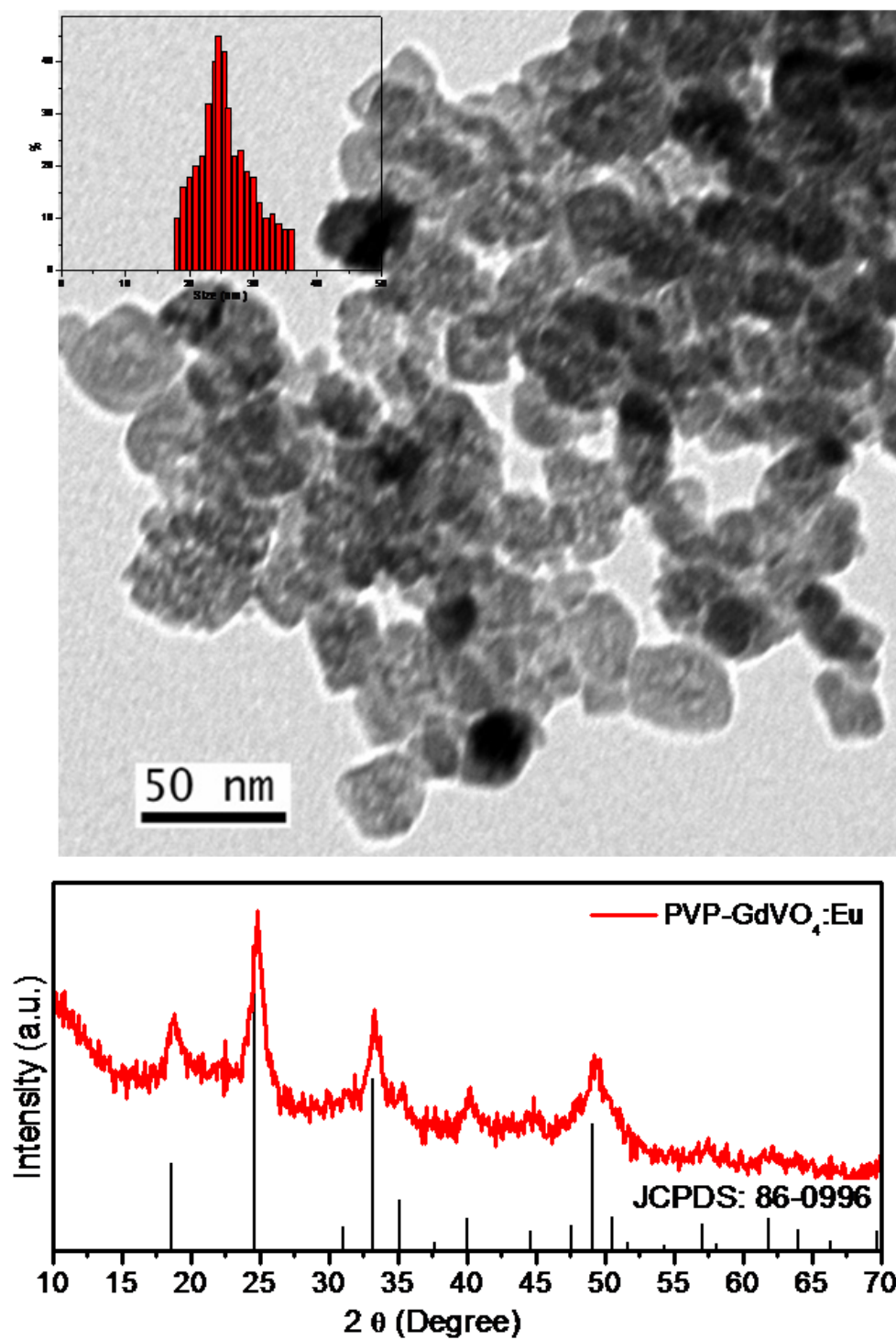


Figure S8. The TEM and XRD patterns of sphere-like PVP-GdVO₄:1–5%Eu nanoparticles with average size of 30 nm.

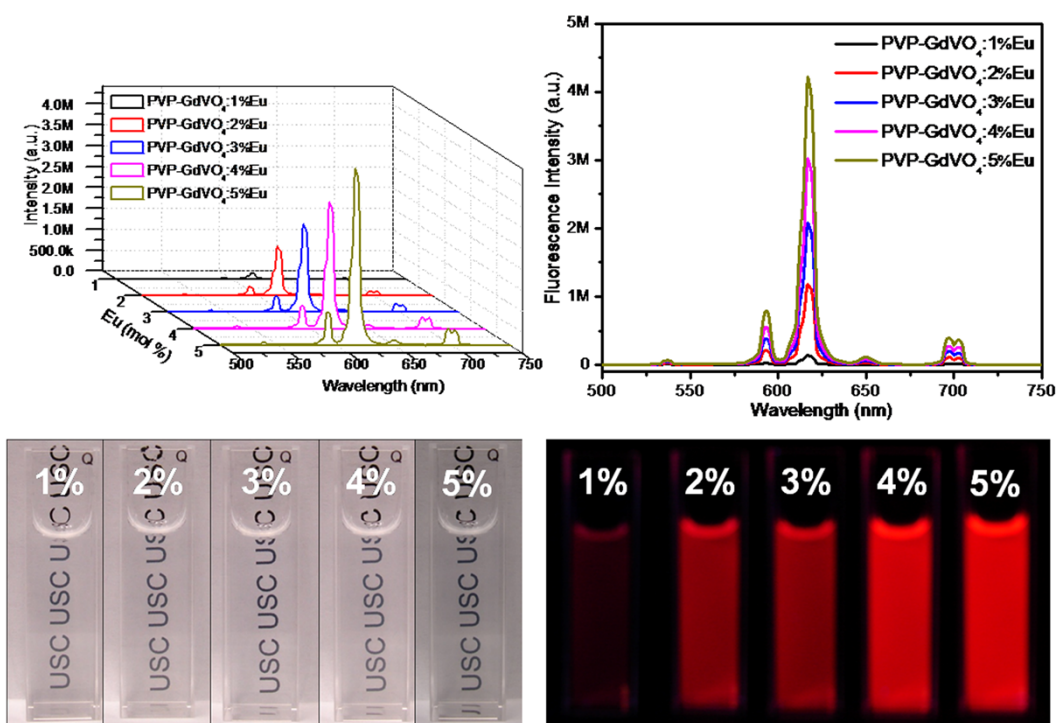


Figure S9. The room-temperature (RT) fluorescence spectra (λ_{ex} : 280 nm) of PVP-GdVO₄ NPs doped with 1–5 mol% Eu³⁺ in aqueous solution with concentration of 50 $\mu\text{g/mL}$, and their corresponding visual fluorescence photographs under excitation at 254 nm from a portable UV lamp.

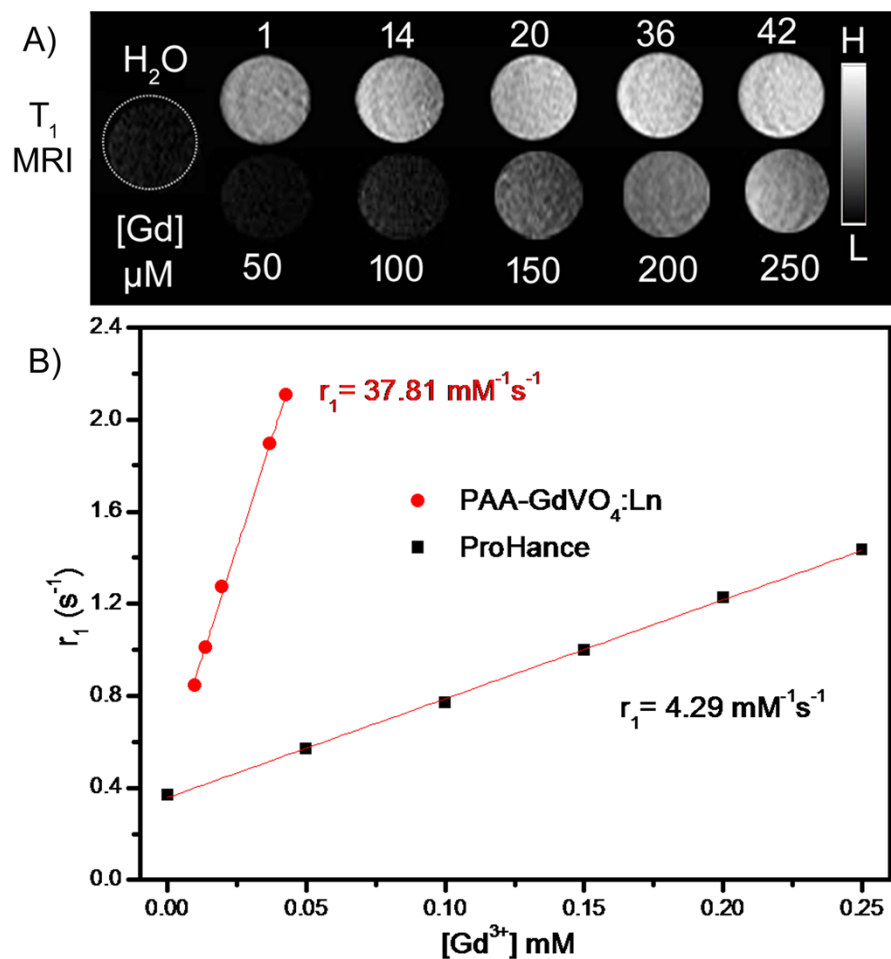


Figure S10. T_1 -weight MR imaging of PAA-GdVO₄:Ln NSs and ProHance[®] aqueous solution at various concentration of Gd³⁺. (the black and white bar changing from black to white indicates the gradual increased in MR signal). b) Water proton longitudinal relaxation rate (r_1) of the NSs and ProHance[®] as function of Gd³⁺ concentration from a 0.5 T MRI system.

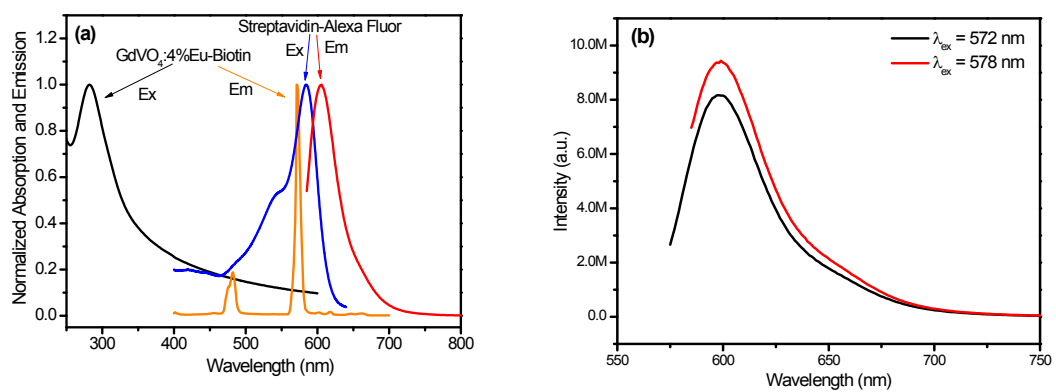


Figure S11. (a) The RT absorption and emission spectrum of GdVO₄:4%Dy³⁺ NSs and Alexa Fluor® 568. The emission band of Dy³⁺ (572 nm) matches well with excitation peak of Alexa entered at 578 nm. (b) the emission spectra of dye Alexa excited at 572 and 578 nm, respectively.

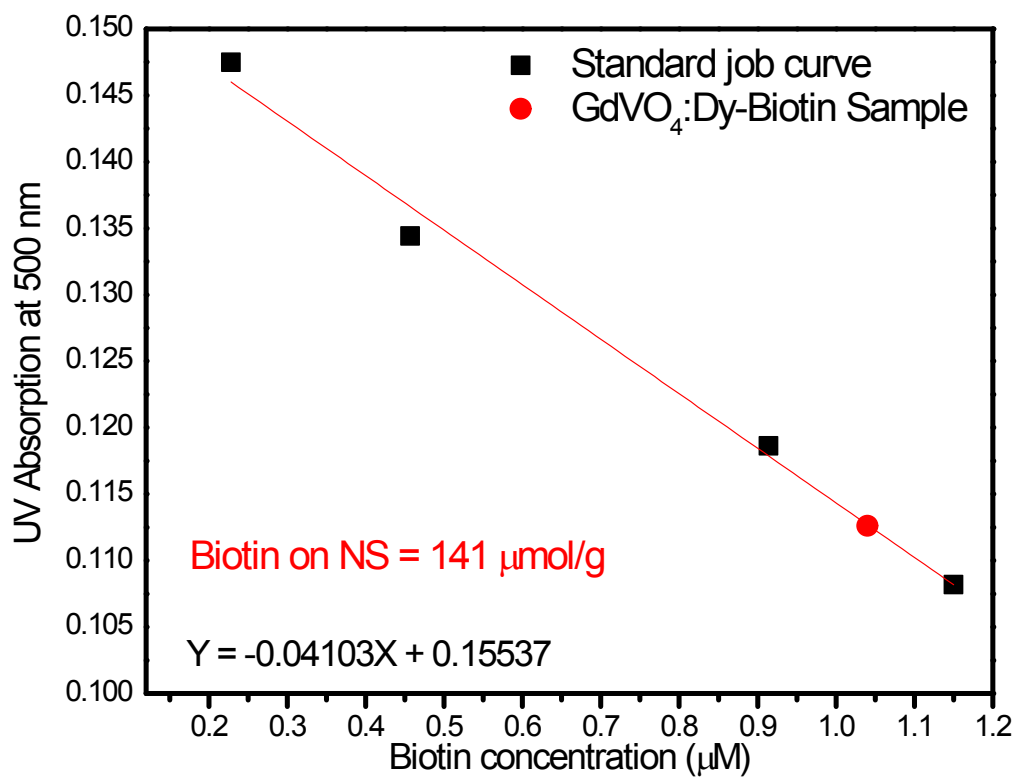


Figure S12. Quantitative analysis of biotin conjugated to GdVO₄:4%Dy³⁺ NSs by using an Avidin/HABA reagent, the amount of biotin attached to the NPs was determined to be 141 $\mu\text{mol/g}$.

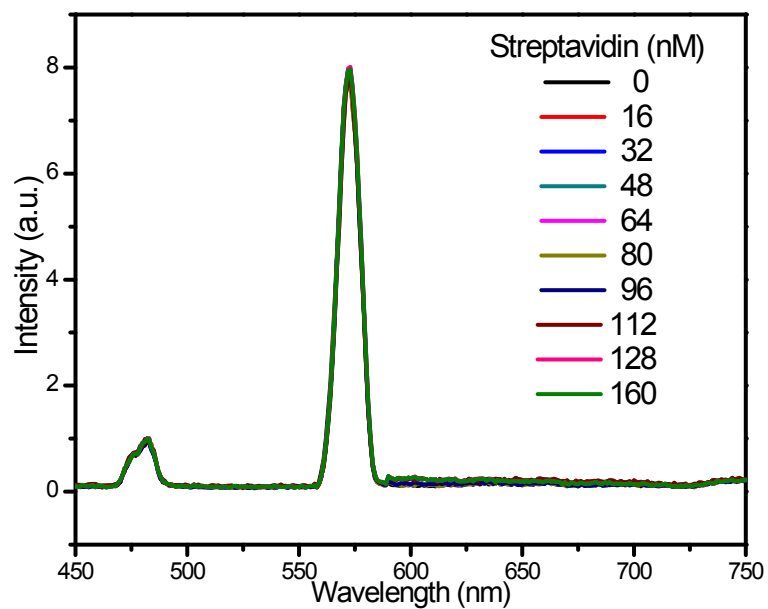


Figure S13. FRET luminescent spectra of the control experiment by employing a mixture of non-biotinylated-GdVO₄:4%Dy³⁺ NSs in presence of different concentrations of streptavidin, where no binding and hence no FRET occurs. All the spectra were normalized to unity at the emission peak of Dy at 482 nm.

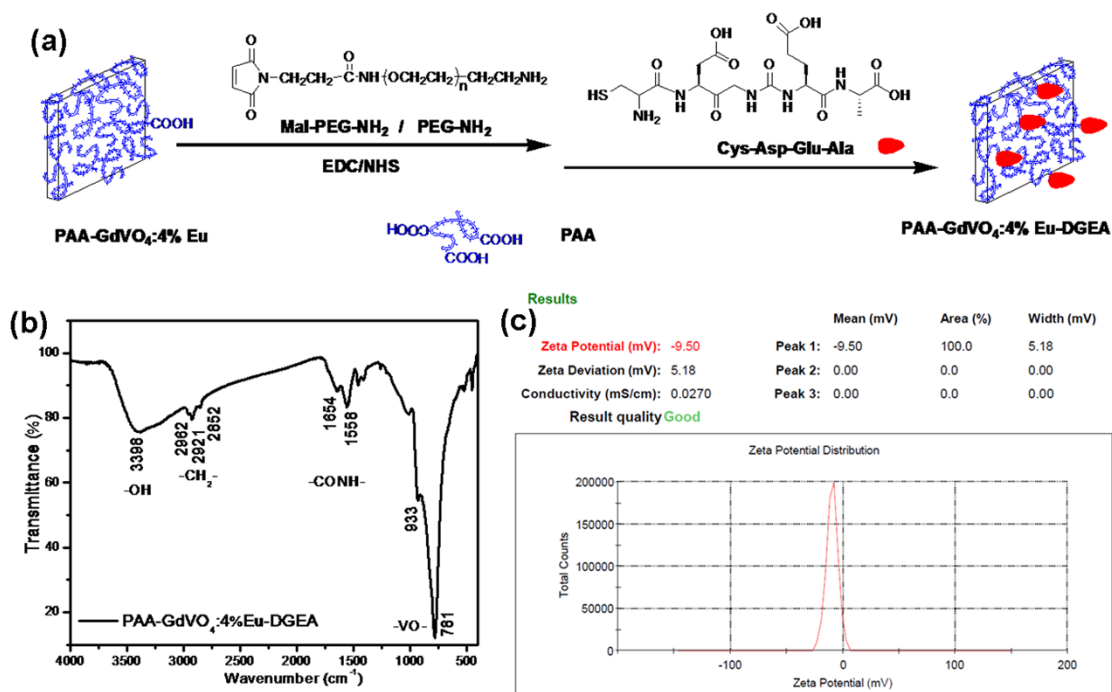


Figure S14. (a) The synthetic route for covalent linking of DGEA peptide to the surface of PAA-GdVO₄:Ln NSs, and (b) the FTIR and (c) zeta potential characterization of the PAA-GdVO₄:Ln-DGEA NSs.

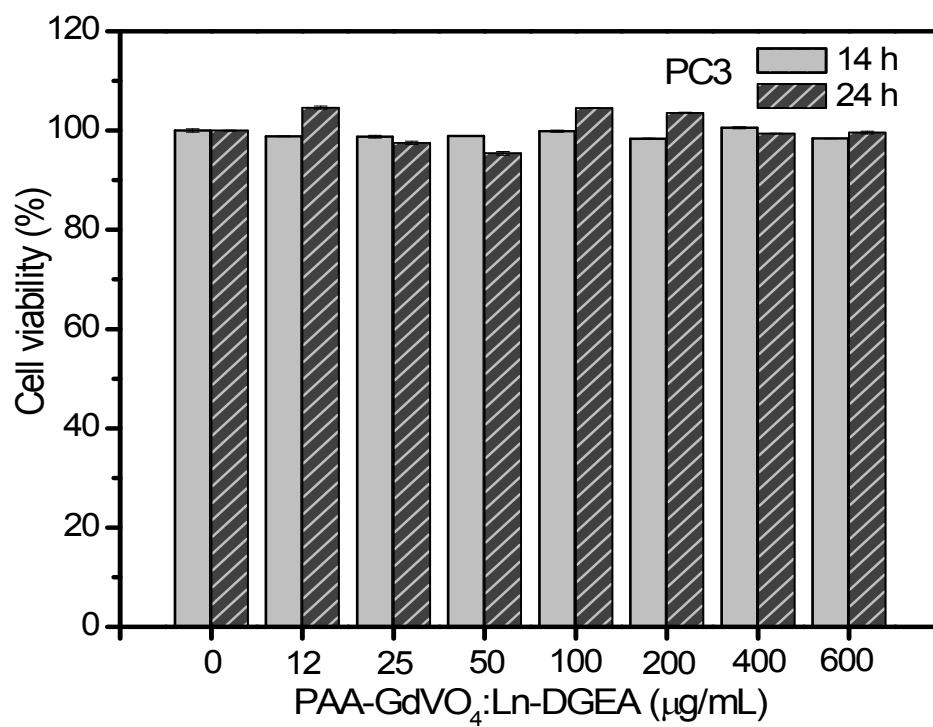


Figure S15. Cell viability of a human prostate cancer cell line (PC-3) incubated with different concentrations of PAA-GdVO₄:Ln-DGEA NSs for 14 and 24 h, respectively.