

SUPPORTING INFORMATION FOR

Like A Pipette to Aspirate and Remove Viable Cancer Cells:

A Reusable and NIR Light-Responsive Film

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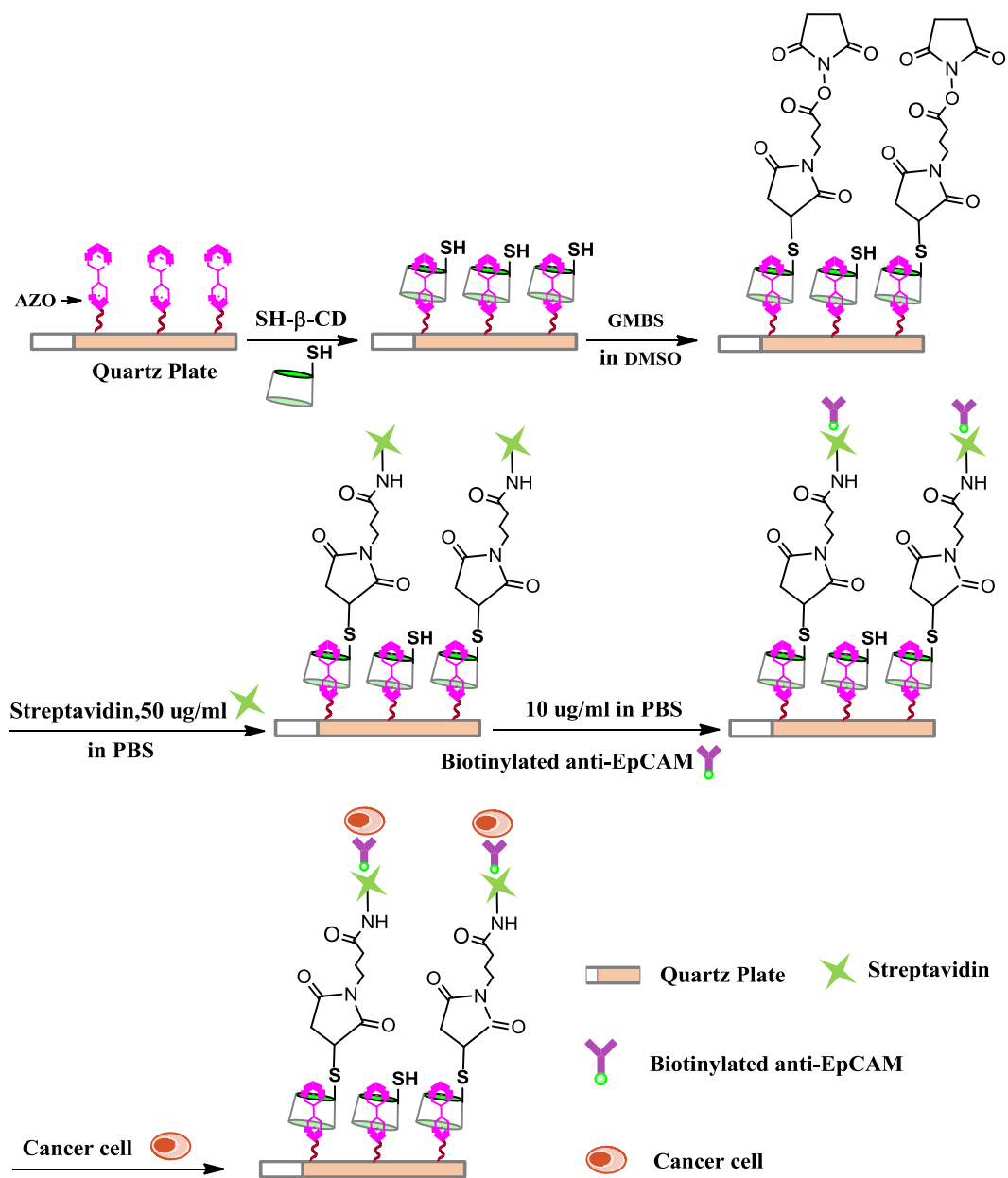
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Scheme S1. Surface modification procedure of the polyelectrolyte multilayers on quartz slide with antibody.

X-ray Diffraction (XRD) measurements of prepared UCNPs

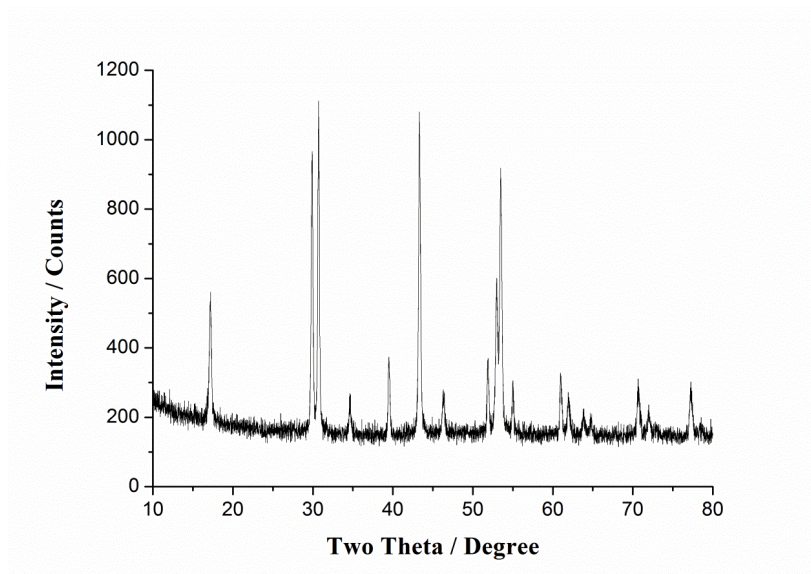


Figure S1. XRD patterns for NaYF₄:Tm/Yb nanocrystals

FTIR measurements of prepared UCNPs and UCNPs@SiO₂

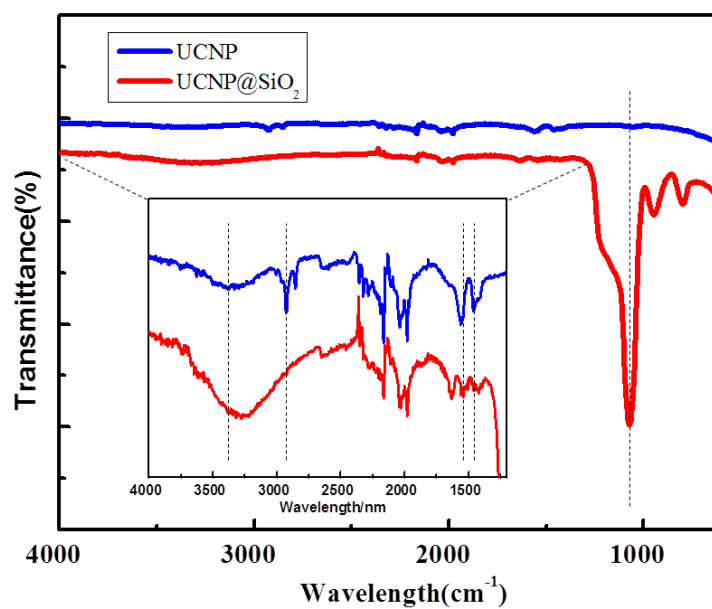
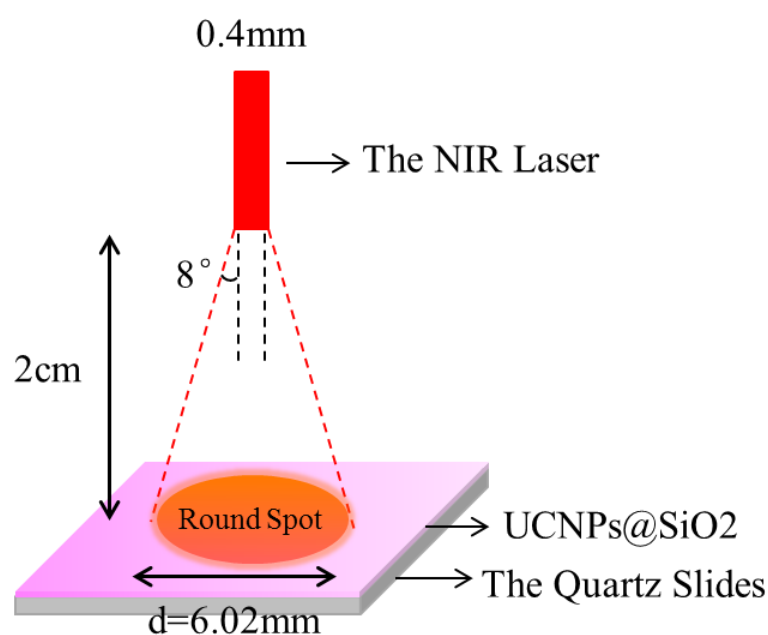


Figure S2. FTIR spectra of NaYF₄:Tm/Yb nanocrystals with and without silica coating.

NIR Activating Photoresponsive Isomerization

In order to calculate the power of the radiation area, the obtained UCNPs@SiO₂ were dispersed in ethanol and deposited on a quartz slides. Then, the quartz substrate loading UCNPs@SiO₂ was exposed to 980 nm NIR laser. The continuous wave 980nm NIR laser (MDL-N-980, Changchun New Industries Optoelectronics Technology Co., Ltd.) was used for irradiation. The power of the laser was calibrated using a UV-A radiometer (Beijing Normal University Optical Instrument Factory, China). As illustrated in Scheme S2, with the distance of 2.0 cm, the irradiation area of the 980 nm laser was a round spot with the diameter of 6.02 mm. Upconversion luminescence spectra and UV-vis spectra were measured to confirm the isomerization of the *trans*-azo group into *cis*-azo when the mixed solutions were irradiated by 980 nm NIR. Control experiment was done without any NIR irradiation.



Scheme S2. Scheme of the NIR irradiation on the azo/UCNPs solutions or the substrate. The NIR light was from an external adjustable 980 nm laser (2 W). The sample was placed 2 cm away from the optical fiber.

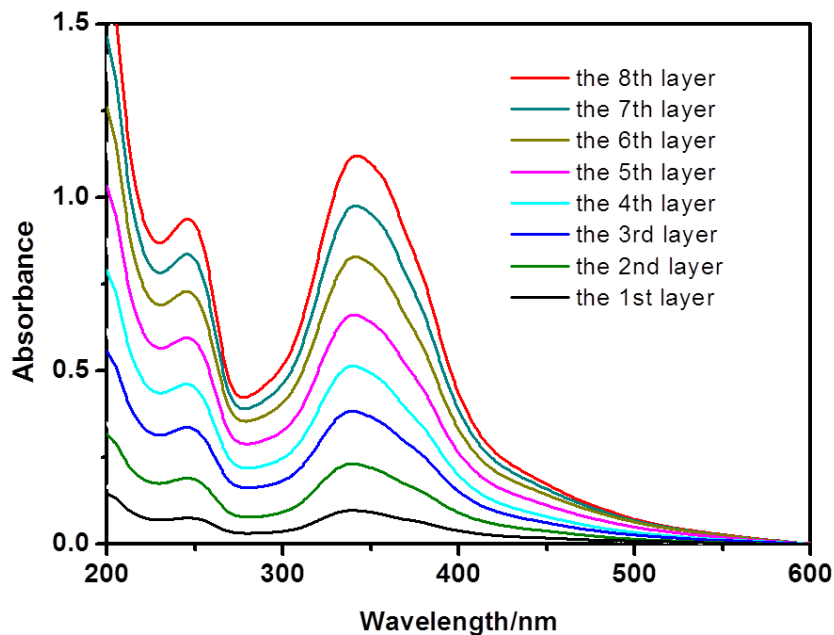


Figure S3. Absorption spectra of the multilayers of $(\text{PAA-C}_2\text{-Azo/Chi})_{m=7}/\text{PAA-C}_2\text{-Azo}$ assembled on a APTES-coated quartz glass substrate (“ m ” denotes the total number of bilayers), measured after each azo-polymer dipping. The absorption bands between 300 and 400 nm are mainly attributed to *trans*-azobenzene ($\pi\text{-}\pi^*$ transition), and their intensities increase with the number of dipping, which indicates the buildup of multilayers in a Layer-by-Layer manner.

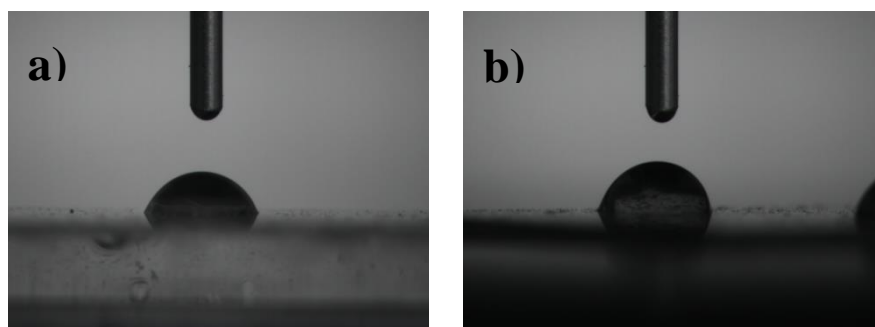


Figure S4. The shapes of water drops on a $(\text{PAA-C}_2\text{-Azo/Chi})_{m=5}/\text{PAA-C}_2\text{-Azo}$ film with flat quartz slide: (a) as-prepared, (b) after heat treatment at 110 °C for 1 h.

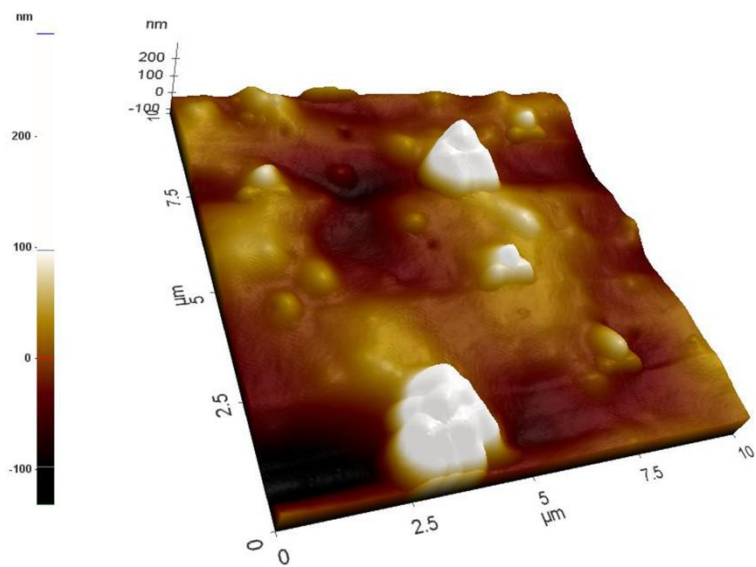


Figure S5. AFM image of the surface of cross-linked (PAA-C₂-Azo/Chi)₆/PAA-C₂-Azo film. The scan size is 10 μm × 10 μm.

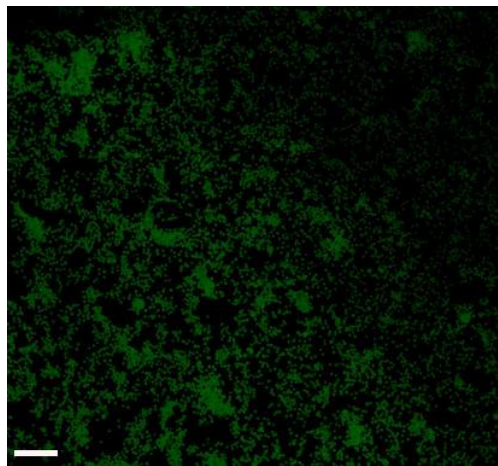


Figure S6. Immunofluorescent staining of EpCAM-loaded quartz slide surface. Secondary immunofluorescent labeled antibody (IF Kine Green AffiniPure Donkey Anti-Goat IgG) was used, shown here is EpCAM expression in green. The scale bars are 100 μm.

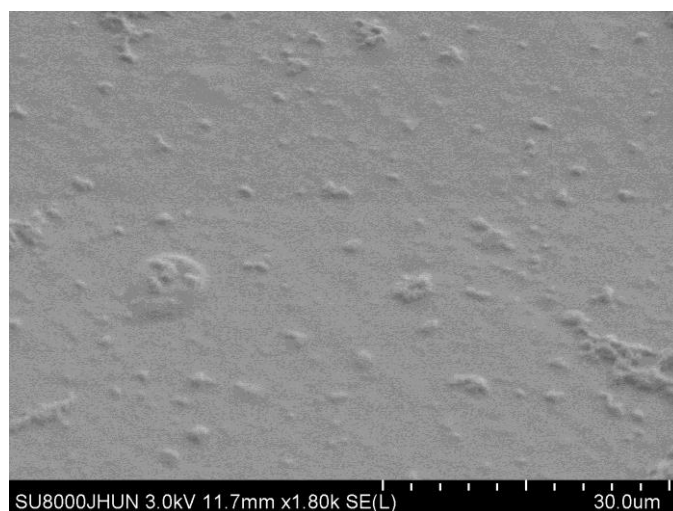


Figure S7. SEM image of antibody-immobilized (PAA-C₂-Azo/Chi)₆/PAA-C₂-Azo multilayer. The scale bars are 30 μ m.

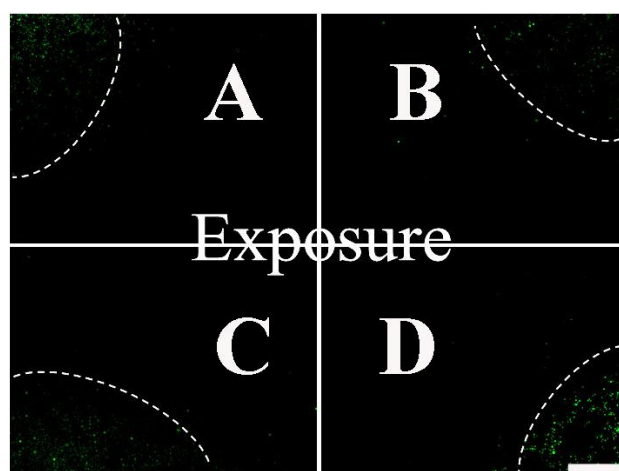


Figure S8. Fluorescence image of NIR light-induced cells release with pattern light irradiation. The substrate was immersed in pH 7.4 PBS solution containing the UCNPs (50 mg/mL). Then the laser was fixed on different parts of substrate (A, B, C and D), followed respectively by a 20 min NIR light exposure (2 min break after 2 min irradiation to avoid heating effect on cells). The scale bars are 500 μ m.

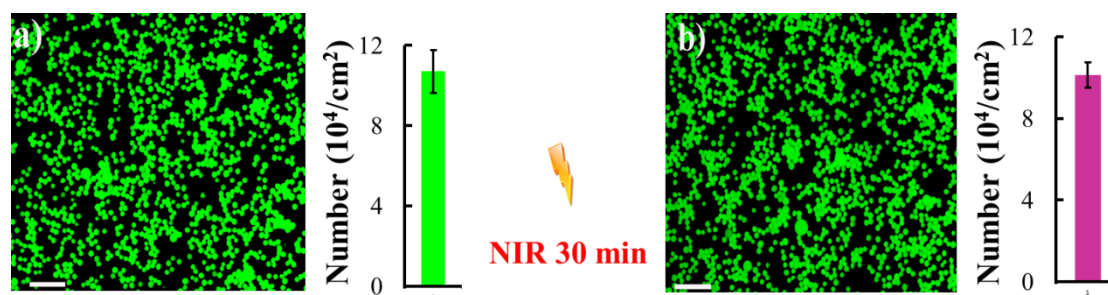


Figure S9. Fluorescence images of NIR light-induced cells release on the multilayer we designed without UCNP@SiO₂ in the culture medium. The scale bars are 100 μ m.

Release Kinetics

The release kinetics of β -CD-RhB is evaluated by monitoring its absorbance at 566 nm. In brief, an as-prepared $m = 6$ cross-linked film on a quartz slide ($12 \times 20 \times 1$ mm) was immersed into the β -CD-RhB solution (30 mL, 2 mg/mL), and then agitated them on an air bath constant temperature oscillator at 25 $^{\circ}$ C overnight, followed by a washing with neutral water. Then, the quartz slide was put into 30 mL UCNPs solutions (50 mg/mL), and β -CD-RhB release behaviors were evaluated by measuring the absorbance of β -CD-RhB in the multilayer at 566 nm upon NIR light irradiation for a predetermined time. The sample was placed 2 cm away from the laser. The surrounding temperature of the sample was controlled at 25 $^{\circ}$ C using a cold plate.

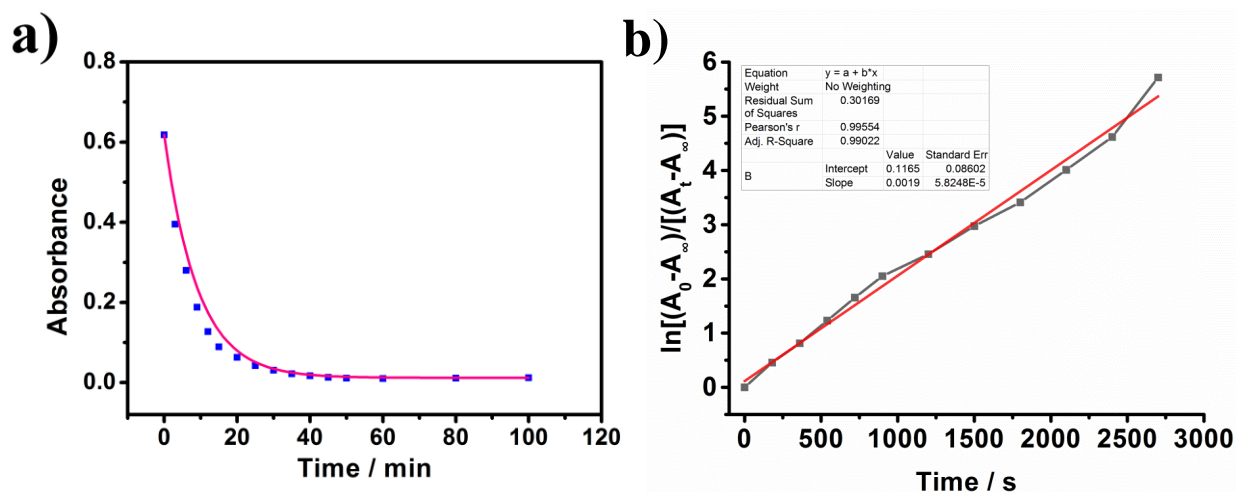


Figure S10. a) NIR remote-controllable release behavior from $m = 6$ dye-loaded film in neutral water upon NIR light (980 nm) irradiation, followed by measuring the absorbance of β -CD-RhB at 566 nm of the film. The red line represents the best fit to a first order exponential release model. b) The release kinetics of β -CD-RhB (monitored at 566 nm). Rate constant is found to be $1.9 \times 10^{-3} \text{ s}^{-1}$.

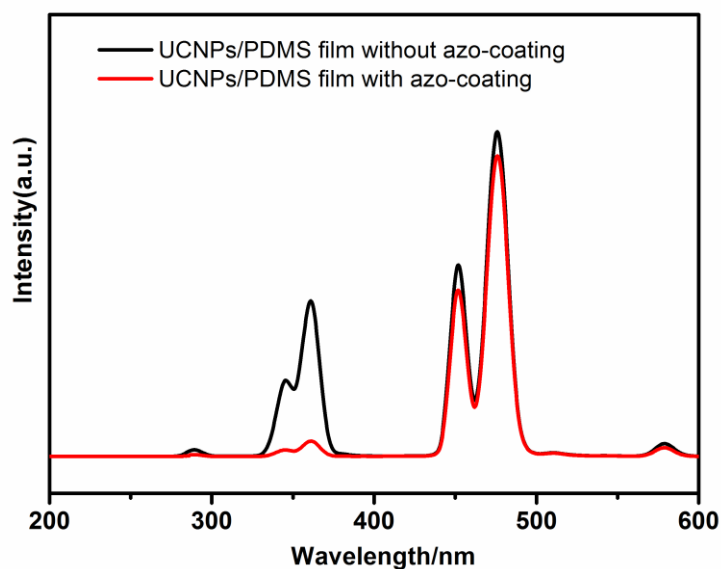


Figure S11. Emission spectra of UCNPs/PDMS film without multilayers and multilayer-assembled UCNPs/PDMS film upon NIR light exposure at 980 nm.