Supporting Information: Enhancement of NIR-to-Visible Upconversion Luminescence using Engineered Plasmonic Gold Surfaces

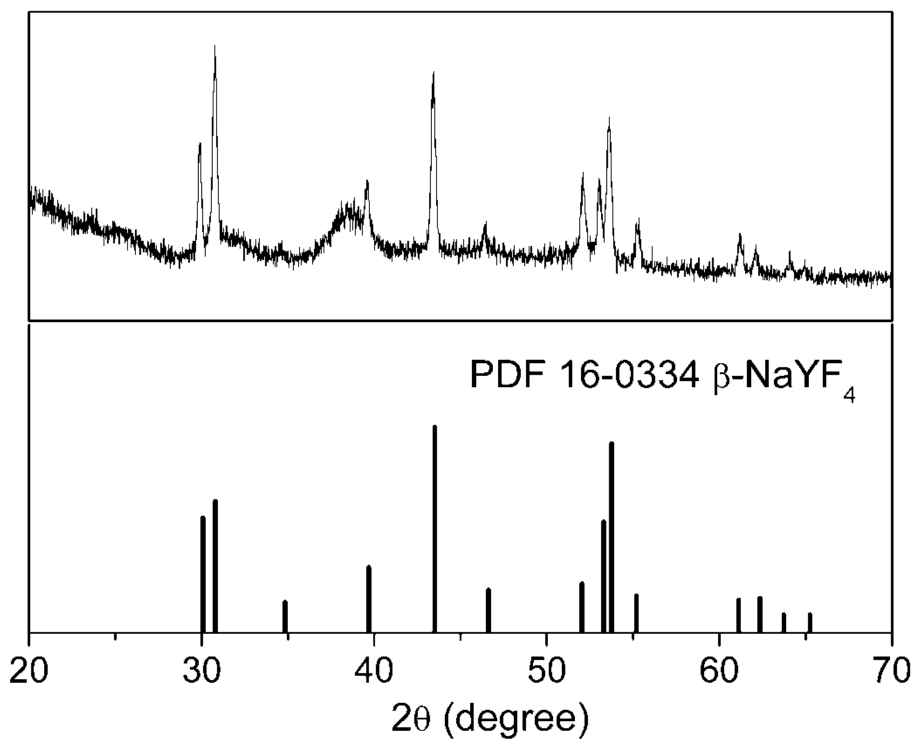

Figure S1. Powder X-ray diffraction (XRD) pattern of β-$NaYF_4$: 17%Yb^{3+}, 3%Er^{3+} nanocrystals synthesized for this study in comparison to the standard PDF card 16-0334 for β-$NaYF_4$.

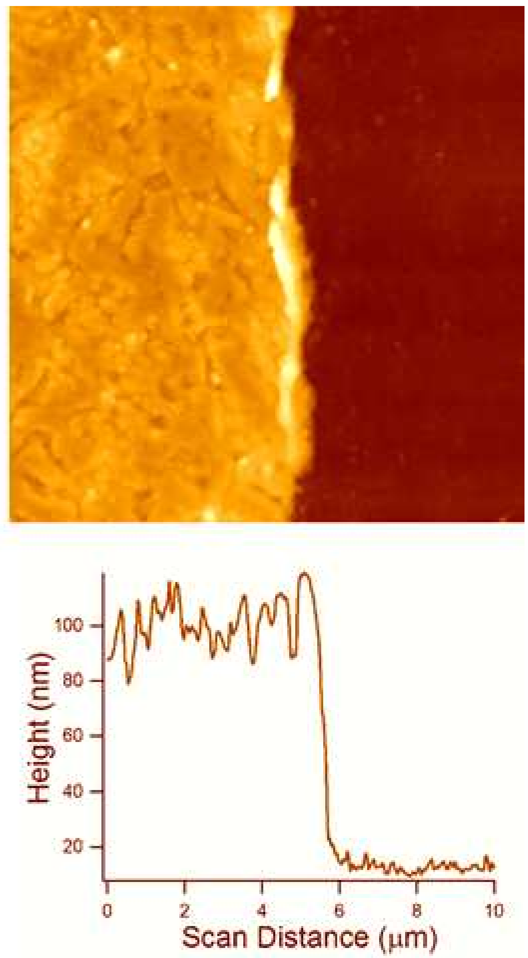

Figure S2. AFM scan of the edge of the upconverting film of β-$NaYF_4$:17%Yb, 3%Er nanocrystals in PMMA on the smooth, unpatterned gold surface adjacent to the patterned area. The thickness of the upconverting film is 89 nm.

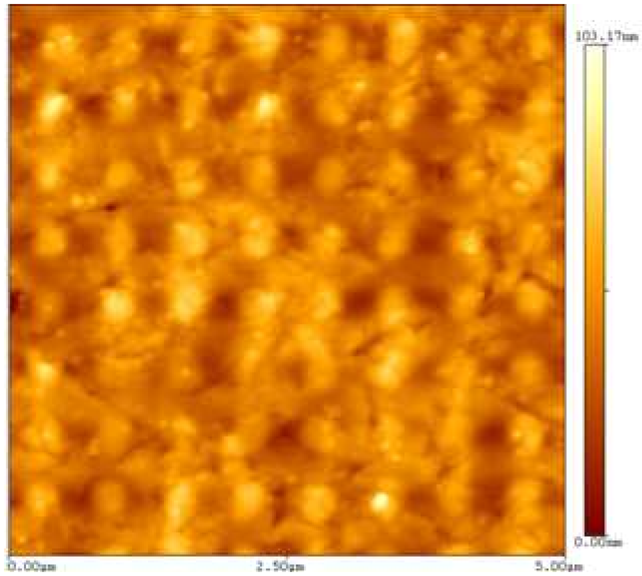

Figure S3. Zoomed-in AFM scan of the coated patterned surface shown in Figure 3 of the article. Nanocrystals of β-$NaYF_4$:17%Yb, 3%Er in the vicinity of the pillar tops are clearly visible.

Figure S4 compares the relative intensity of scattered / reflected light from a tungsten lamp collected from the patterned and unpatterned sections of the thin gold films. The spectra in Fig. S4 were collected using the Aramis confocal microscope by placing the sample on the stage, illuminating the sample surface with a Tungsten lamp, and collecting the scattered / reflected light from a selected area (i.e., patterned or unpatterned) of the sample surface. It can be seen that the nano-patterned surface reflects / scatters less light, compared to the surrounding smooth-gold surface, across the visible spectrum. For convenient reference, the maxima of the green (539 nm) and red (653 nm) upconversion emission peaks of $NaYF_4$: 3%Er,17%Yb nanoparticles are marked in Fig. S4. At 539 nm and 653 nm, the patterned areas are 1.5 and 1.2 times less reflective, respectively, compared to the unpatterned surface.

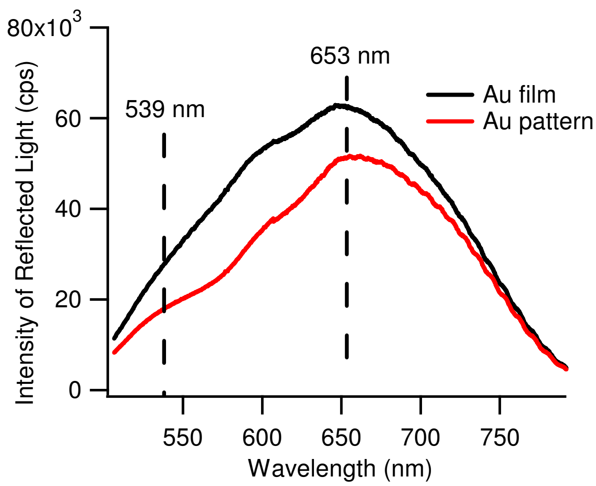

Figure S4. Intensity of light from a tungsten lamp reflected / scattered from the patterned (red) and unpatterned (black) areas of the gold film on a glass substrate. The spectra were measured using the Aramis confocal microscope. Spectra are not corrected for instrument response.