Electronic Supplementary Material (ESI) for Nanoscale.


# Polarization-Dependent Extraordinary Optical Transmission from Upconversion Nanoparticles

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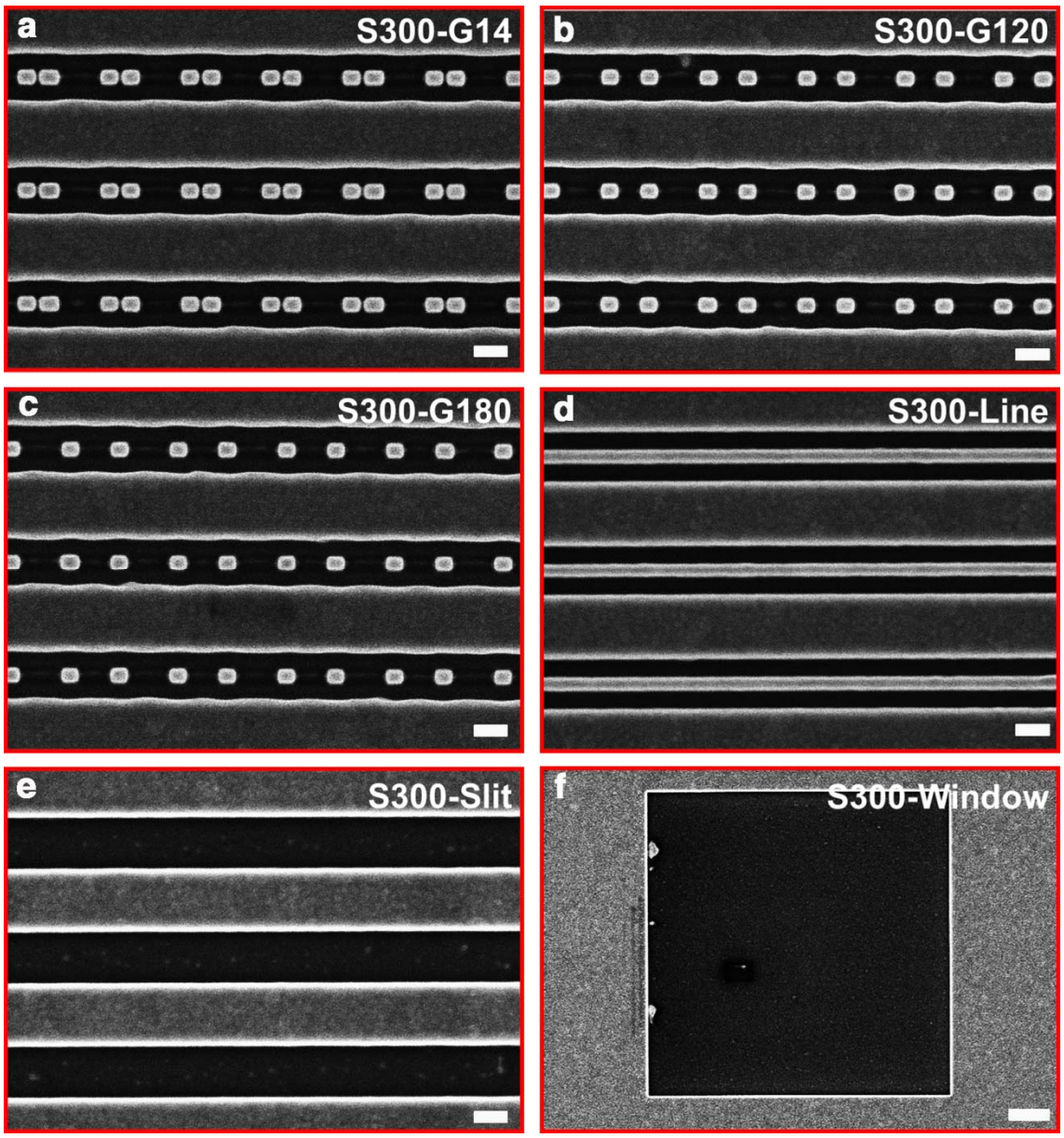


**Figure SI-1** SEM images: **(a)** S300-G14, **(b)** S300-G120, **(c)** S300-G180, **(d)** S300-Line, **(e)** S300-Slit, **(f)** S300-Window structures. Scale bars in (a-e) are 200 nm and (f) 1 μm, respectively.

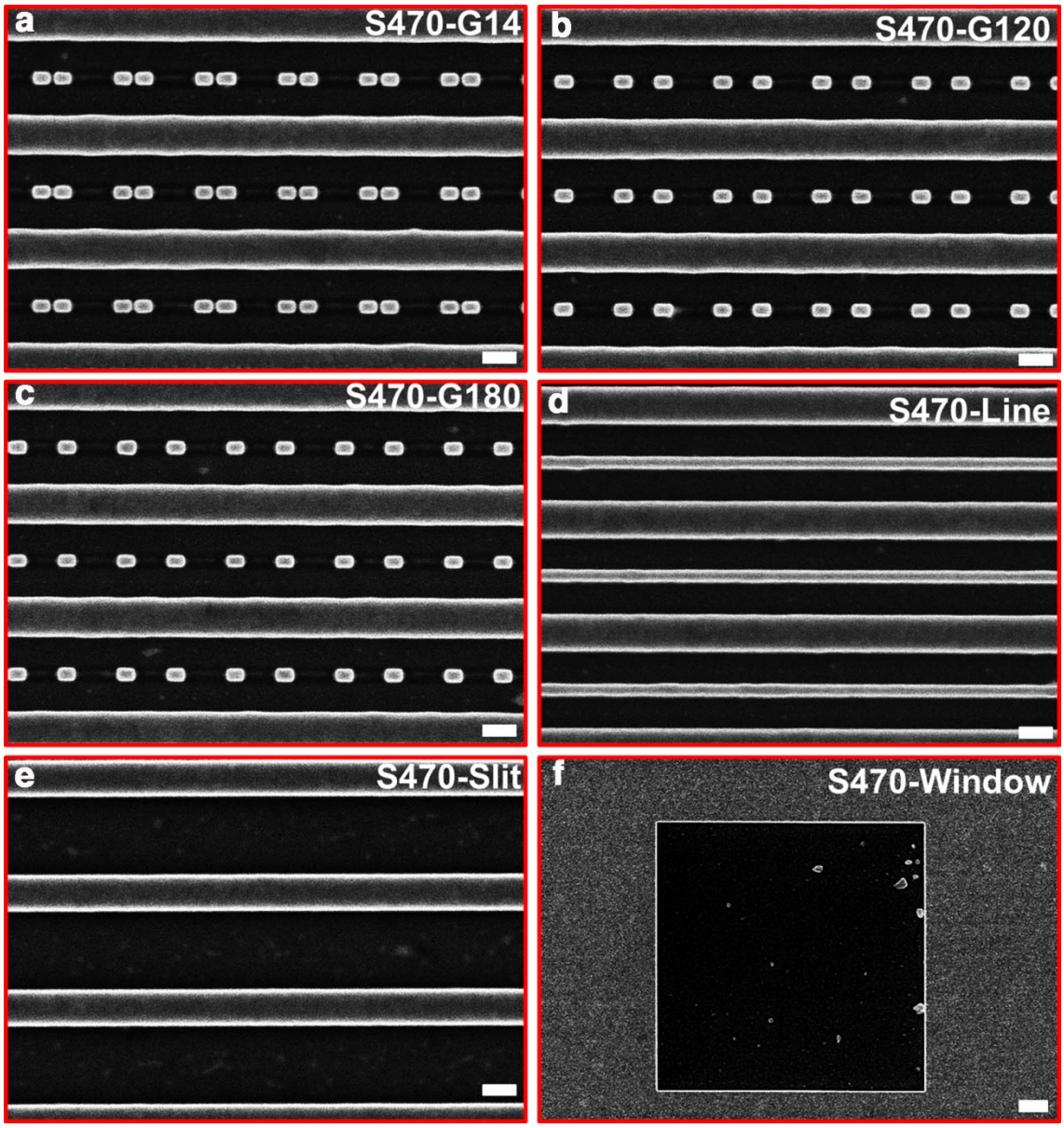


**Figure SI-2** SEM images: **(a)** S470-G14, **(b)** S470-G120, **(c)** S470-G180, **(d)** S470-Line, **(e)** S470-Slit, **(f)** S470-Window structures. Scale bars in (a-e) are 200 nm and (f) 1 μm, respectively

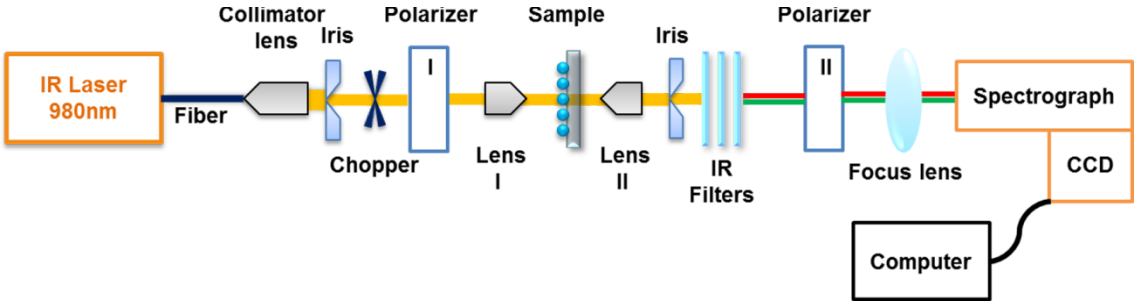


**Figure SI-3** Schematic of experiment measurement system for UC emission measurement. Sample and polarizer II are rotated 90° accordingly in this experiment.

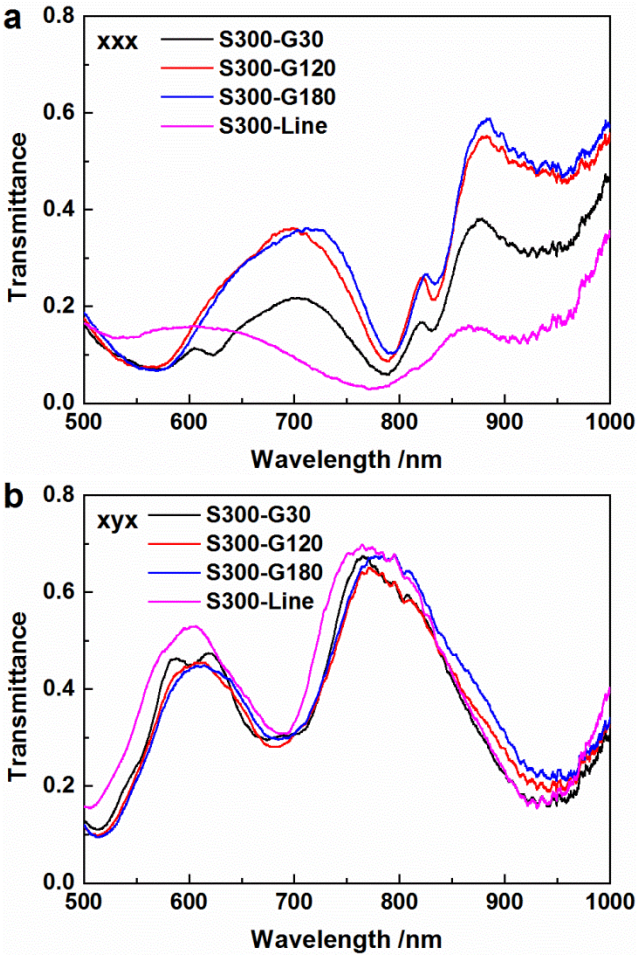


**Figure SI-4** Experiment measured white light transmittance spectra for S300-G30, S300-G120, S300-G180, and S300-Line array with **(a)** xxx and **(b)** xyx configuration, respectively.

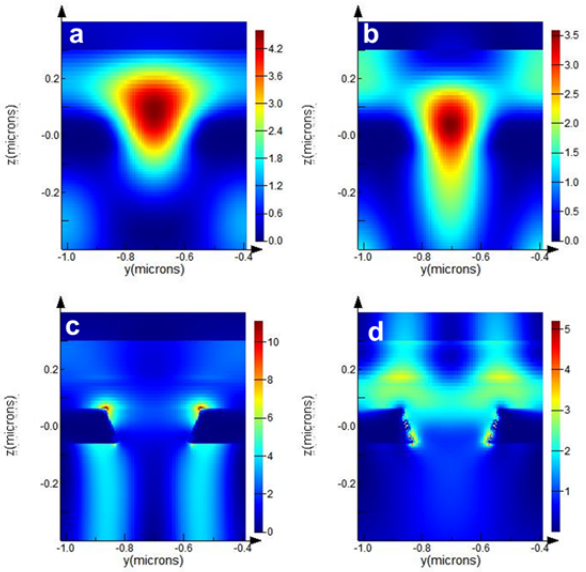


**Figure SI-5** Tansverse plane views (FDTD simulations) of the different transmission modes for an unitary cell of a periodic slit structure in the xxx configuration at **(a)** 900 nm, **(b)** 690 nm; xyx configuration at **(c)** 820 nm and **(d)** 600 nm, respectively. The color represents the electric filed intensity.

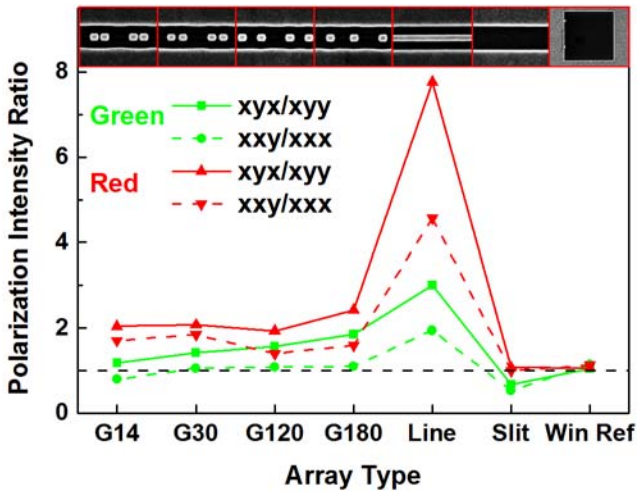


**Figure SI-6** Summary of the polarization intensity ratio for green and red emission for each type of array ( $\frac{I_{xyx\ or\ xxy}^{UC\ green\ or\ red}}{I_{xyx\ or\ xxy}^{UC\ green\ or\ red}}$ ) with different measurement configuration (indicated on the graph) for S300 arrays. The emission intensities are corrected with the respective opening area for each type of array.

## 2.2 Materials and Sample Preparation

### Description of the UC NP synthesis:

Lanthanide acetate salts (yttrium acetate hydrate 99.9% – 1.56 millimoles, ytterbium acetate hydrate 99.9% – 0.4 millimoles, Erbium acetate hydrate 99.9 % – 0.04 millimoles) were mixed with oleic acid (12 ml) and octadecene (34 ml) and heated to 120 °C under vacuum of 3 mTorr. The solution turned crystals clear solution when all the salts dissolved completely. The crystal clear solution was maintained at that vacuum and temperature for 1 hour and 30 minutes. Following that the solution was cooled down and subsequently a methanol solution (20 ml) containing NaOH (5 millimoles) and $NH_4F$ (8 millimoles) were added to the above lanthanide oleate solution. The solution turns cloudy and it was stirred overnight under ambient conditions. The solution was heated at 1.5 °C/min to 60 °C to remove methanol from the solution. This was done for 1 hour to ensure complete removal of the methanol. A flow of argon stream was passed into flask after the evaporation of methanol. The temperature was then raised to 100 °C at 4 to 5 °C per min. To reach 300 °C the solution was heated under an argon flow stream at 10 °C/min. The solution was maintained at 300 ± 2 °C for 70 minutes. The solution was cooled down to room temperature. The nanoparticles were sedimented using anhydrous ethanol and then redispersed in hexanes. The sedimentation/redispersion was done twice more to remove octadecene and oleic acid. The final dispersion is a little cloudy which is then filtered through a syringe glass membrane filter of 0.45 μm in pore size. The final dispersion in chloroform looks crystal clear and can be stored for months. The TEM of the NPs showed that they were uniform (~ 20 nm) and the hexagonal crystal structure of the NPs was confirmed from the XRD measurements.