Electronic Supplementary Information

RET assisted random lasing in light harvesting bio-antenna enhanced with plasmonic local field

Partha Kumbhakar, Subrata Biswas, Pathik Kumbhakar*

Nanoscience Laboratory, Department of Physics, National Institute of Technology Durgapur, 713209, India

**Corresponding author: E-mail: pathik.kumbhakar@phy.nitdgp.ac.in & nitdgpkumbhakar@yahoo.com*

Contents

The PL emissions from MB dye under different laser irradiation time

In order to identify the effect of incidence of pump laser light on the emissive property of MB dye we have performed a control experiment in which we have measured the emission spectrum of MB dye dispersion after irradiating it with the same CW laser light for some prolonged time duration. Figure S1 and the inset of Fig. S1 shows the emission spectra of the MB dye collected at different time interval after constantly irradiating it with the pump laser radiation and from the curves it is clearly seen that there is almost no changes in emission intensity for the duration up to 15 min and after 45 min of laser irradiation, emission intensity is diminished only by 10%.

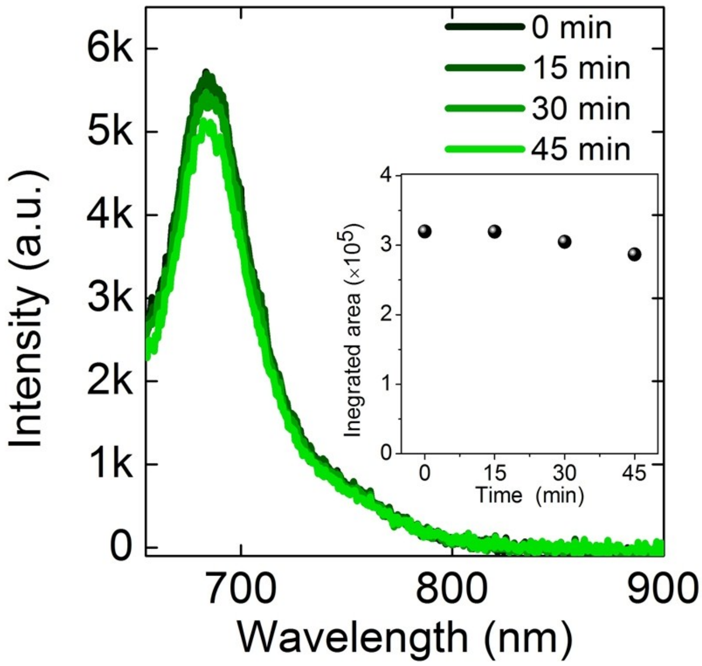

Fig. S1: The PL emission behaviour of the MB dye at different laser (λ_{ex}=632.8 nm) irradiation time. Inset shows the integrated area of emission spectra as a function of temperature.

De-convoluted PL emission spectra of binary system at different A/D ratio

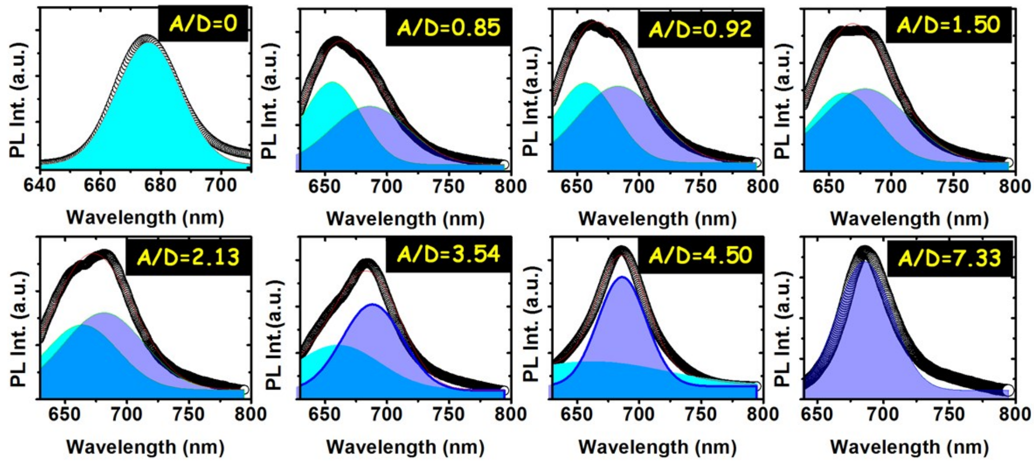

Fig. S2 The spectral overlap between the donor and acceptor emissions with Gaussian curve fitting.

Variation of output emission intensity with pump intensity for RL generation in binary mixture for different concentrations of Ag NPs, ZnO NPs and Ag_ZnO NPs

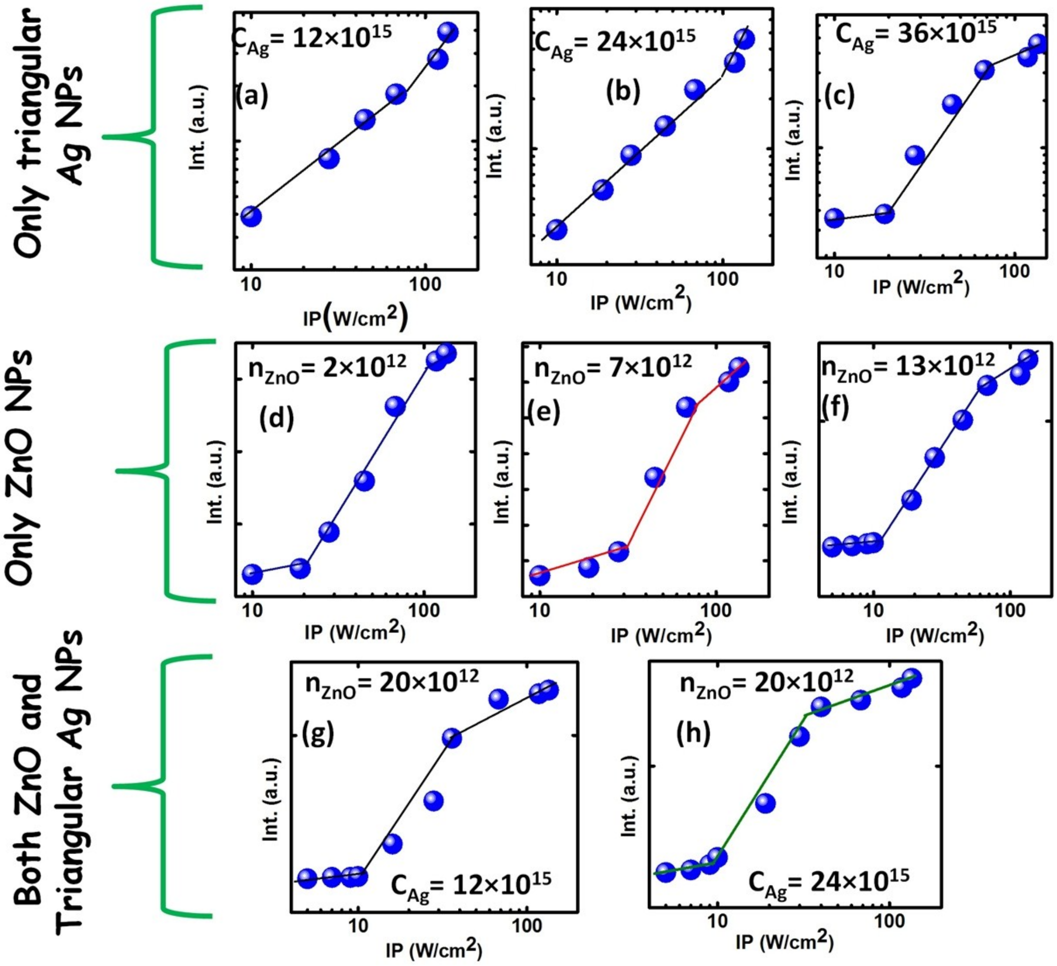

Fig. S3 (a-c) The variations of emission intensity with pump energy for RL generation in gain medium for this different concentration of triangular shaped Ag NPs (d-f) Variations of emission intensity with pump energy for different concentration of ZnO NPs. (g-h) The lower panel shows the variations of RL emission for different concentrations of triangular shaped Ag NPs (C_{Ag}=12, and 24×10^{15} ml^{-1}) and a fixed concentration of ZnO NPs (n_{ZnO}=20 ×10^{12} ml^{-1}) when it is pumped by a CW He-He laser of 632.8 nm wavelength with various pump intensities, where A/D ratio has been kept fixed at 7.33.

S4. Schematic illustration of synthesis methods of ZnO and triangular Ag NPs

The schematics of synthesis procedure of ZnO and triangular Ag NPs are appended below. We have discussed the synthesis methods of ZnO NPs in the experimental section

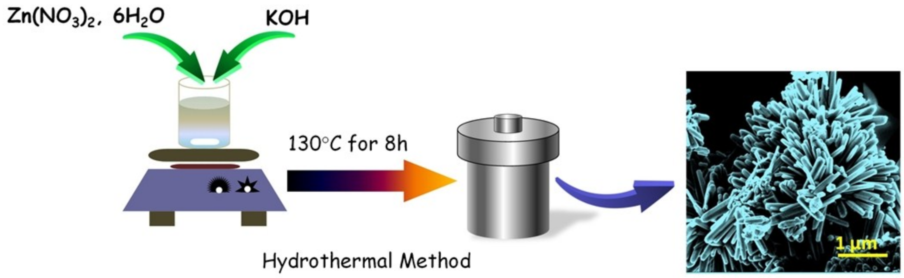

Fig. S4(a). *Schematic diagram of synthesis procedure of flower like ZnO NPs.*

Colloidal triangular silver nanoparticles are synthesized by using the similar procedure as used earlier in our group [1] with silver nitrate (Ag NO_3) as precursor material, dimethyl-formamide (DMF), and polyvinyl-pyrrolidone (PVP). At first, 0.05 mM of PVP has been added to 50 ml of DMF under constant magnetic stirring at room temperature. After 30 min of stirring, 23 mM of $AgNO_3$ has been added to the solution. After vigorous stirring for 10 min, the final mixture solution is transferred into a teflon-lined stainless-steel autoclave (of 100 ml capacity) for solvothermal treatment at 160 °C, as shown in Fig. S4b.

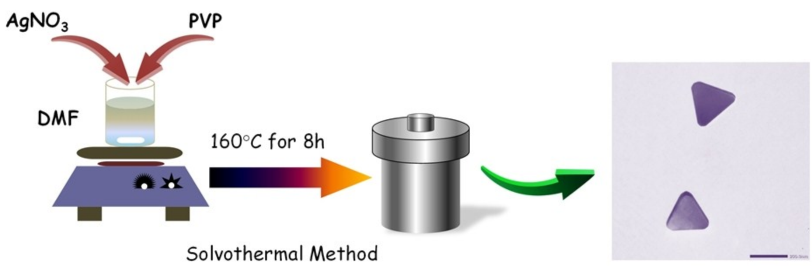

Fig. S4(b). *Schematic diagram of synthesis procedure of triangular shaped Ag NPs.*

References

1. K. Mondal, S. Biswas, P. Kumbhakar, *Plasmonics,* 2019, https://doi.org/10.1007/s11468-019-01016-6