Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016
Editors K. K. Kar, A. Shah and R. Sharma
Vol. 3, No. 1, p. 75
doi:10.3850/978-981-09-7519-7nbl16-rps-75

Fabrication of quantum dots, metal nanostructures and 2D nanocomposites materials for enhanced photo-catalytic and nonlinear optical properties for applications in future photonic devices

P. Kumbhakar*, S. Biswas and A. K. Kole

Nanoscience Laboratory, Dept. of Physics,
National Institute of Technology, Durgapur, 713209, West Bengal, India
*Email: pathik.kumbhakar@phy.nitdgp.ac.in, nitdgpkumbhakar@yahoo.com

Low dimension materials have drawn huge attention of researchers due to their unique properties arising due to the quantum confinement effect. Mn^{2+} or Cu^{2+} doped 0D ZnS quantum dots (d-dots) [1] or 1D silver nanowire (AgNWs) and 2D hexagonal boron nitride (hBN) [2] and graphene oxide (GO), ZnS nanosheet and its composites have been studied extensively for their tunable photoluminescence (PL) and enhanced nonlinear optical (NLO) properties [1-5]. Tunable dual emissions in UV and yellow-orange regions have been reported by us, just by varying Mn^{2+} concentration in ZnS d-dots. Also tunable visible PL emissions have been obtained by varying the Cu^{2+} doping concentration (0-1%) in ZnS d-dots. A charge transfer mechanism from host to dopant has been provided to explain the observed tunability in PL emission in ZnS:Mn d-dots. Figure 1 (upper panel) shows a typical PL emission spectra obtained from synthesized undoped ZnS, Cu^{2+} doped and Mn^{2+} doped ZnS d-dots.

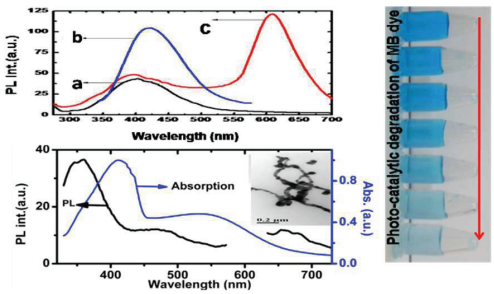

Figure 1: Upper panel shows the PL spectra of (a) ZnS, (b) ZnS:Cu (1.00%) and (c) ZnS:Mn (40.0%). The lower panel is the absorption and PL emission (ex-330nm) spectra of the AgNWs. Photo-catalytic degradation of Methylene Blue (MB) dye by ZnO-ZnS nanocomposite is shown in the right column

Also we have synthesized multi-plasmonic shapes [3] of silver nanoparticles by varying reaction temperature only in a simple chemical method. At 90^0C temperature, we have obtained 1D AgNWs of several μm in length, which shows two absorption bands corresponding to surface Plasmon resonance (SPR) and also the sample shows distinct PL emission due to the splitting of primary SPR enhanced PL emission (Figure 1, lower panel).

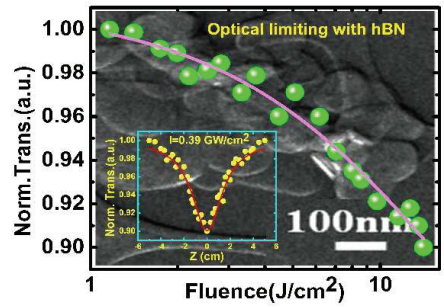

Figure 2: OL effect of hBN and Inset shows a typical OA Z-scan traces (background - TEM image)

Wurtzite (WZ) ZnS nanosheets, ZnS–ZnO composite, and fungi–like ZnO nanostructures have also been synthesized and studied their photo-catalytic performances. It has been found that ZnO-ZnS composites show highest degradation efficiency of 74% due to the formation of surface complex and higher visible light absorption (Figure 1 2nd column). The NLO properties of hBN and GO have also been investigated by the open and closed aperture Z-scan techniques and both the materials show optical limiting (OL) effects (Figure 2) and may find potential applications in laser related military safety devices.

References

1. A. K. Kole, C. S. Tiwary, P. Kumbhakar, J. Appl. Phys. 113 (2013) 114308
2. A. K Kole, P. Kumbhakar, U. Chatterjee. Appl. Phys. Lett. 100 (2012) 013103.
3. S. Biswas, A. K. Kole, R. Sarkar, P. Kumbhakar. Mater. Res. Exp. 1 (2014) 04504.
4. A. K. Kole, C. S. Tiwary, P. Kumbhakar. J. Mater. Chem. C. 2 (2014) 4338.
5. P. Kumbhakar *et al.* Adv. Opt. Mater. 3 (2015) 828.