Visible light induced photocatalytic activity of sulfur doped hollow TiO_2 nanoparticles, synthesized via a novel route

Rajib Ghosh Chaudhuri and Santanu Paria*

Interfaces and Nanomaterials Laboratory, Department of Chemical Engineering, National Institute of Technology

Rourkela 769008, Orissa, India.

*Email: santanuparia@yahoo.com, sparia@nitrkl.ac.in

Supporting information

Particles characterized by fluorescence spectroscopy.

Fluorescence spectroscopy is another characterization technique that gives the direct information about the band gap and quantum yield property of the material. Fig. S1 (ESI†) shows fluorescence emission spectrum of S doped hollow TiO_2 nanoparticles. The sample was excited at 295 nm wavelength and measured the emission spectra of the material. The synthesized hollow particles shows a distrinct sharp peak at 593.6 nm wavelength with an impressive full width at half-maximum (FWHM) as small as 9.1 nm, which could be attributed to the narrow size distribution of the particles. The band gap of the S doped hollow TiO_2 was calculated from the emission spectra and found to be 2.09 eV, the obtained value is in good agreement with the value of 2.50 eV obtained by UV-Vis spectroscopy technique. The quantum yield (QY) was calculated for these particles by using phenol as a standard material ($QY = 0.14 \pm 0.01$).[1] The fitting equation of integrated intensity vs. absorbance and the quantum yield of standard phenol, and S doped hollow TiO_2 particles are shown in Table S1 (ESI†).

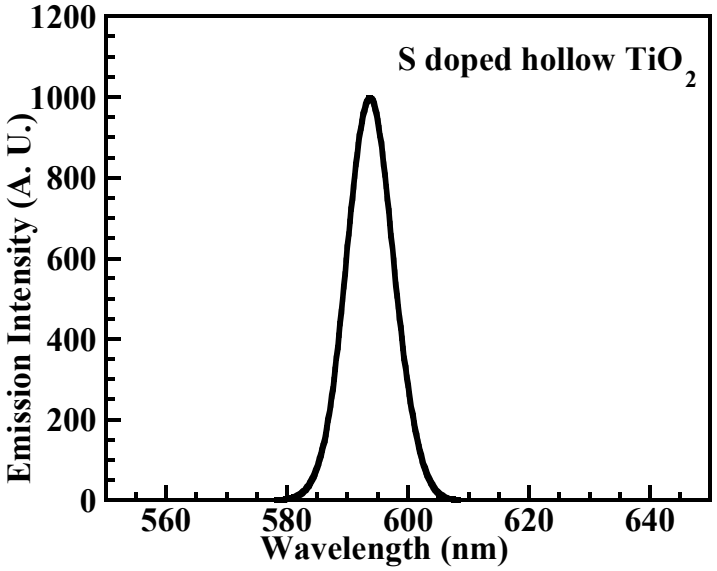


Fig. S1. Fluorescence emission spectra of S doped hollow TiO_2 particles.

Table S1. The fitting equation and R^2 value of integrated intensity vs. absorbance line for phenol and S doped hollow TiO_2 particles form fluorescence spectrum.

Material	Equation	R^2	QY
Phenol	y = 111.90x – 310.90	0.939	0.14
S doped hollow TiO_2	y = 143.97x + 6.14	0.989	0.4920

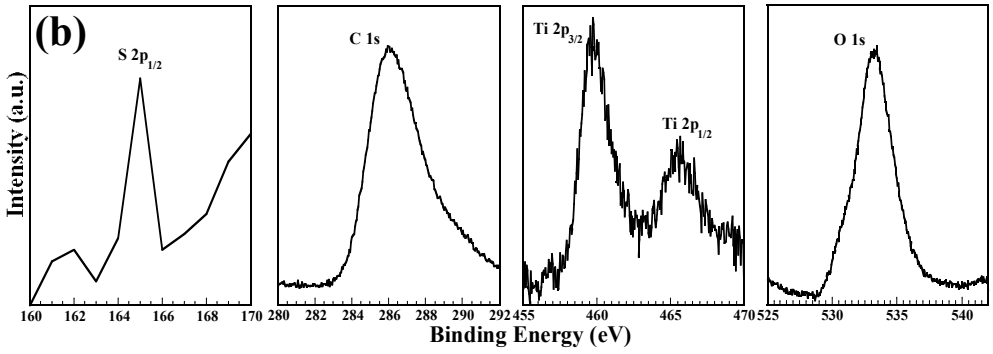


Fig. S2. High resolution XPS patterns of elemental S, C, Ti, and O within the particles.

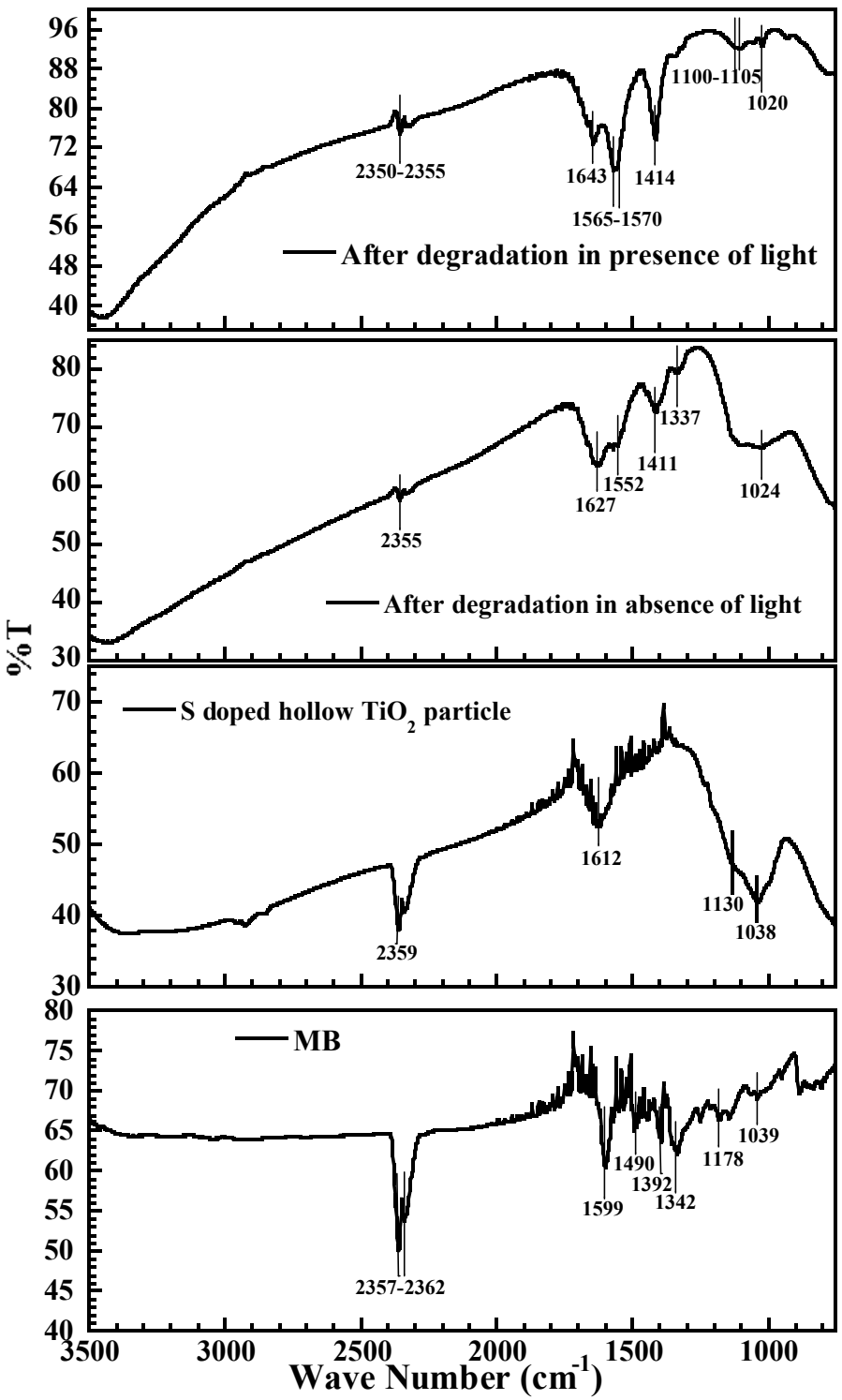


Fig. S3. FT-IR spectrum of MB, S doped hollow TiO_2 particles, catalyst after exposure of the MB in absence and presence of light.

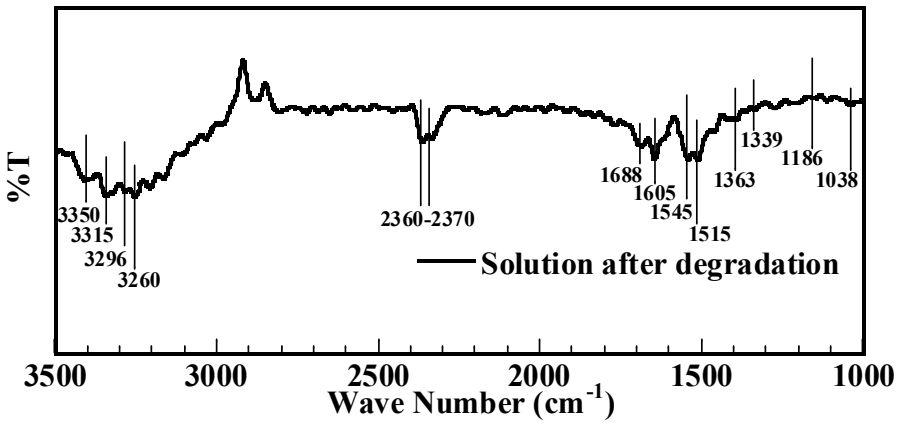


Fig. S4. FT-IR spectrum of solution after degradation.

Table S2. Different parameters (surface area, pore volume, average pore size) of Degussa P25 and S doped hollow TiO_2 catalyst and % removal of MB dye in the presence of both catalysts.

Particles	Surface Area (m^2/g)	Pore Volume (cm^3/g)	Avg. Pore Size (nm)	% Degradation in solar light
Degussa P25[27]	63.0	0.06	3.8	30.0
S doped hollow TiO_2	318.11	0.13	3.4	98.6

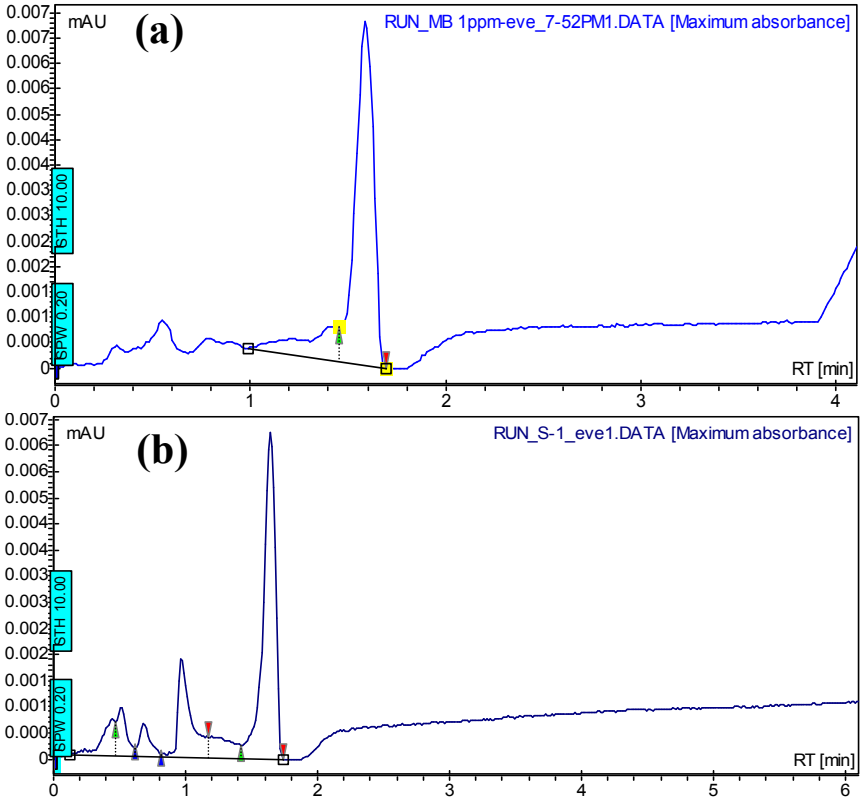


Fig. S5. HPLC spectrum of (a) 1 mg/l MB and (b) 98.6% MB degradated solution.

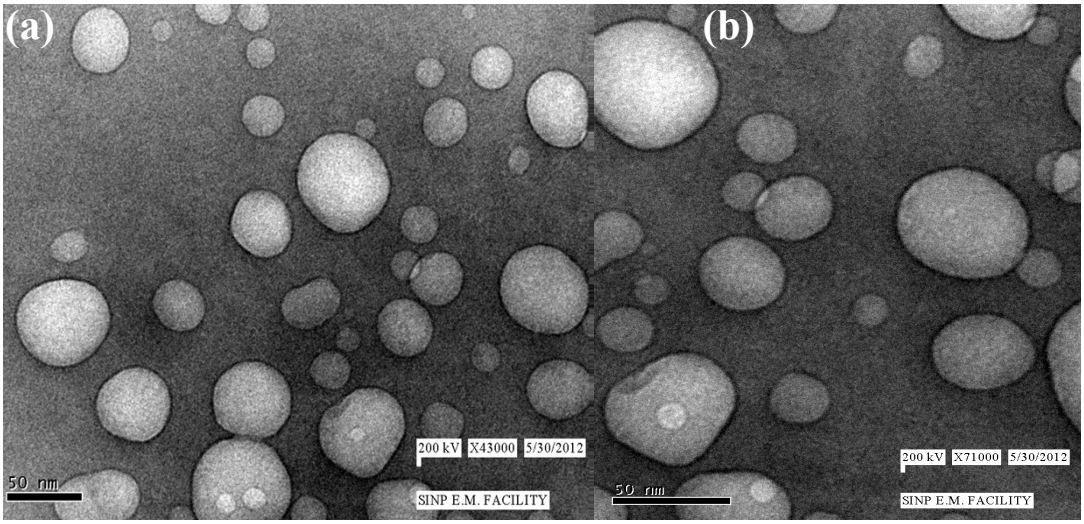
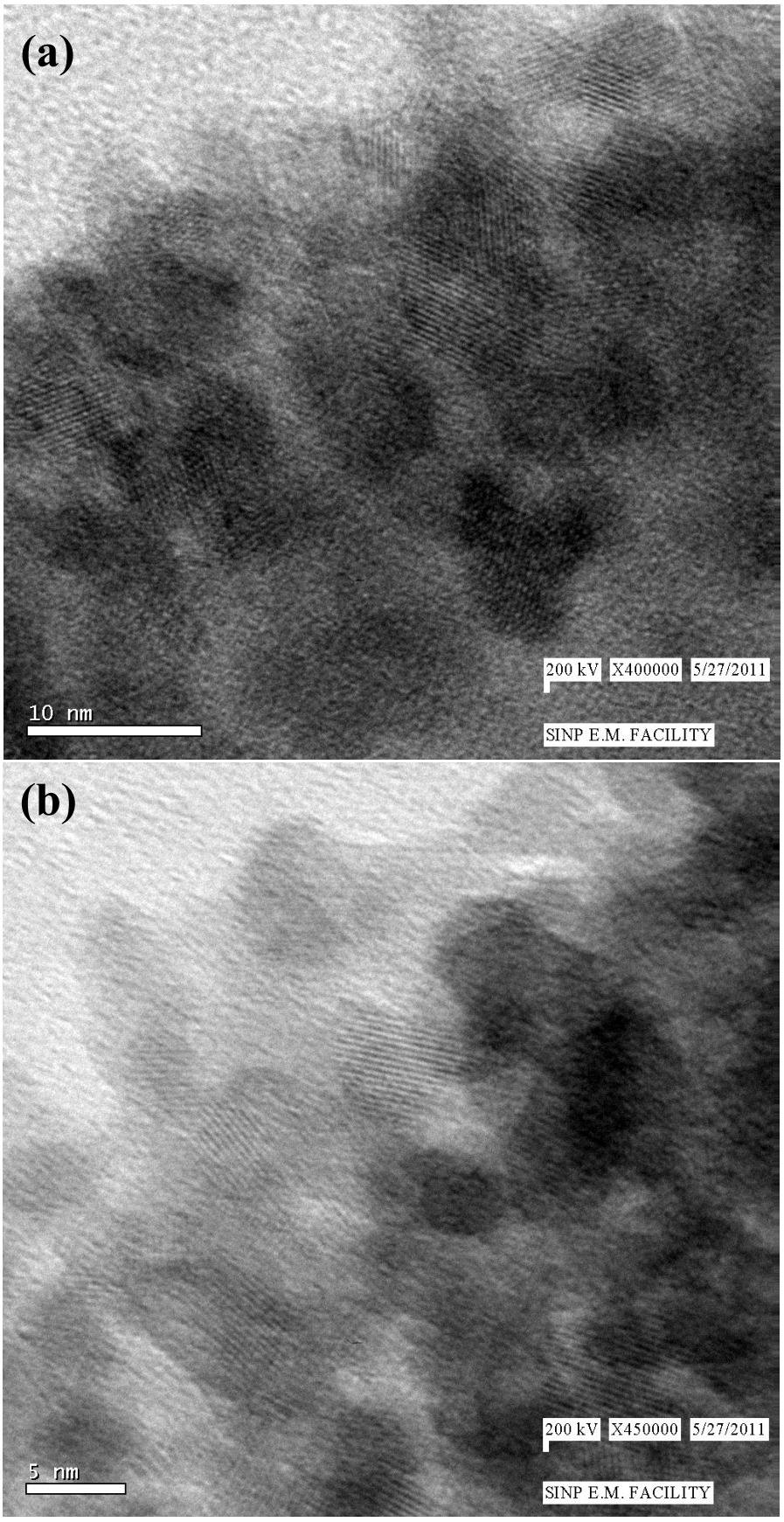


Fig. S6. TEM image of hollow TiO_2 particles synthesized at 0.01 mM TBOT concentration in 1.2 mM SDBS media. The average size of the particles are 80 nm confirmed by DLS analysis.


(a)
200 kV X400000 5/27/2011
10 nm
SINP E.M. FACILITY
(b)
200 kV X450000 5/27/2011
5 nm
SINP E.M. FACILITY

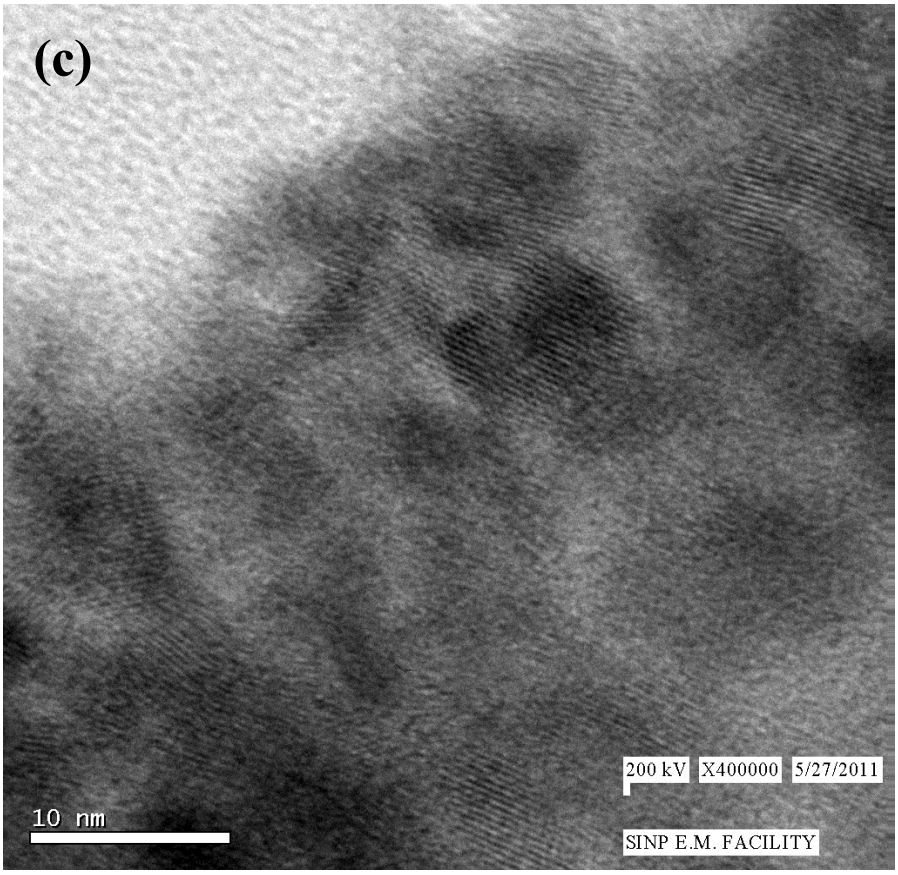


Fig. S7. The high resolution images of the shell layer of hollow TiO_2 particles at different positions.

References

1 R F Chen. Fluorescence quantum yield of tryptophan and tyrosine *Anal. Lett.*, 1967, **1**, 35–42.