Electronic Supplementary Information

Luminescent Carbogenic Dots for Detection and Determination of Hemoglobin in Real Samples

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The band gap energy (E_g) of SnO_2 NCs can be calculated by plotting $(\alpha h\upsilon)^{1/n}$ versus photon energy ($h\upsilon$) based on the following equation:

$$(\alpha h\upsilon)^{1/n} = \kappa\,(h\upsilon - E_g)$$

……Equation (S1)

Here, α corresponds to absorption coefficient, h is Planck's constant, υ is frequency of vibration, κ is the proportonal constant and n corresponds to nature of the sample transition which is equivalent to ½ for direct allowed transition.

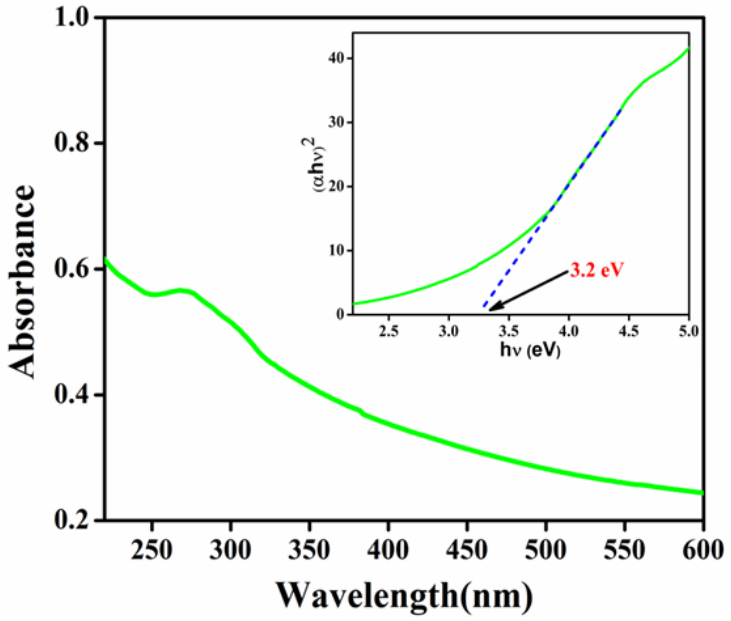

Fig. S1 Absorption spectrum of SnO_2 NCs dispersed in 1-propanol. Inset picture represents corresponding Tauc plot for optical band gap calculation.

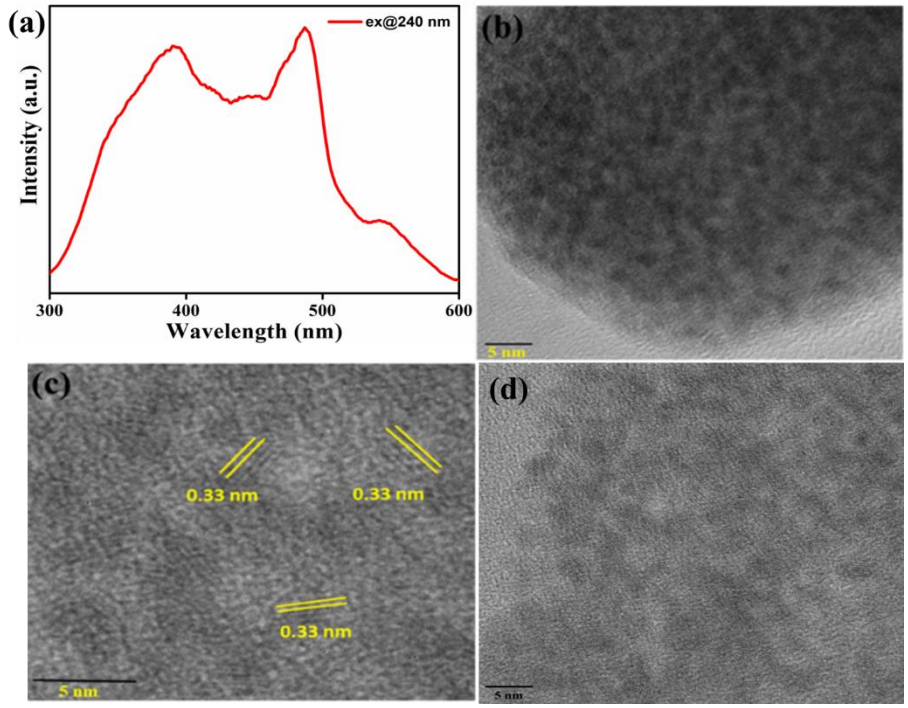

Fig. S2 (a) Emission spectrum of SnO_2 NCs recorded at 240 nm excitation wavelength after purification. (b) TEM image of the SnO_2 NCs. (c) HRTEM image for the SnO_2 NCs, showing the presence of well-defined crystalline planes corresponding to (110) plane with d-spacing value 0.33 nm. (d) Additional representative TEM image of SnO_2 NCs collected from different area.

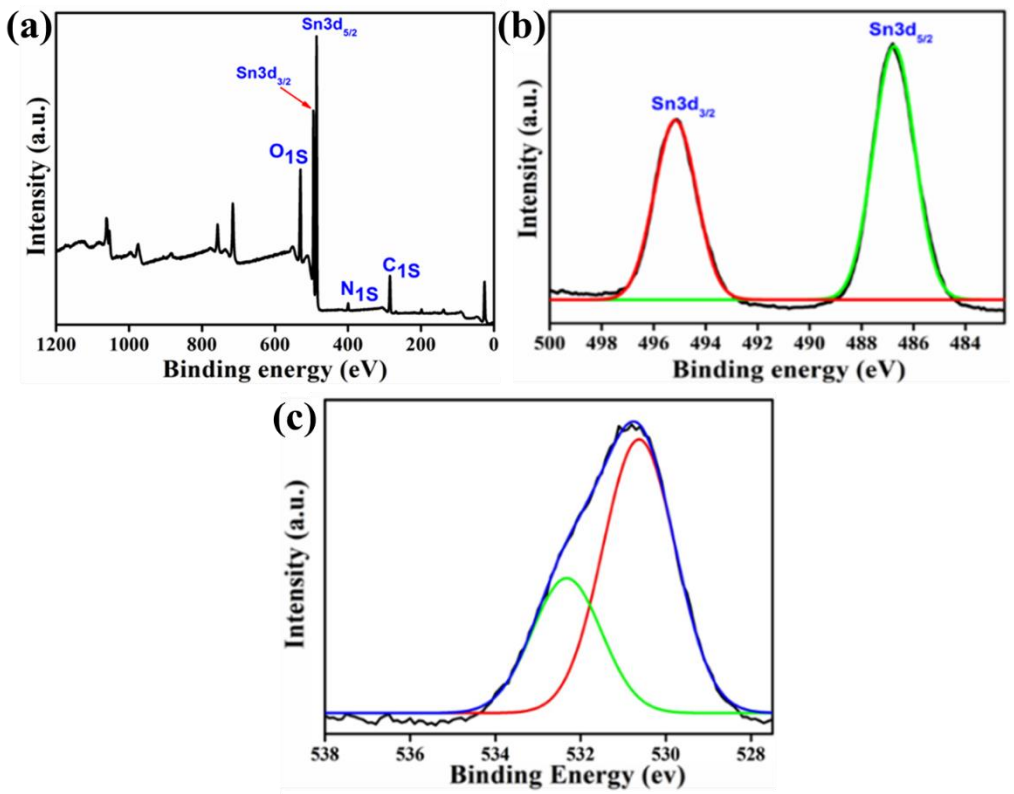

Fig. S3 (a) XPS analysis plot for SnO_2 NCs. (b) XPS analysis plot for SnO_2 NCs. Peaks, appearing at 495.2 eV and 486.8 eV corresponds to Sn $3d_{3/2}$ and Sn $3d_{5/2}$ respectively. (c) Deconvoluted XPS plot for O_{1s} signal. Peaks observed at 532.3 and 530.6 eV corresponds to lattice oxygen of SnO_2 NCs and adsorbed oxygen species of O^{2-}, O^- or O^{2-} present over the surface.

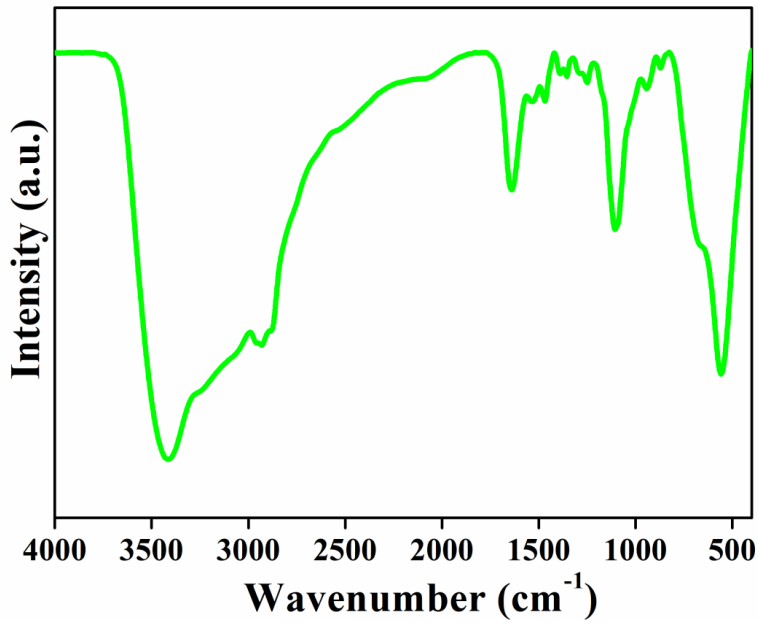

Fig. S4 FTIR spectrum recorded for SnO_2 NCs.

Here, intense peaks appearing at 3422 cm^{-1} and 1636 cm^{-1} were ascribed as -OH group stretching and bending vibration respectively, associated with adsorbed water molecules. Besides, strong peak appearing at 1106 cm^{-1} could be due to Sn-OH stretching. Characteristic peaks appearing at 556 cm^{-1} and 660 cm^{-1} were characteristics of the symmetric and asymmetric stretching mode of Sn-O-Sn bond vibration.

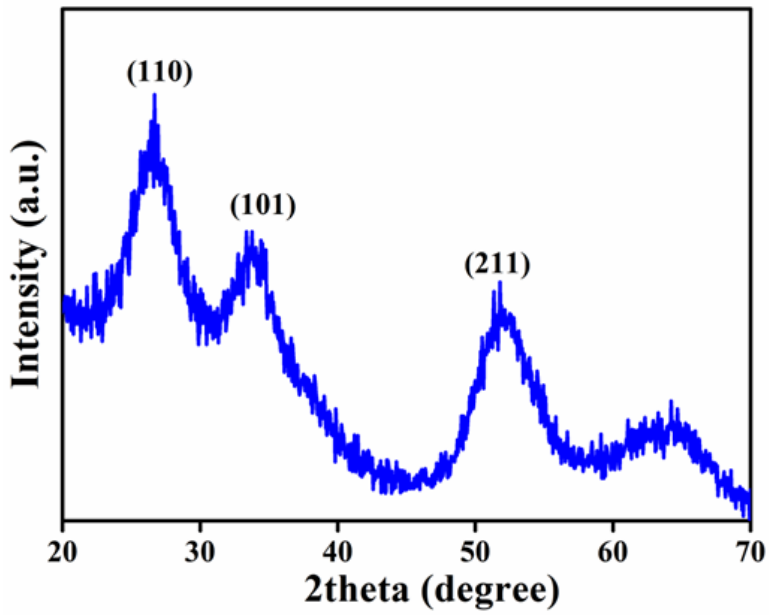

Fig. S5 Powder X-ray diffraction pattern corresponding to SnO_2 NCs.

Quantum Yield Calculation:

Quantum yields (QY) of purified Cdots in water were obtained using the below mentioned formula with respect to quinine sulphate (QS) in 0.1 M H_2SO_4.

$$Q_S = Q_R \times \frac{I_S}{I_R} \times \frac{A_R}{A_S} \times \frac{\eta_S^2}{\eta_R^2}$$

……Equation (S2)

Where Q_S= QY of Cdots; Q_R= QY of reference; I_S= area under PL curve of Cdots; I_R= area under PL curve of QS; A_R= absorbance of the QS; A_S= absorbance of the Cdots; η_S= refractive index of Cdots; η_R= refractive index of QS.

QY of quinine sulphate = 0.54.

Table S1. Measured parameters, as-obtained from time resolved photoluminescence study of the Cdots dispersed in aqueous medium.

Cdot Medium	λ^2	Fraction of the first component (α_1)	First component lifetime (τ_1) (ns)	Fraction of the second component (α_2)	Second component lifetime (τ_2) (ns)	Fraction of the third component (α_3)	Third component lifetime (τ_3) (ns)	Average lifetime (τ_{av}) (ns)
Cdot dispersed in water	1.09	0.51	0.37	0.26	3.65	0.2	11.83	9.1

The average life time of the Cdot-water dispersion was calculated by using following equations (S3) and (S4).

$$I_t = \sum_i \alpha_i \exp(-t/\tau_i)$$

……Equation (S3)

$$\tau_{av} = \frac{\sum_i \alpha_i \tau_i^2}{\sum_i \alpha_i \tau_i}$$

……Equation (S4)

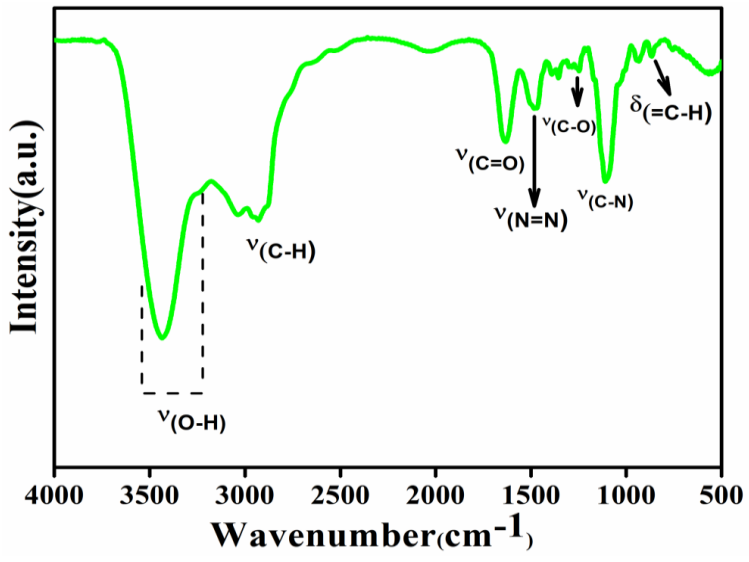

Fig. S6 FTIR spectrum recorded for as-synthesized Cdots.

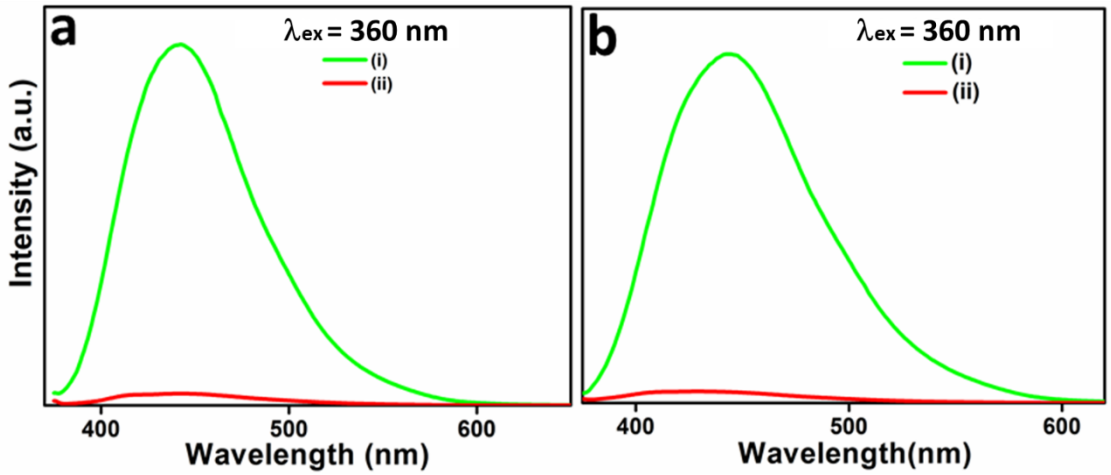

Fig. S7 (a) Emission spectra of (i) the supernatant part, obtained after the reaction between $SnCl_2$ and TTDDA i.e. of Cdots, (ii) supernatant of the reaction mixture of purified SnO_2 and TTDDA. (b) Emission spectra of (i) supernatant part, obtained after the reaction between $SnCl_2$ and TTDDA i.e. of Cdots, (ii) supernatant of the reaction mixture of $SnCl_4$ and TTDDA.

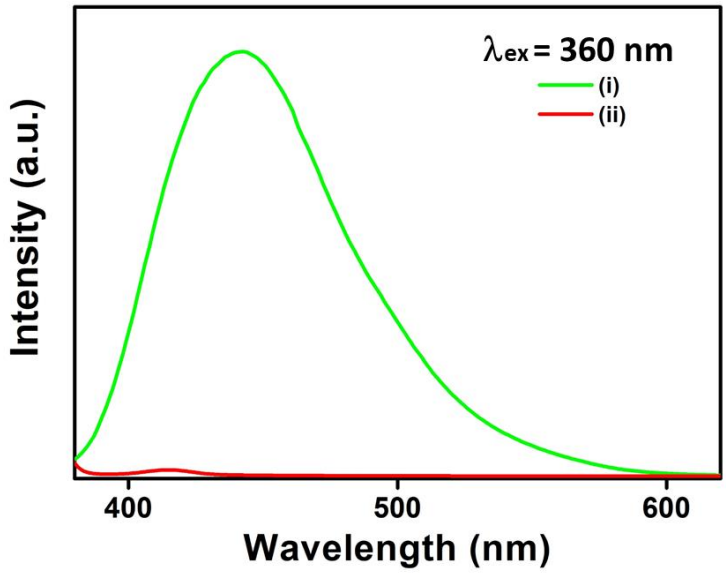

Fig. S8 Emission spectra of (i) the supernatant part, obtained after the reaction between $SnCl_2$ and TTDDA i.e. of as-prepared Cdots and (ii) supernatant of the reaction mixture, obtained following heating of only TTDDA in 1-propanol at 80 ^{o}C.

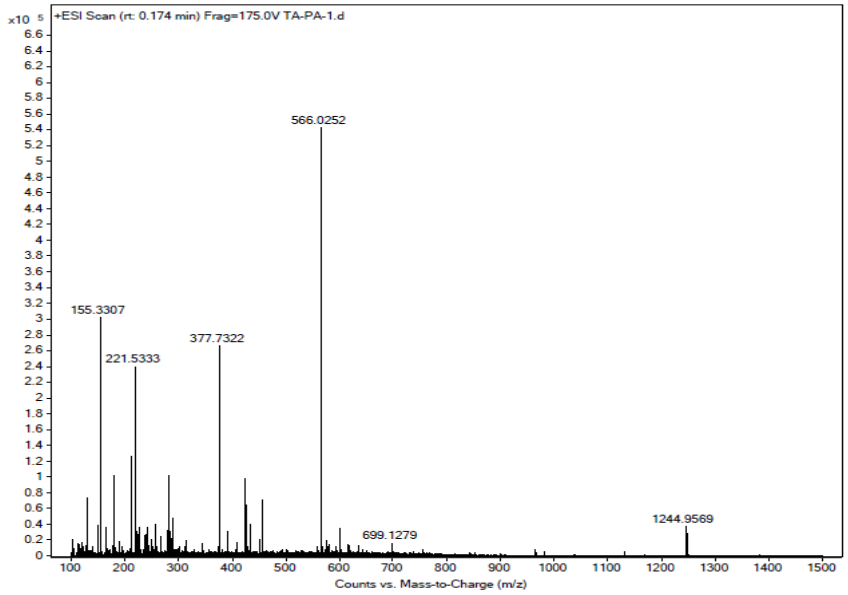

Fig. S9 HRMS spectrum of the isolated luminescent carbonaceous material.

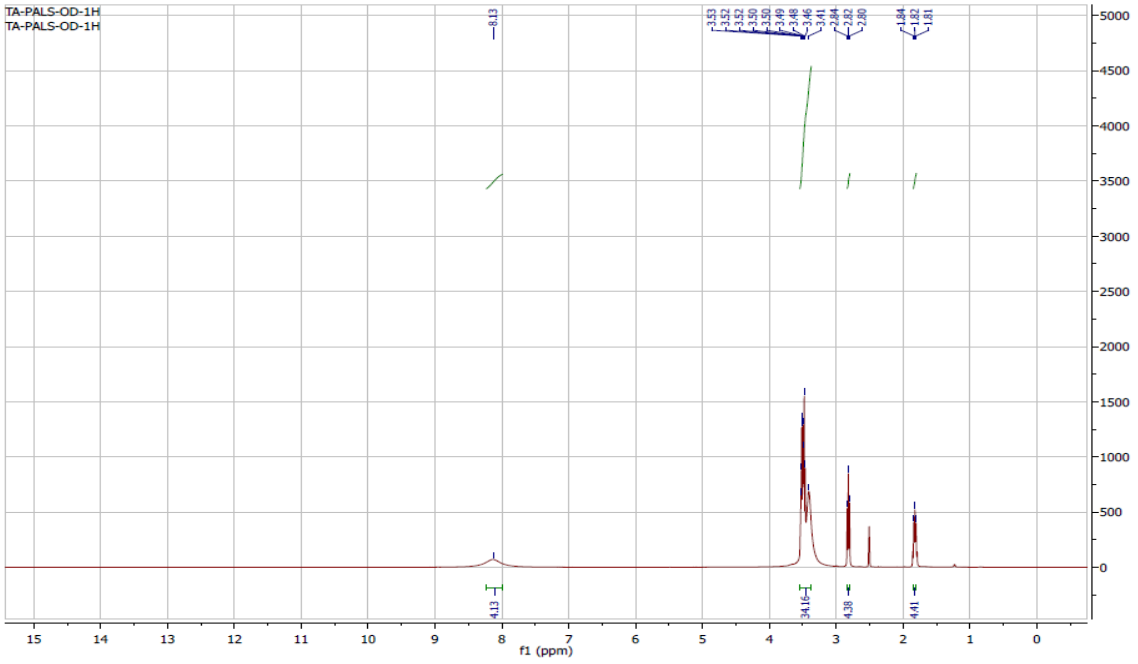

Fig. S10 ^{1}H NMR spectrum of the isolated carbonaceous product.

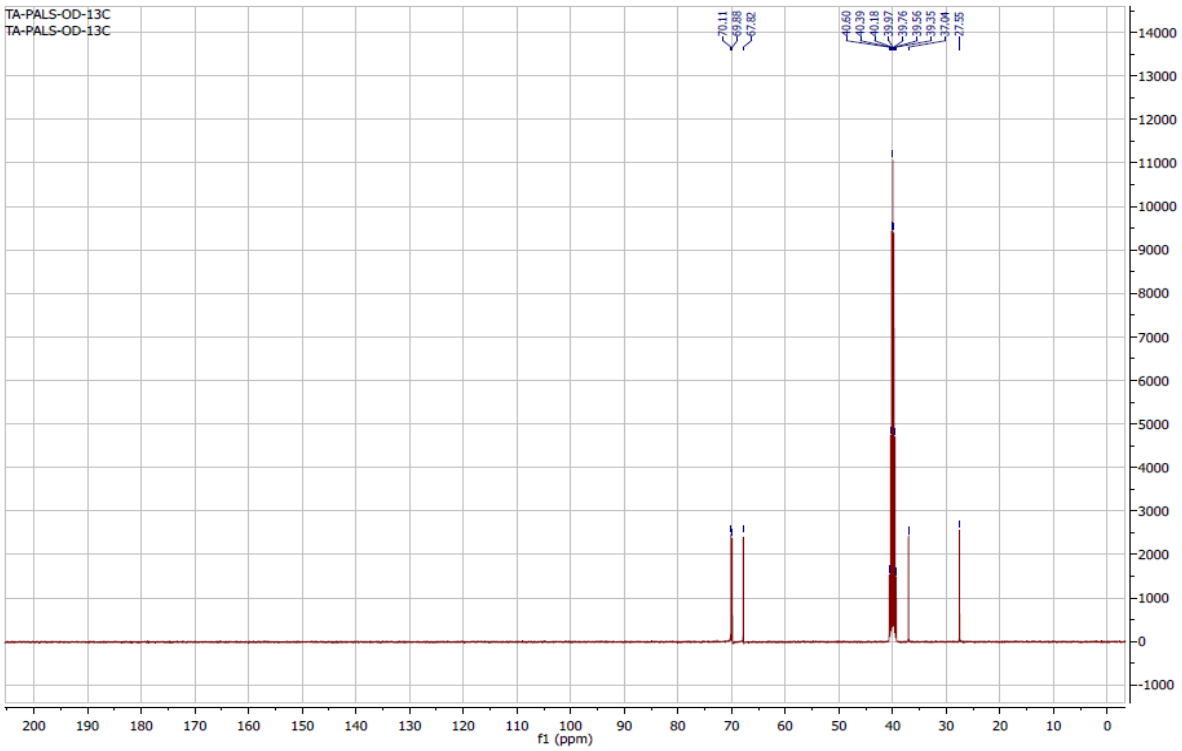

Fig. S11 ^{13}C NMR spectrum of the isolated carbonaceous product.

Fig. S12 Digital photograph of the reaction mixture following addition of nitro blue tetrazolium chloride (NBT).

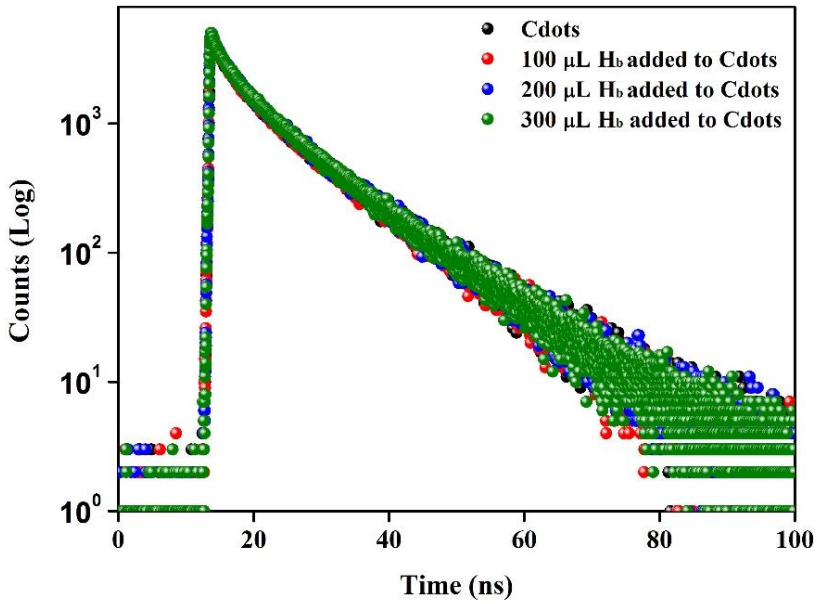

Fig. S13 PL decay profile of Cdots added with increasing concentration of H_b.

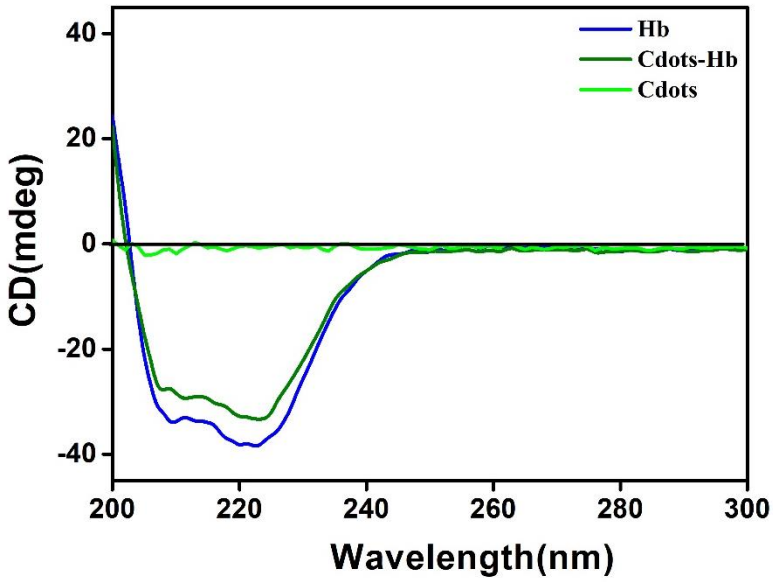

Fig. S14 CD spectra of Cdots, Cdots-H_b and only H_b.

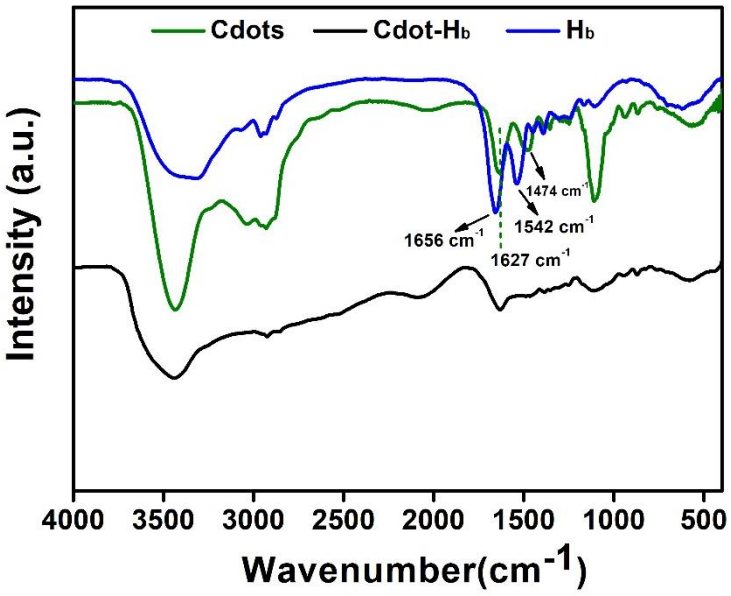

Fig. S15 FTIR spectra of Cdots, H_b and Cdot-H_b.

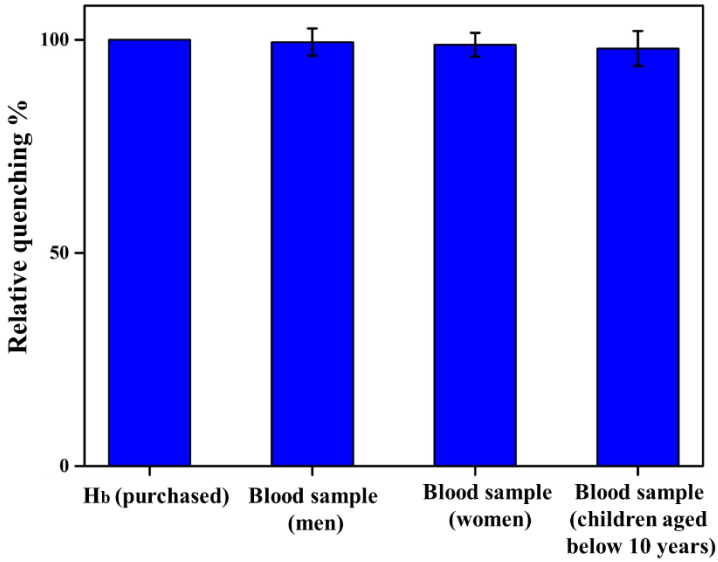

Fig. S16 Sensor response towards blood samples, voluntarily collected from adult men, adult women and children aged below 10 years. Response was similar for all the real samples with respect to commercially available H_b sample.

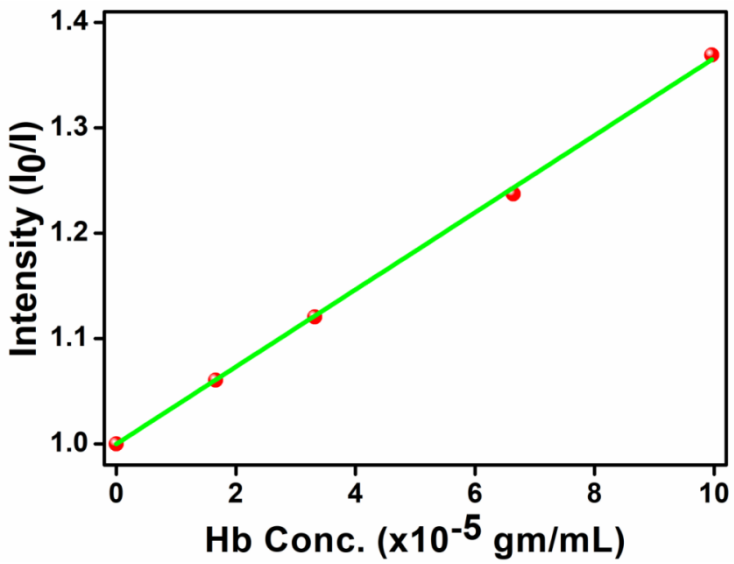

Fig. S17 PL calibration plot for quantifying H_b present in unknown samples.

Table S2. Details of the experimental result for quantifying H_b present in sample coded as HB-MPS.

Sample HB-MPS (100 fold diluted with buffer 7.4)	**I_0/I**	**From calibration plot gm/mL (x 10^{-5})**	**H_b concentration (gm/dL)**
0 µL	1		
10 µL	1.006	**0.16388**	**14.8**
20 µL	1.011	**0.30045**	**13.6**
50 µL	1.027	**0.74053**	**13.6**
			14±0.7

Table S3. Details of the experimental result for quantifying H_b present in sample coded as HB-RB.

Sample HB-RB (100 fold diluted with buffer 7.4)	**I_0/I**	**From calibration plot gm/mL (x 10^{-5})**	**H_b concentration (gm/dL)**
0 µL	1		
20 µL	1.012	**0.32776**	**14.8**
50 µL	1.026	**0.71015**	**12.99**
90 µL	1.05	**1.36567**	**14.06**
			13.95±0.91

Experiment with Urine Sample (Fig. 5b)

Sample 1: Urine

Sample 2: Urine with blood (concentration of H_b is 15.5 µM)

Sample 3. Urine with blood (concentration of H_b is 19.4 µM)

Sample 4. Urine with blood (concentration of H_b is 25.8 µM)

Sample 5. Urine with blood (concentration of H_b is 38.7 µM)

Sample 6. Urine with blood (concentration of H_b is 77.5 µM)

Concentration of Cdots in chitosan gel is 0.02 mg/mL

Quenched at urine with blood (concentration of H_b is 25.8 µM)

References:

1. J. E. Murphy, M. C. Beard, A. G. Norman, S. P. Ahrenkiel, J. C. Johnson, P. Yu, O. I. Micic, R. J. Ellingson and A. J. Nozik, *J. Am. Chem. Soc*, 2006, **128**, 3241-3247.