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Ultra Broad Emission from Fe Doped Carbon Quantum Dots

Authors : Asha Bhardwaj, Pushpendu Biswas

Abstract : Carbon Dots (CDs) are known to be absorbing in the UV and emitting in the blue to visible region [1-2]. As CDs have high bio compatibility, high emission efficiency, are environment friendly and are nontoxic in nature, they are a material of great importance for various biomedical as well as optoelectronic applications [3-6]. For bioimaging and photothermal therapy in cancer treatment CDs should be highly photostable, show interaction with NIR band [3], show quick excretion from the body and have high Quantum yields. NIR I stands for emission in the 650-950 nm region and NIR II stands for emission in the 1000-1700 nm range [4]. Penetration depth of NIR II is larger than that of NIR-1 or visible light [5]. Also, it shows heating effect which is beneficial for selective ablation of cancer cells while not harming the healthy cells. Therefore, efforts are being made by the scientific community to synthesize CDs which emit in the NIR II region. Here we report CDs emitting in all the three regions (Visible, NIR I and NIR II) of electromagnetic spectra ranging from 300-1150 nm. Wide range emissive CDs and Fe doped CDs are prepared by a one-step hydrothermal method. Fe concentration has been increased in steps to assess the contribution from Fe incorporation in the CD lattice [6]. The CDs emit in three wavelength ranges, from 300-600 nm, 600-800 nm (NIR I) and 900 – 1150 nm (NIR II). Such kind of broad emission behaviour in single system carbon dots is being reported for the first time. Further excitation wavelength (λex) dependent emission characteristics reveal that the emission peak wavelength values are unaffected by the changing excitation wavelength in the visible region. Also, NIR I and NIR II emission is observed only for 300 and 310 nm excitation, hinting towards two photon and three photon emission [4]. Emission from 650-1150 nm is not observed for λex > 310 nm. Additionally, as expected the absorption spectra also ranges from 250-600 nm, as compared to commonly observed blue or UV absorption in CDs. The exquisite ultra-wide range emitting nontoxic CDs can find application not only as broad band emitters but also in photothermal therapy for cancer cell theranostics.

Keywords : Broad Emission, absorption, Carbon dots, NIR Emission
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