

Enhanced Photophysics of Zinc Phthalocyanine Derivative by Conjugating to Noble Nanoparticles

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Zinc phthalocyanine (ZnPc) derivatives have many interesting properties, such as high absorption capacity in the first near-infrared region, good reactive oxygen species (ROS) generation efficiency, and excellent photostability [1-3]. However, ZnPc are highly hydrophobic and tend to aggregate, which decreases their photosensitivity. Therefore, many attempts have been made to increase the water solubility of phthalocyanine derivatives. The simplest approach is to conjugate hydrophilic elements, such as sulfo, carboxyl, amino, ammonium, hydroxy and as well as polyethylene glycol groups at peripheral and non-peripheral positions. Recent studies highlight the potential of ZnPc to be combined with various nanoparticles, such as Ag, Au, or different polymers, to enhance biodistribution and photodynamic activity [1]. In this study, zinc phthalocyanine was functionalized with chitosan surface modified gold nanoparticles and were characterized using UV-Vis absorption spectroscopy, X-ray diffraction (XRD), zeta potential measurements, and dynamic light scattering (DLS). The results demonstrated that the reaction temperature plays a crucial role in controlling the size, shape, and crystalline structure of the gold nanoparticles (GNPs). Moreover, it was shown that chitosan can act as a scaffold for the assembly of GNPs, which were successfully used for ZnPc functionalization. The first optical indication of GNP formation was a visible color change over time, from violet to light pink. This visible color arises from the resonant interaction of light with GNPs via surface plasmon excitation. Since the optical spectrum of GNPs strongly depends on their size, shape, local environment, and electronic coupling, their formation was monitored not only visually but more accurately through UV-Vis extinction spectroscopy, showing a characteristic absorption maximum at 520 nm. The zeta potential was approximately -32.25 mV, and DLS analysis revealed a mean GNP diameter of approximately 272.2 nm. All diffraction peaks could be attributed to the (111), (200), (220), (311), and (222) planes of a face-centered cubic (fcc) gold crystal. Also, photophysical parameters of chitosan-functionalized noble nanoparticles conjugated with zinc phthalocyanine derivative will be discussed. The UV-Vis absorption spectra of $\text{ZnPc}(\text{COOH})_4$ and $\text{ZnPc}(\text{COOH})_4\text{:AuNPs}$ structures showed a well-defined B-band absorption maximum at around 364 nm and only a slight attenuation for the Q-band of $\text{ZnPc}(\text{COOH})_4\text{:AuNPs}$ systems compared to the pure ZnPc. Additionally, a minor red shift in the characteristic Q-band of $\text{ZnPc}(\text{COOH})_4$ from 700 nm to 708 nm in $\text{ZnPc}(\text{COOH})_4$ AuNPs structures was observed.

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