Charge-Transfer Complexation in Metal Phthalocyanine Derivatives/Au NPs Hybrid Structures

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Abstract. This study reports the synthesis, photophysical characterization, and fluorescence behavior of [octakis(chloromethyl)phthalocyaninato]zinc conjugated with gold nanoparticles (AuNPs). The compound was prepared via a chloromethylation reaction of zinc phthalocyanine, followed by conjugation with AuNPs stabilized with tannic acid or sodium citrate. UV-Vis absorption spectra revealed intense Q bands in the 580–780 nm range, with additional solvent-dependent features in the near-IR region. Steady-state fluorescence measurements showed red-shifted emission by 6–10 nm relative to the absorption maxima, with small Stokes shifts indicating minimal energy loss between absorption and emission. Fluorescence lifetimes, determined using time-correlated single-photon counting, exhibited bi-exponential behavior, reflecting two distinct molecular populations in DMSO:H_2O. Quantum yields were low, suggesting that the compounds are more suitable as diagnostic fluorescence probes than as photosensitizers for photodynamic therapy. Transient absorption spectroscopy revealed negative bands corresponding to ground-state bleach and stimulated emission, with an estimated lifetime of ~12 ns, and no observable triplet state absorption. These results provide insights into the photophysical properties and non-radiative deactivation pathways of the hybrid system. The study demonstrates the potential of [octakis(chloromethyl)phthalocyaninato]zinc:AuNPs assemblies for advanced photonic and biomedical applications and highlights the importance of controlled nanoparticle functionalization to tune their emission properties.

Keywords: Metallophthalocyanines · Gold nanoparticles · Fluorescence · Transient absorption

A. R. Várkonyi-Kóczy and J. Kacprzyk (Eds.): Inter-Academia 2025, LNNS 1925, pp. 27–35, 2026.
https://doi.org/10.1007/978-3-032-22615-0_4

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