Resonant optical nonlinearities in Zn phthalocyanines

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In this work, we have studied the nonlinear absorption process of phthalocyanines, macrocyclic organic compounds which exhibit large optical nonlinearities. Phthalocyanines present singlet and triplet states which provide strong resonant nonlinear effects with fast lifetimes. In this way, saturable absorption and reverse saturable absorption can be observed depending on the excitation wavelength. Owing to these effects, phthalocyanines are promising candidates for applications in optical-limiters, optical switches and sensitizers for photodynamic therapy.

The singlet and triplet states dynamics of Zn phthalocyanines (ZnPc) was studied at 532 nm using single pulse [1] and pulse train Z-scan [2] techniques, which were subsequently analyzed with a three and five energy level diagram respectively. The excited singlet state absorption cross-section for ZnPc, for instance, was determined to be ~2.7 times higher than the ground state one, giving rise to reverse saturated absorption. Reverse saturated absorption also occurs from the triplet state, after its population through an intersystem crossing process, whose characteristic time is around 9 ns. The excited state absorption spectrum of the ZnPc was investigated employing the Z-scan technique with white-light continuum pulses. Two distinct excited state absorption behaviors were observed: a saturable absorption at the Q-band region (~ 670 nm) and a reverse saturable absorption around 500 nm. A three-energy-level diagram was used to explain the experimental results, leading to the excited state absorption cross-section determination from 450 nm up to 700 nm. The high excited singlet and triplet states absorption cross-sections of phthalocyanines indicates its use in application requiring reverse saturated absorption in a broad spectral band.

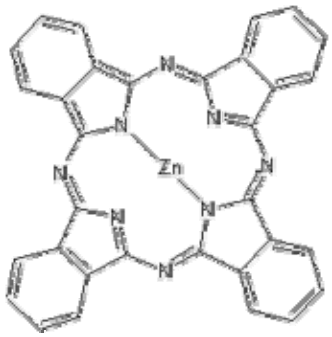

Figure 1 – Molecular structure of ZnPc.

Keywords: Organic materials, optical properties, nonlinear optics, ultra-short lasers.

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