TWO-PHOTON ABSORPTION IN PERYLENE DERIVATIVES

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Abstract

The two-photon absorption (2PA) cross-section for perylnes derivatives solutions were measured using the Z-scan technique with femtosecond laser pulses at 775 nm. All perylene derivatives studied present high 2PA process, comparable to very high ones recently reported in the literature. Besides, our results allow one to draw some correlation between the molecular structure and the 2PA process, which, in principle, can guide further works to develop molecular design strategies to create structures with optimized 2PA coefficients.

Samples studied

The perylene tetracarboxylic derivatives (PTCD) samples were provided by Dr. J. Duff from the XRRC of Canada, and their concentrations are listed in Table 1. The absorption spectra in the UV-Vis region,obtained with a Cary 50 spectrophotometer, are presented in Fig.2.

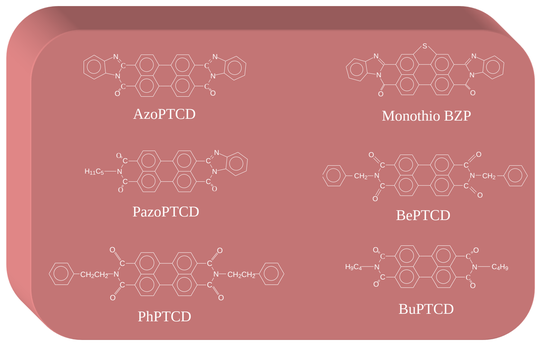

Figure 1 – Molecular structures of the compounds investigated.

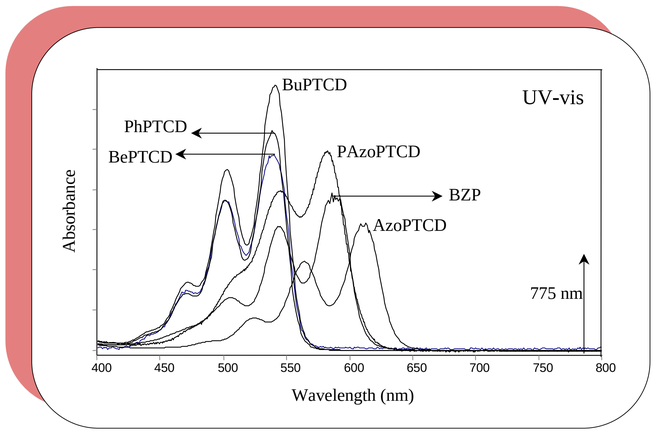

Figure 2 – Absorbance spectra for the perylene samples dissolved with 10% trifluoroacetic acid (TFA) in dichloromethane.

Z-scan experiments

Open aperture Z-scan experiments were performed using laser pulses at 775 nm delivered by a commercial Ti:sapphire chirped pulse amplified (CPA) system CPA-2001 from Clark-MXR Inc., operating at a 1 kHz repetition rate. The laser pulse energy employed in our measurements was typically 0.1 μJ.

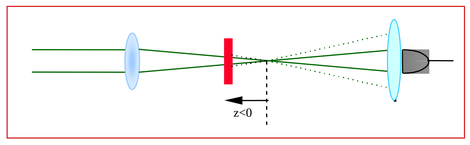

Figure 3 – Open aperture Z-scan experimental setup.

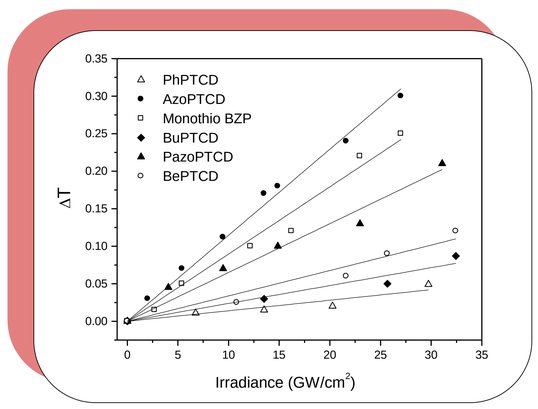

Figure 3 – Linear dependence of the ΔT on the laser irradiance. This results reveals the two-photon origin of the observed process.

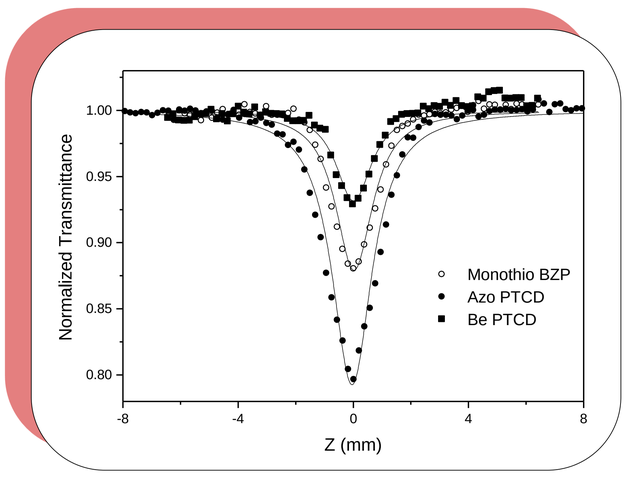

Figure 4 – Z-scan signature for the some perylene soutions performed with 190 fs pulses at 775 nm and an intensity of about 15 GW/cm^2. The solid lines represent theoretical fittings with the parameters given in the Table 1.

Results

Z-scan measurements were carried out for the all perylene samples in order to determine their 2PA coefficients. The δ values are listed in Table 1.

Table 1: Concentration and 2PA cross-sections for the perylene derivatives.

PTCD	Concentration (10^{17} molecules/cm^3)	β (cm/GW)	δ (10^{-50} cm^4 s photon^{-1})
PhPTCD	6.4	0.002	84
BuPTCD	6.0	0.002	92
BePTCD	4.3	0.007	420
PazoPTCD	6.0	0.016	660
Monothio BZP	5.0	0.016	820
AzoPTCD	7.0	0.032	1200

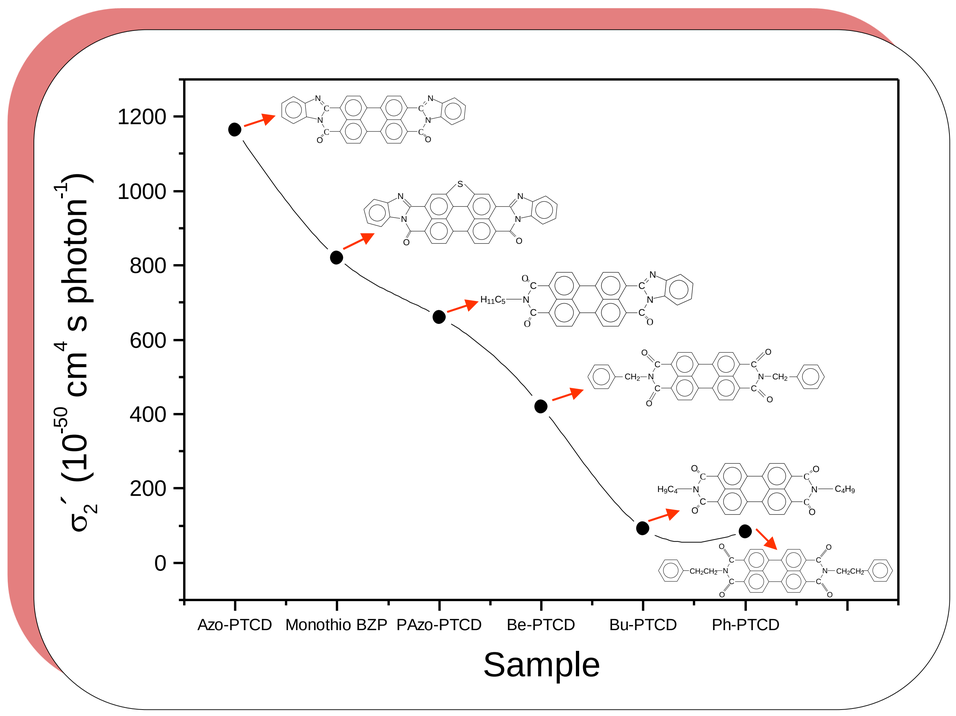

Figure 4 – Experimental values of the 2PA cross-section for the PTCD compounds studied. The solid line in this figure was drawn to guide the eye.

Conclusion

We have measured the two-photon absorption cross-section of a series of conjugated perylenes derivatives using Z-scan technique with femtosecond pulses at 775 nm. We found large δ values comparable to the best organic compounds presented in the literature. The strongest δ value measured was 1200x10^{-50} cm^{-4} s photon^{-1} corresponding to the Azo PTCD molecule. Also we found out a strong correlation between the molecular structure and the δ values corresponding to what is expected for one highly conjugated structure.