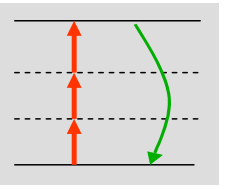


CePOF
Centro de Pesquisa em Óptica e Fotônica

Two- and three-photon absorption in Meh-PPV/chloroform solution

D. S. Corrêa, L. De Boni, S. L. Oliveira, D. T. Balogh,
S. C. Zilio, L. Misoguti, C. R. Mendonça

IFSC - USP

Abstract

In recent years conjugated polymers have attracted much attention, not only for its electrical conductivity, but also for its high nonlinear optical effects. One of such effects is the multi photon absorption, which has become a subject of growing-interest for many researchers and scientists, owing to its several possible applications in many fields of science, as shown in this work. Thus, it becomes of prime importance to characterize those materials that strongly present this property. In this context, this work reports the study of two- and three-photon absorption in the Meh-PPV/chloroform solution.

Multi-photon absorption

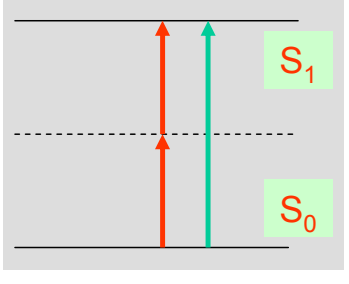
$$\vec{P} = \chi^{(1)}.\vec{E} + \chi^{(2)} : \vec{E}\vec{E} + \chi^{(3)} : \vec{E}\vec{E}\vec{E} + \ldots$$

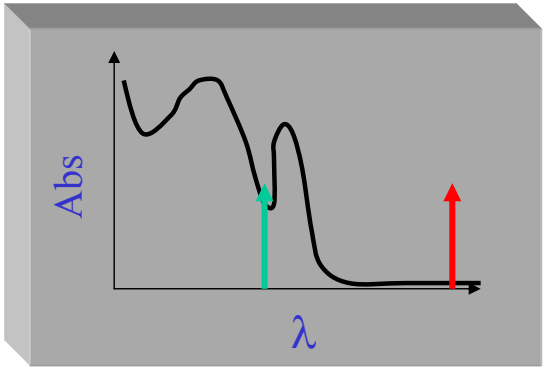
α_n: *n-photon absorption coefficient*

$$\alpha = \alpha_1 + \alpha_2 I^2 + \alpha_3 I^3 + \ldots \alpha_n I^n$$

Effective absorption coefficient increases with the light intensity.

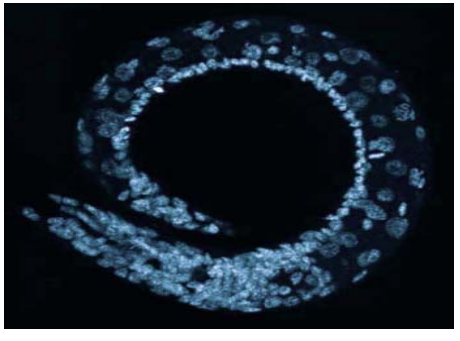
2PA



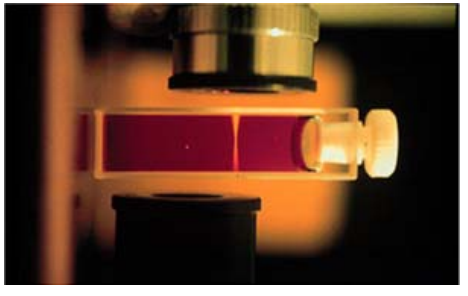


Technological application

- Two- and three-photon fluorescence microscopy

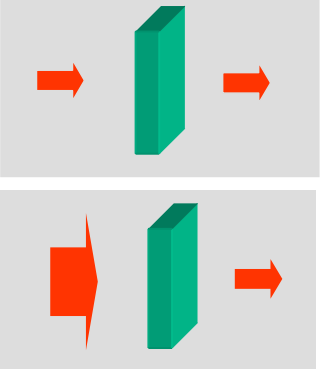


- 3D optical storage



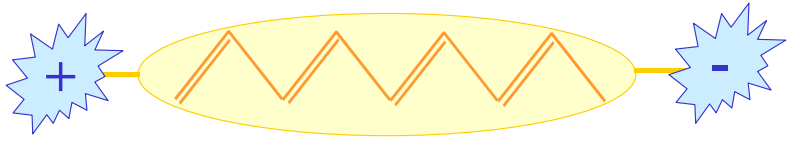
- Two-photons PDT

- Optical limiting

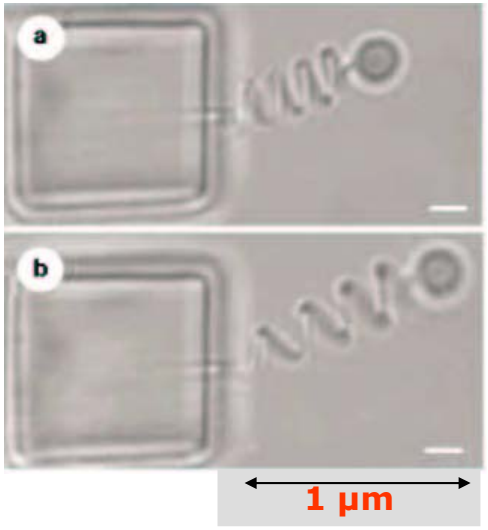


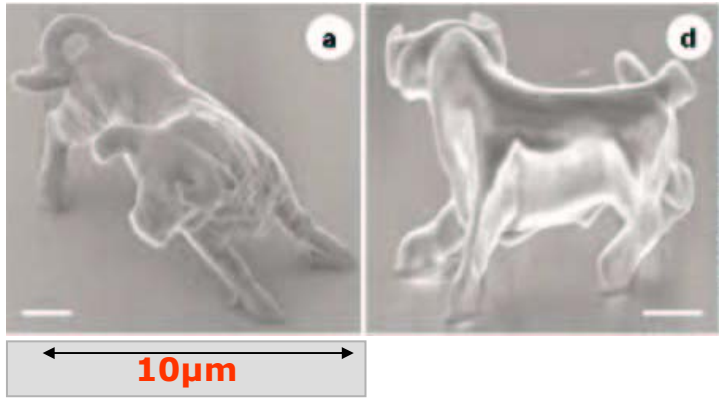
Technological application

- *Molecular engineering*



- *fabrication of micro and nano estructures*





Molecular engineering

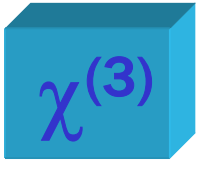
- *Test 2PA and 3PA theories*
- *Correlation between the molecular structure and nonlinear optical properties.*
- *Development of material with high nonlinearities*

Why organic materials present high nonlinear optical processes?

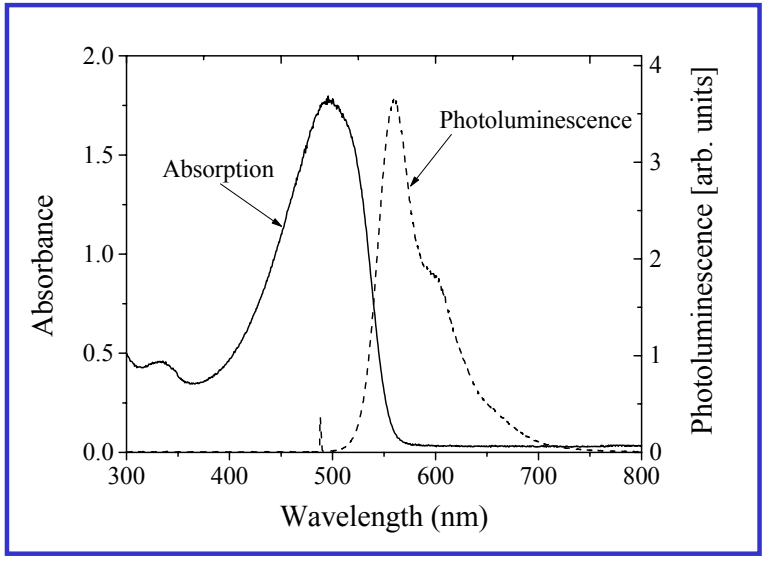
→ *π-conjugation*

→ *Saturation phenomenon*

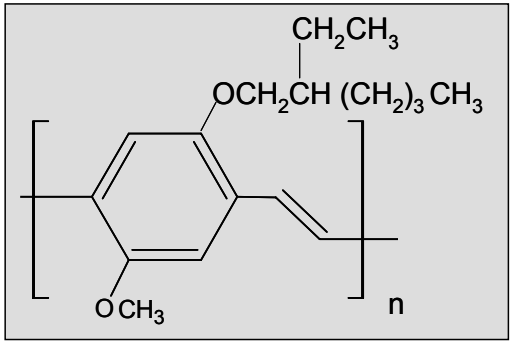
High optical nonlinearities



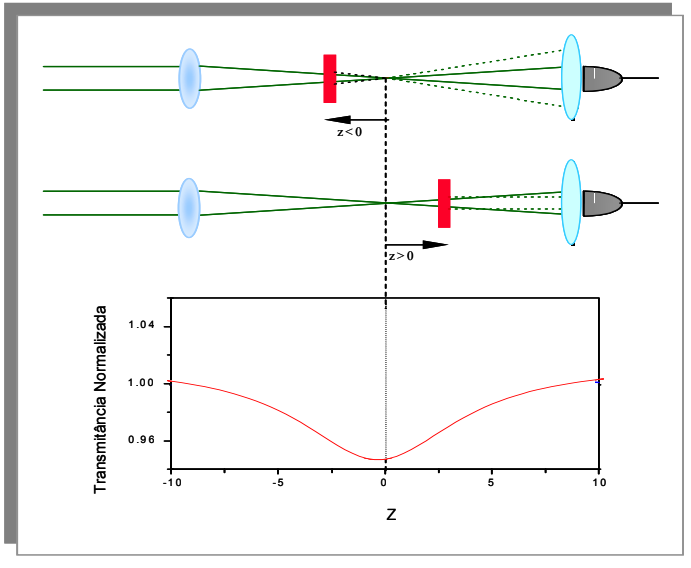
MEH-PPV



Molecular structure



Z-scan Technique

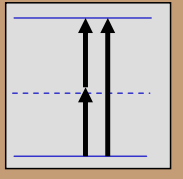


Z-scan signature

- ✓ *Experimental simplicity*
- ✓ *Sensitive method*
- ✓ α_n *: determination of nonlinear absorption coefficiente*

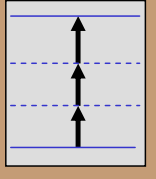
$$T(L) = \sum_{m=0}^{\infty} \frac{[-q_0]^m}{(m+1)^{3/2}}$$

$$q_{(0)} = \frac{I_0 \alpha_2 L \omega_0^2}{\omega_z^2}$$

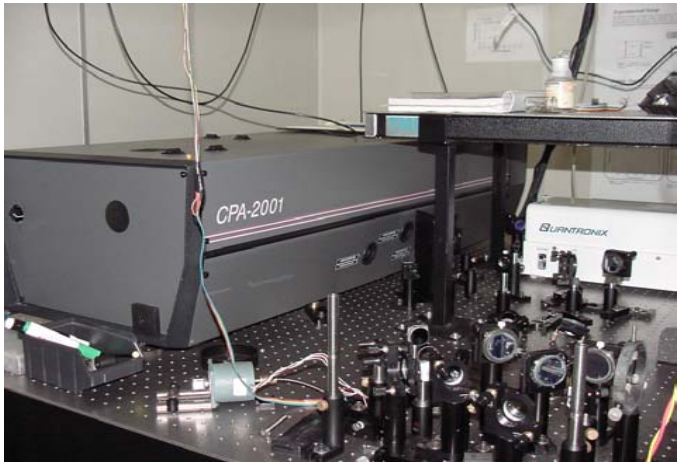


$$T(L) = \frac{1}{\sqrt{\pi}\sqrt[3]{2\alpha_3 L I^2}} \int_0^1 \frac{R_{(x)}}{x\sqrt{-\ln x}} dx$$

$$R_{(x)} = \ln\left(\sqrt{1+2\alpha_3 L I^2 x^2} + \sqrt{2\alpha_3 L I^2 x^2}\right)$$



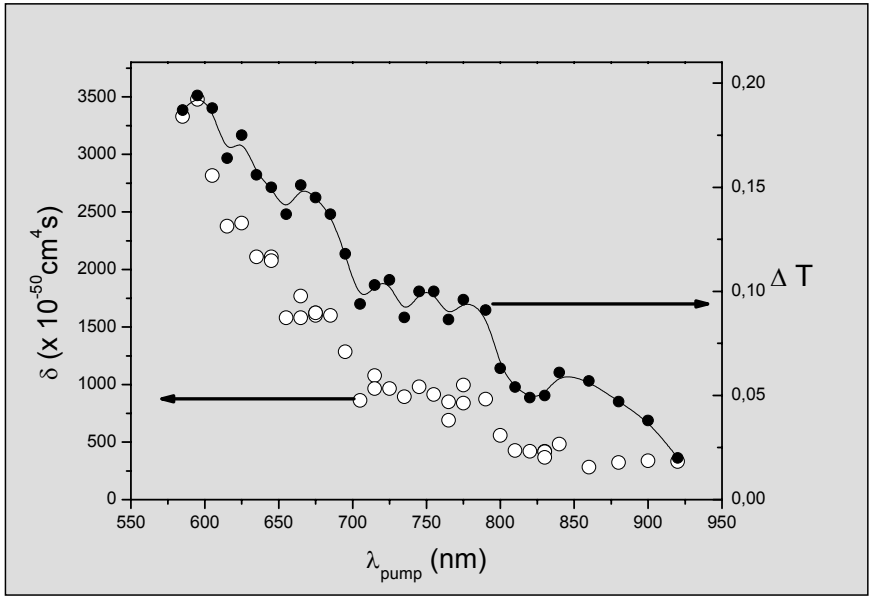
Experimental Setup

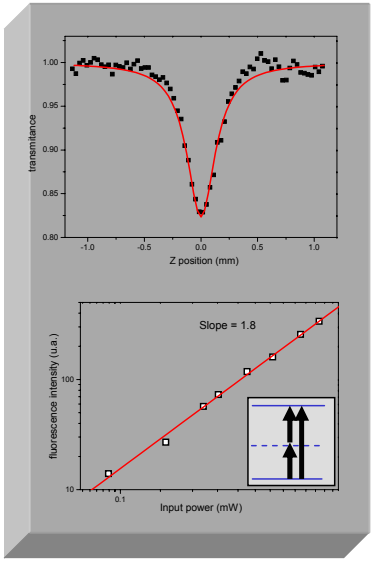


- ✓ *Ti:sapphire chirped pulse amplified system (CPA-2001)*
  - ✓ *775 nm*
  - ✓ *150 fs*
  - ✓ *1KHz*

- ✓ *Optical parametric amplifier (TOPAS)*
  - ✓ *460 - 2600 nm*
  - ✓ *≈120 fs*

Two-photon absorption

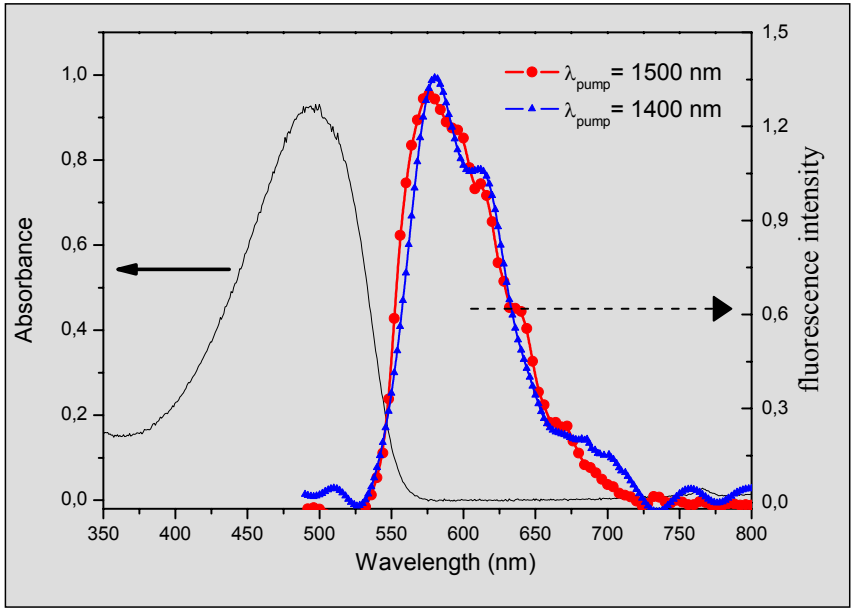


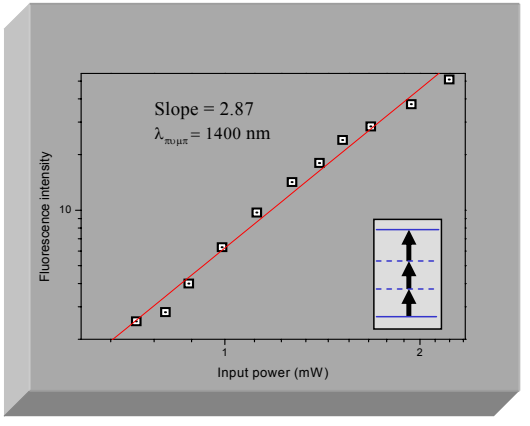


2PA: δ=1 to 3000 x GM cm^4 s $photon^{-1}$

Larger δ_{2PA} near the linear absorption band ⟶ resonance enhancement

Three-photon absorption





3PA: *needs to be evaluated*

Conclusions

- Occurrence of the 2PA process in a large range of VIS spectrum
- Larger δ_{2PA} closer to the linear absorption band because of the resonance enhancement.
- Occurrence of 3PA process, which δ_{3PA} needs to be evaluated.
- High $\chi(3)$ e $\chi(5)$ related to π-conjugation along the polymer backbone.