Three-dimensional optical data storage in azopolymer induced via two-photon absorption

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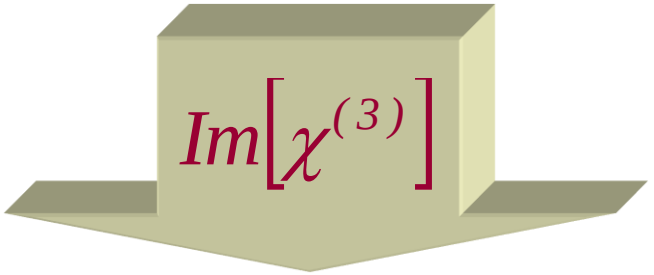
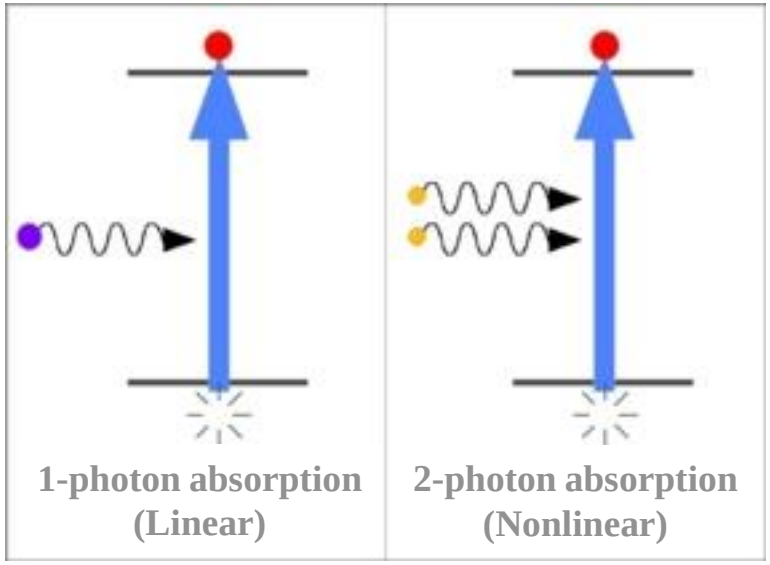
IMMP

Two-photon absorption

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





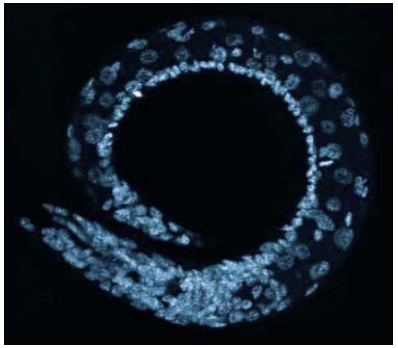
$$\alpha = \alpha_0 + \beta\, I$$

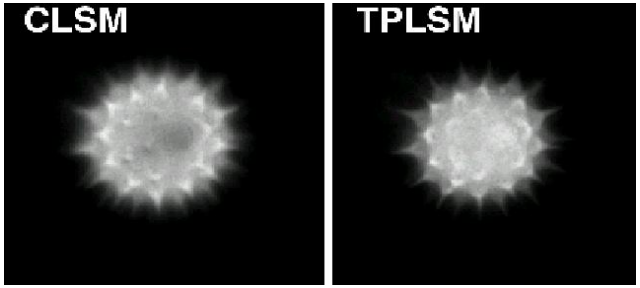
β: two-photon absorption coefficient

Applications

- **Two-photons fluorescence microscopy**

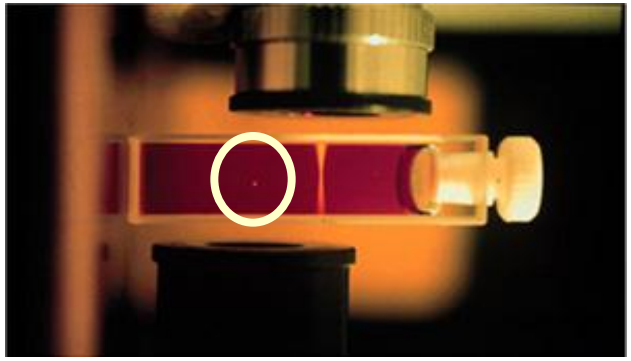
C. elegans (3PEF)
Nematode (worm)





pollen grain

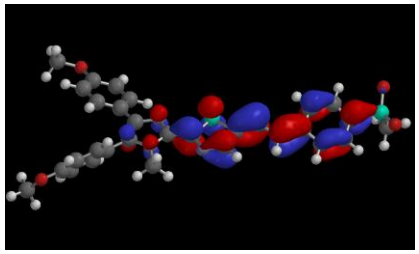
- **Two-photon PDT**
- **3D Optical Storage**

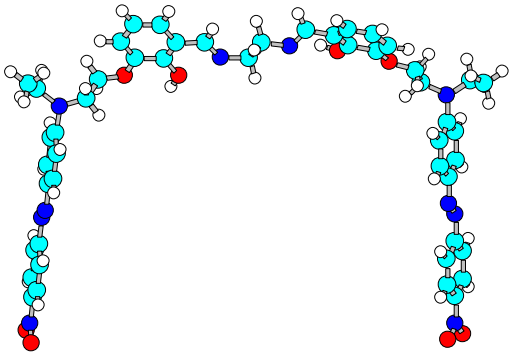


Spatially localized excitation

Applications

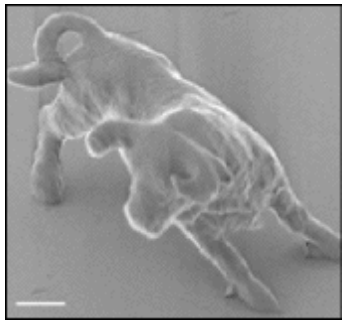
- **Optical Limiting**
- **Molecular engineering**





Relation between the molecular structure and the 2PA process

- **Two-photons photo-polimerization**



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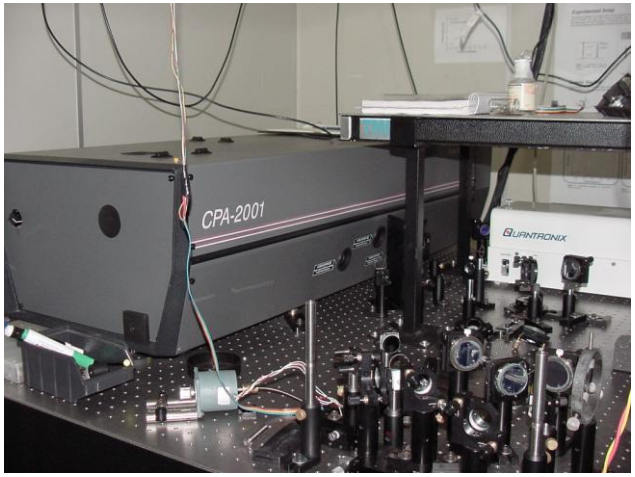
Experimental – Z-scan

150 fs Laser

Clark – MAXR CPA - 2001

λ=775 nm; f=1 KHz;

E_p=800 μJ



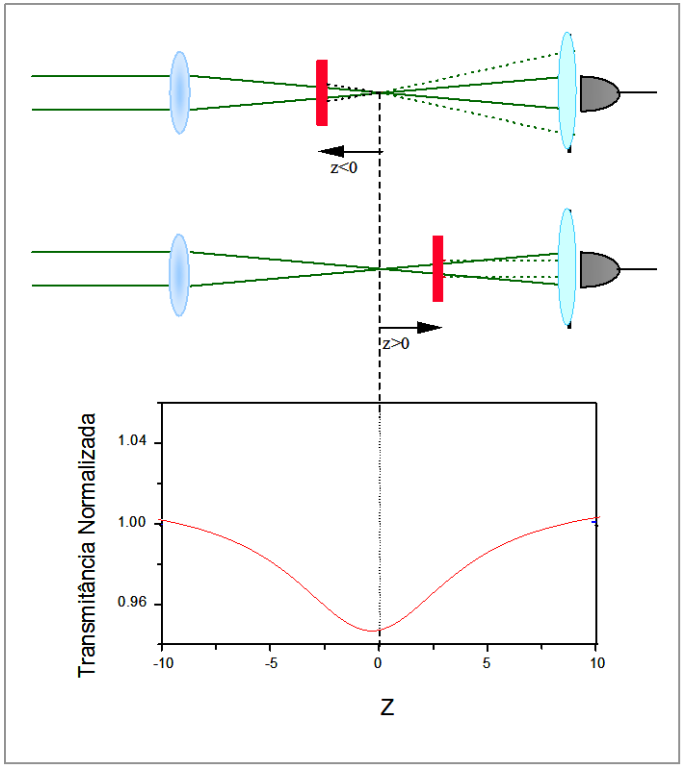
OPA

Pump - Laser Clark

460 - 2600 nm

≈120 fs

20-60 μJ

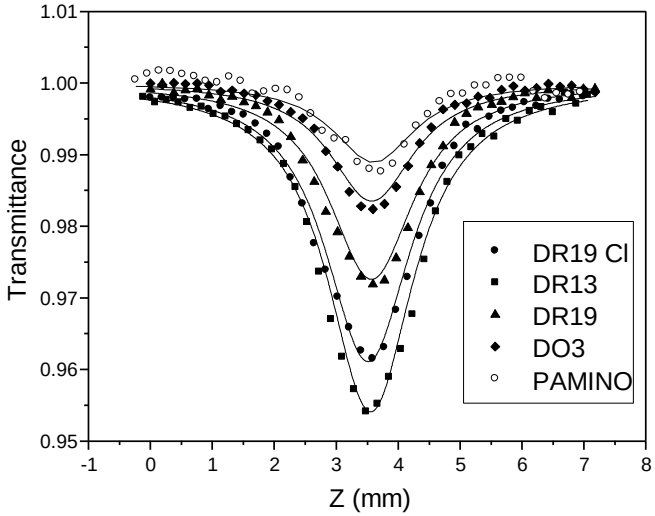


$$\alpha(I) = \alpha_0 + \beta I$$

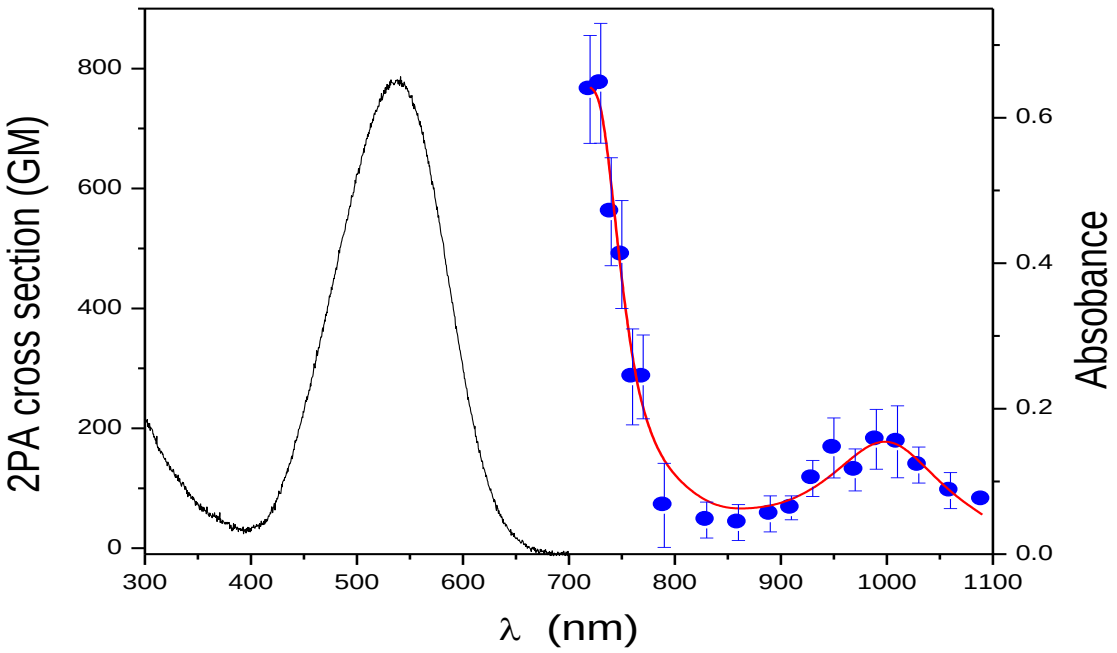
$$\Delta T \propto \beta$$

Two-photon absorption spectrum

Individual Z-scan measurements for several azoaromatic compounds

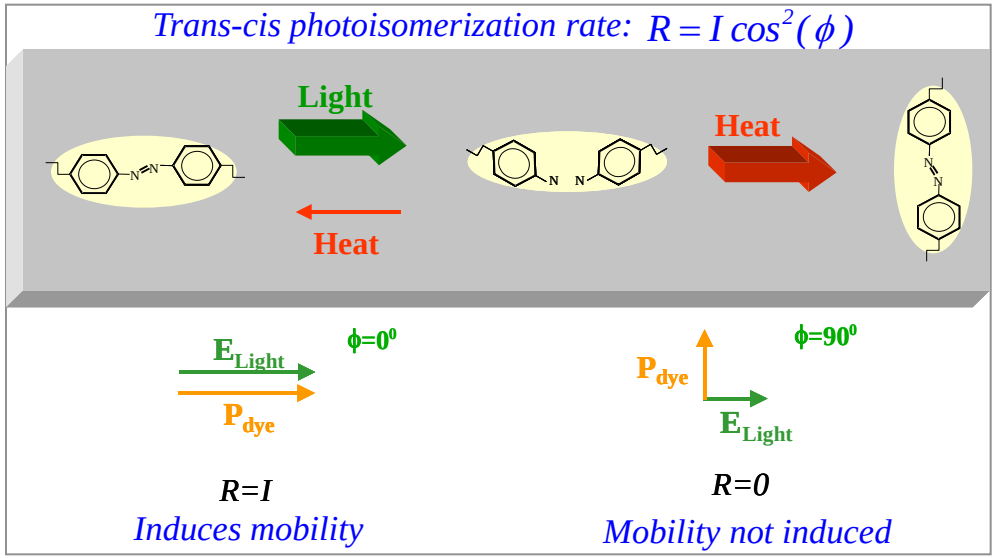


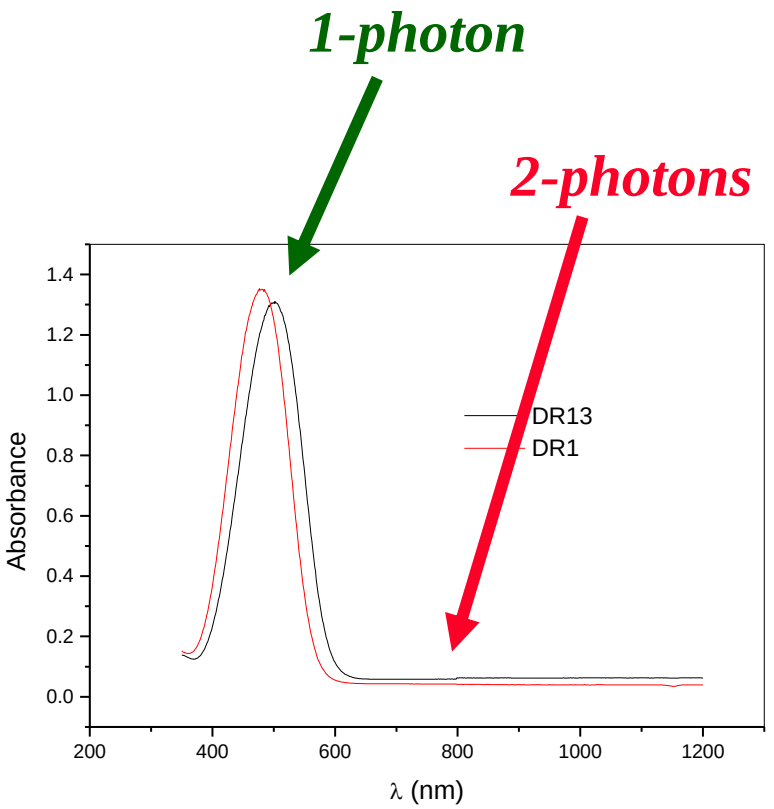
Degenerate two-photon absorption spectrum for DR13 (solution0



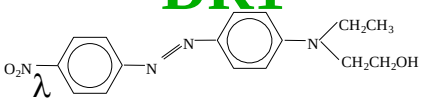
σ_{2PA}= 200 x 10 $^{-50}$ cm^4 s @ 775 nm

Two-photon optical storage (3D)

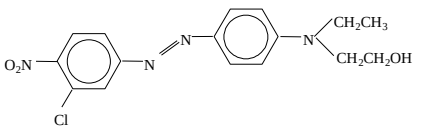




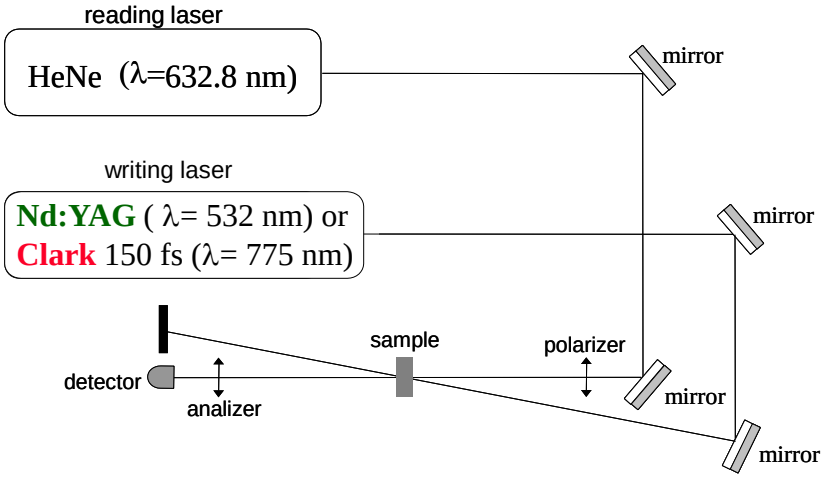
DR1



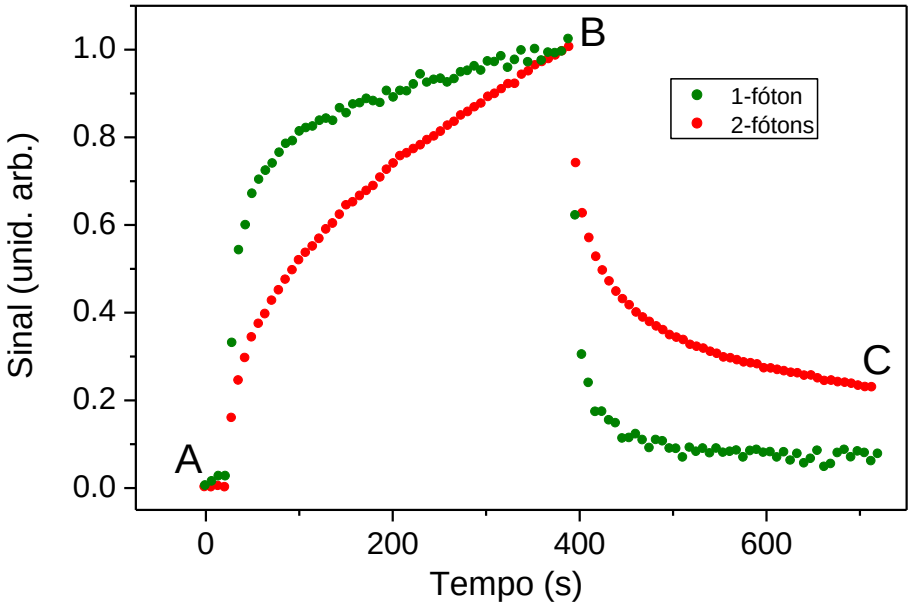
DR13



Two-photon optical storage (2D)



Guest host films – PMMA/DR13



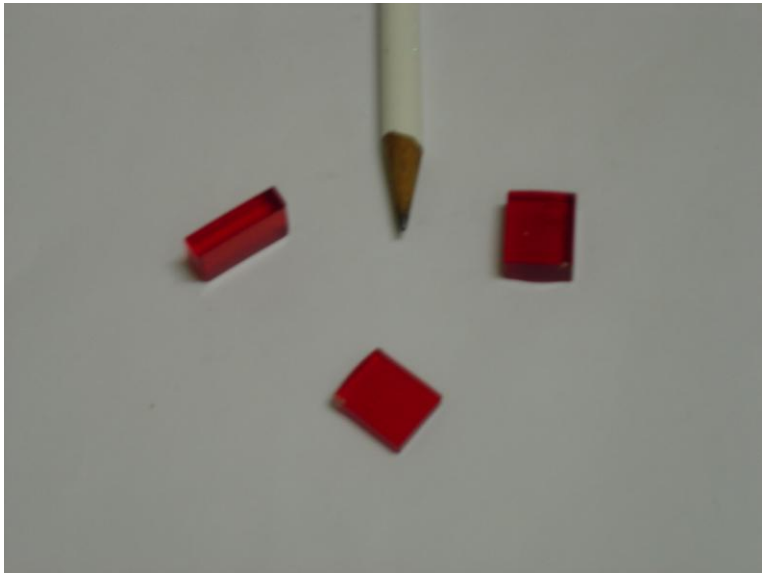
λ= 532 nm I= 0.1 W/cm^2

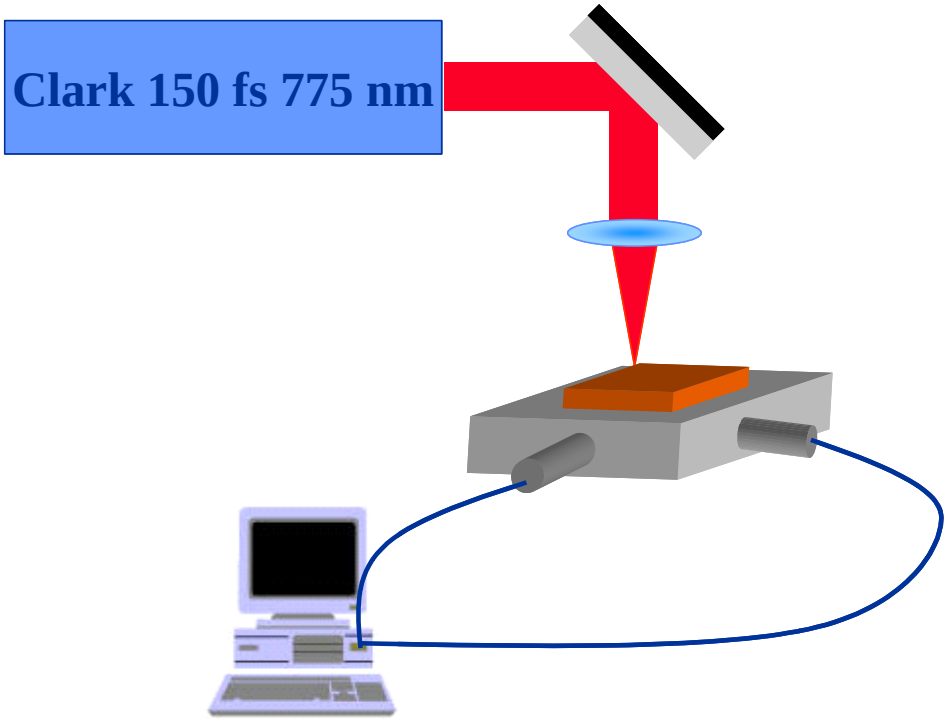
λ= 775 nm I= 25 GW/cm^2

Accumulative nature of the orientation process

Two-photon optical storage (3D)

PMMA/DR13 sample
(1x2x0.5 cm^3)



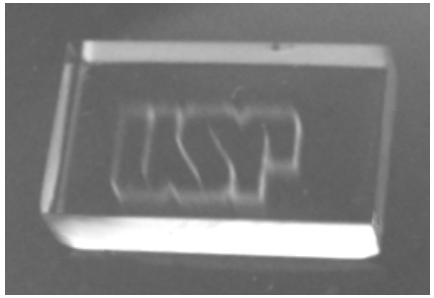


3D Writing System

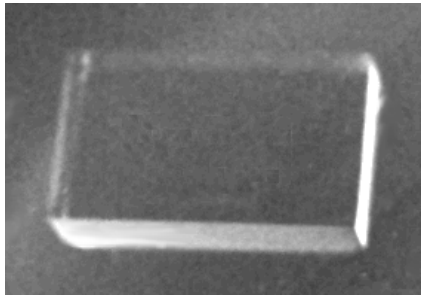
- ✓ *Focalized laser beam*
- ✓ *PC interfaced translation stage*

Two-photon optical storage (3D)

Two photon induced birefringence image recorded in the sample volume



(a)



(b)

Pattern induced at 3 mm from the sample surface

Sample positioning

a) 45^0 *with the polarizer axis*
b) parallel to the polarizer axis

- ✓ *Erasing procedure*
  - ❖ *heating*
  - ❖ *overwriting with circularly polarized light*
- ✓ *ReWritable*
- ✓ *Increase the density of information*
- ✓ *Protection of the information in the sample volume*