Femtosecond laser induced structural transformations in transparent oxide glasses.

Bertrand Poumellec*†[1]

[1]Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO) – Université Paris Saclay – France

Abstract

The increase of demand in optical telecommunication rate is such that optical integration is a requisite for the foreseen development. In this way, direct laser writing in glasses could be a solution especially when using femtosecond laser. According to the pulse energy at moderate repetition rate (< a few 100kHz), the irradiation changes the fictive temperature and thus produces a change of refractive index. On increase of the pulse energy, some glasses can be locally decomposed into reduced glass and oxygen gas that self–organized under the light into nanogratings giving rise to large form birefringence, very thermally resistant and orientable by turning the laser polarization. This is useful for achieving optical waveguides but also any kind of lenses.
Among them, we demonstrated the possibility to achieve an achromatic rotator by combining several irradiated layers. But we find also, that according to some specific conditions, only one irradiation may also produce light rotatory power. On this point, we do not know today if this chiral property arises from rotatory combination of linear property or from chiral arrangements at the molecular level.

The local creation of second order optical susceptibility for frequency conversion can be achieved by driving the glass to crystalize. The thermal problem, here, is similar to the one with CW laser but with fs laser the material can be transparent and the modification in the bulk. This will be shown in Li2O-Nb2O5-SiO2 glass.

For this glass, the direction of the crystals is controllable for a range of parameters with the direction of polarization and so the orientation of the susceptibility. This is a real advanced because the electromagnetic field direction in a waveguide is not free.
Finally, we found that when the glass is not congruent, phase separation during crystallization may also induce similar nanogratings like in SiO2.

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*Speaker
†Corresponding author: bertrand.poumellec@u-psud.fr

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