ESRF	**Experiment title:** Poling induced anisotropy in LBG glasses studied by small angle X-rays scattering	**Experiment number**: ME1000
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Names and affiliations of applicants (* indicates experimentalists):

Bernard Champagnon, Laboratoire de Physico-Chimie des Matériaux Luminescents, Université Claude Bernard Lyon 1

*Valeria Califano, Laboratoire de Physico-Chimie des Matériaux Luminescents, Université Claude Bernard Lyon 1

Dominique Vouagner, Laboratoire de Physico-Chimie des Matériaux Luminescents, Université Claude Bernard Lyon 1

Vladimir Sigaev, Mendeleev University, Moscow, Russia.

Report:

Introduction

The thermal poling technique applied to glass materials opens new perspective in the field of non linear optics and in particular for second harmonic generation (SHG).
The poling is a polarisation technique which consists in applying an electric field between two electrodes in physical contact with the two opposite surfaces of a glass sample.
The first glass submitted to the thermal poling was silica[1], however the poling process were applied also to glasses of original composition, such as borate glasses[2, 3].
The result of these experiments was an induction of SHG in these glasses, normally forbidden in isotropic, centrosymmetric or disordered materials.
The mechanism of the poling induced SHG is still debated. It can be due to a migration of mobile cationic impurities towards the cathode[4] or to the orientation under the electric field of hyperpolarizable moieties[1]. In the first case the non linear properties are concentated in a thin layer at the anodic surface, while in the second the whole bulk of the sample is optically non linear. Experimentally, most of the poled silica glasses showed a superficial non optical layer, while borate glasses showed a bulk non linearity.

Experimental

The glass chosen for the poling experiments is the lanthanum boron germanate or LBG (La_2O_3-B_2O_3-GeO_2). For these glasses, classical X-rays measurements showed no sign of crystallisation. Nevertheless, birefringence was observed[5].
It is well known that in the short order range the structure of a glass is similar to that of the crystal of the same composition. In the case of LBG glasses, this is the stillwellite-like $LaBGeO_5$, which is a chain-framed acentric structure which shows SHG. We hypothesise that the electric field effect during the poling is orienting fragments of chain-framed structure along its direction.

Some of the LBG glasses were submitted to thermal poling at 300°C and an applied electric field of 8 kV/mm. Other LBG samples were submitted to optical poling (where the source of the electric field is a polarised UV laser radiation) at 400°C and with a laser power of 100-300 mW. Their anisotropy was detected by SAXS, thanks to the bidimensional detector of the BM02 SAXS instrument.
Plates were cut from the thermally poled samples, along a direction both parallel and perpendicular to the poling field direction. The plates were polished to a thickness of 100 μm.
For the UV poled glasses only the face parallel to the electric field could be tested because of the small thickness of the samples.
The energy of the X-rays beam was 19.05 KeV.

Results
The SAXS profile of a thermally poled sample is shown in figure 1, where the X-rays where focused on the face S_1 perpendicular (a) and on the face S_2 parallel (b) to the poling field direction.

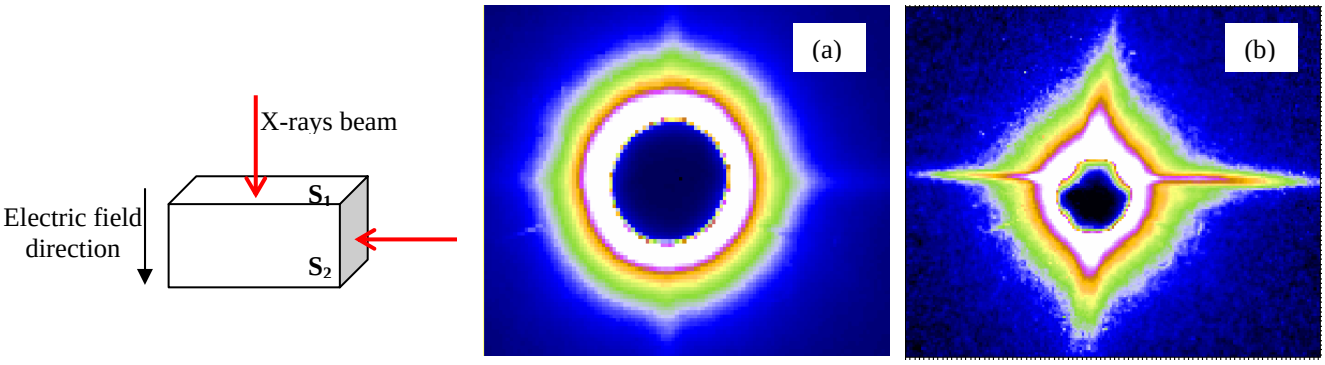

Fig. 1- SAXS profiles recorded by means of the two-dimensional detector of the D2AM beamline at ESRF (a) X-rays focused on the S_1 face and (b) X-rays focused on the S_2 face.

When the X-rays are focused on the S_1 face, the scattering is isotropic, that is the X-rays are scattered in the same way in the whole cone of 2θ opening. When the X-rays are focused on the S_2 face, the scattering is anisotropic: the base of the cone is not a circle anymore, but an ellipse. The peaks visible on the 2D profile don't depend on the sample and don't have to be considered. The ellipse shape indicates that the X-rays are scattered differently in the two mutual perpendicular direction, parallel and perpendicular to the poling electric field. This is clearly due to an orientation of glass moieties in the sample. More than ten different regions of the samples were analysed, giving all the same result.
The UV poled glasses showed an even stronger anisotropy (not shown).

Conclusions
We determined that the poling process breaks the isotropy of the LBG glasses and that this is due to orientation of glass moieties. The anisotropy concerns the whole bulk of the sample. The mechanism of poling is then different from that of silica glasses, where the non linearity is a superficial phenomenon. From previous experiments[5], we can state that the moieties are orientated along the poling electric field direction.
These results were presented in the thesis of Valeria Califano defended at the University of Lyon on the 30th June 2005.

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