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3. ABSTRACT TITLE

Thermal poling of glass modified by gamma radiation

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5. PRESENTATION preference for "Oral Presentation".

6. BRIEF BIOGRAPHY

Olivier Deparis was born in Tournai, Belgium, in 1969. He received the Engineering degree (with greatest honours) from Faculté Polytechnique de Mons (Belgium) in 1991. From 1993 to 1997, in collaboration with the Belgian Nuclear Research Centre, he carried out researches on nuclear radiation effects in silica glass fibres for which he received the Doctorat en Sciences Appliquées (Ph.D.) degree (summa cum laude) from Faculté Polytechnique de Mons in 1997. From 1997 to 2001, he carried out researches at Faculté Polytechnique de Mons on mode-locked erbium-doped fibre lasers, fibre Bragg gratings and the dynamics of external-cavity semiconductor lasers. In January 2002, he joined the Optoelectronics Research Centre at the University of Southampton (UK) where he carries on researches on poling of glass. He is author and co-author of more than 30 publications in journals and 60 publications in conference proceedings. He is member of OSA (Optical Society of America), member of NPSS (Nuclear and Plasma Sciences Society) and LEOS (Lasers and Electro-Optics Society) of the IEEE (Institute of Electrical and Electronics Engineers) and member of SPIE (International Society for Optical Engineering).

7. ABSTRACT TEXT

In the past, it has been reported that silica glass exposed to gamma radiation exhibits enhanced second-harmonic generation (SHG) when it is thermally poled [1]. More specifically, the second-order nonlinear susceptibility induced by thermal poling was found to increase with an increase in the gamma-ray dose. To explain this effect, it was speculated that radiation-induced defects produce electric dipole moments which are oriented in the direction of the applied electric field during poling and then frozen in the glass when it is cooled to room temperature with the voltage still applied. Although promising, this result has been reported only for type-III silica glass which was irradiated at doses of 10 kGy and 100 kGy. On the other hand, all the poling parameters being identical, type-II silica glass exhibits higher second-order optical nonlinearity than type III silica glass.

In this paper, we report on thermal poling of glass modified by gamma radiation. Type-II silica glass (Herasil) and type-III silica glass (Suprasil) were exposed to gamma-rays from a Cobalt-60 source at

high dose rates (6.8 or 9.1 kGy/h) and total doses (119 kGy, 0.8 MGy, 1.5 MGy and 7.1 MGy) and then thermally poled in air at 280 °C, 4 kV for 30 minutes. After poling, SHG in the poled glass samples was investigated using a mode-locked and Q-switched Nd:YAG laser (1064 nm). As a means to study pre-existing and radiation-induced defects, optical absorbance spectra (from ultraviolet to infrared) were measured after irradiation, and also after poling. For each type of silica, a fresh (non-irradiated) sample was poled in the same conditions and taken as a reference.

Second harmonic (SH) intensity in the poled Herasil reference sample was found to be 10 times higher than in the poled Suprasil reference sample, as expected. Depending the type of silica and the dose, the SH intensity in the irradiated samples was either considerably reduced or almost unchanged in comparison with the corresponding reference sample. In none of the samples, including the Suprasil ones, enhancement of SH intensity was observed, in contradiction with [1]. For the Suprasil glass, the SH intensity is reduced by three orders of magnitude in all the irradiated samples but the amount of this decrease depends on total dose and dose rate. For the Herasil glass, the SH intensity is almost unchanged in two samples irradiated at 0.8 MGy and 1.5 MGy while it is reduced by four orders of magnitude in a sample irradiated at 7.1 MGy.

These new and unexpected results on thermal poling of silica glass modified by gamma radiation are important for our understanding of the poling mechanisms, in particular on the aspects related to the role of defects. Actually, absorbance measurements give evidence that glass is significantly modified when it is exposed to high-energy radiation such as gamma rays. The analysis of absorbance spectra also shows that the type of defects and their relative concentrations depend on the type of silica, the dose rate and the total dose. Our results demonstrate that the presence of defects has a strong impact on the SHG induced in the modified glass by thermal poling.

[1] K. Tanaka et al., Jpn. J. Appl. Phys., vol. 34 (1995), pp. 173-1774

8. KEY WORDS : Poling, Radiation, Defects, Second-Harmonic Generation, Nonlinear Optics