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STUDY OF OPTICAL FIBER AS NEW RADIATION DOSIMETER*

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Abstract. New preliminary results obtained in the study of optical fiber properties, for the development of a new radiation dosimeter sensitive to high energy photon beams, are presented in this paper. Optical fiber has been exposed to high energy photon beam generated by ALIN 10 linear accelerator. The exposure of the optical fibers to the high energy photon beam has produced an increase in radiation induced attenuation (RIA), a physical quantity used to exposure dose quantification. Attenuation in the optical fibers was measured before, during and after irradiation, for two wavelength values. The experimental results show that the optical fiber has a good response to radiation exposure and, therefore, can be useful in achieving the purposes of this study.

Key words: optical fiber, radiation dosimeter, RIA, high dose rate dosimeter.

1. INTRODUCTION

Optical fibers are used in various fields, ranging from telecommunications to medicine. The exposure to ionizing radiation induces an increment in attenuation. The excess of the optical loses are due to the generation of point defects in the silica core. This effect will be used for the development of a new radiation dosimeter. The optical fiber radiation induced attenuation is proportional to exposure radiation dose (C.Yan 2007 [1], M.C.Paul 2007 [2]).

Multimode optical fiber is characterized by the light wavelength transmitted simultaneously through the multi-mode wavelength guide. Modes appear due to light propagation only through the fiber core with different angles.

The AFS50/125Y multimode optical fiber was chosen to be used in this study. This optical fiber is characterized by a core diameter of 50 μm, cladding diameter of 125 μm and coating diameter of 250 μm. This optical fiber is

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characterized by good transmission proprieties in the UV, VIS and NIR spectral regions.

Next is presented the measurement methodology as the obtained experimental results of the preliminary study of the radiation induced attenuation of the multimode optical fiber exposed to high energy gamma ray, delivered by the linear accelerator ALIN10, developed by National Research and Development Institute on Laser, Plasma and Radiation Physics (INFLPR).

2. EXPERIMENTAL MEASUREMENTS

In these experiments the optical fiber was arranged in a spiral with a inner ant outer diameter of 19 cm respectively 27 cm and was mounted on a plastic support. A 2 mm thick PMMA sheet was used for build-up. The fiber was mounted in high energy photon beam delivered by the ALIN10 linear accelerator. The attenuation was read with a M200 OTDR at 850 nm and 1300 nm.

The attenuation before photon beam exposure is presented in Fig. 1.

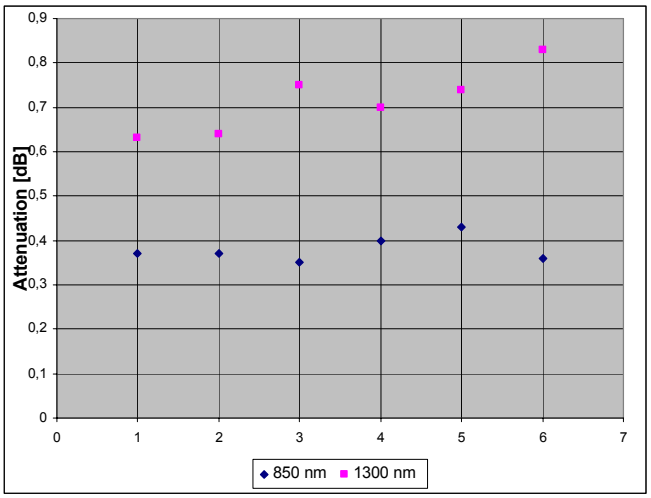

Fig. 1 – Optical Fiber attenuation before photon beam exposure.

The attenuation induced by photon beam exposure is presented in Figure 2. Measured data shows an increment of attenuation proportional to exposure dose. After an exposure of around 300 Gy the attenuation increment is out of measured range of the OTDR (Fig 3b). Continuing to expose the fiber to the photon beam, a movement of the first attenuation peak in the connector part was observed (Fig. 4).

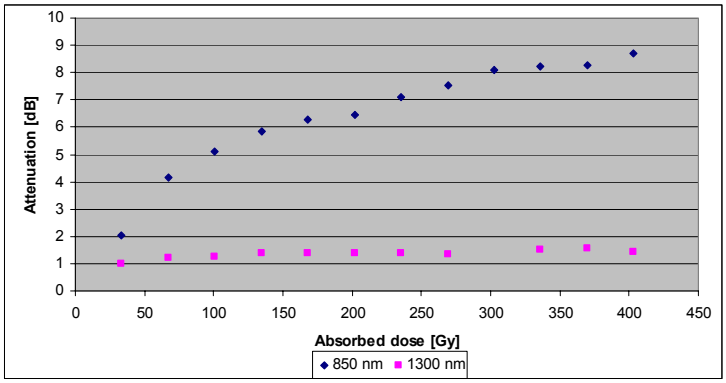

Fig. 2 – Optical Fiber attenuation while the fiber was exposed to high energy photon beam.

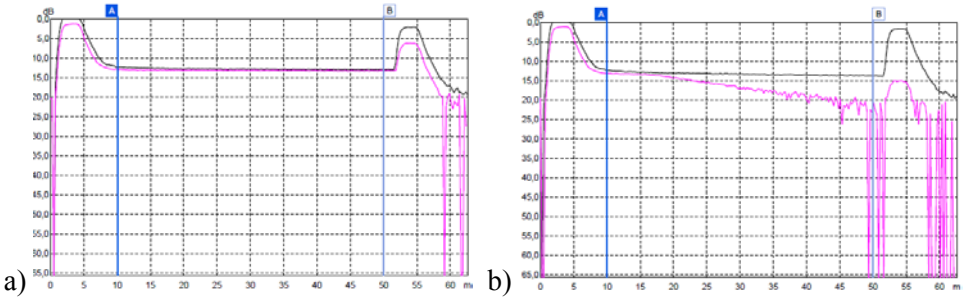

Fig. 3 – Measured spectra with wavelengths of 850 nm (black) and 1300 nm (red).
In a) the optical fiber attenuation is measured before high energy photon beam irradiation,
and b) after 400 Gy high energy photon beam exposure.

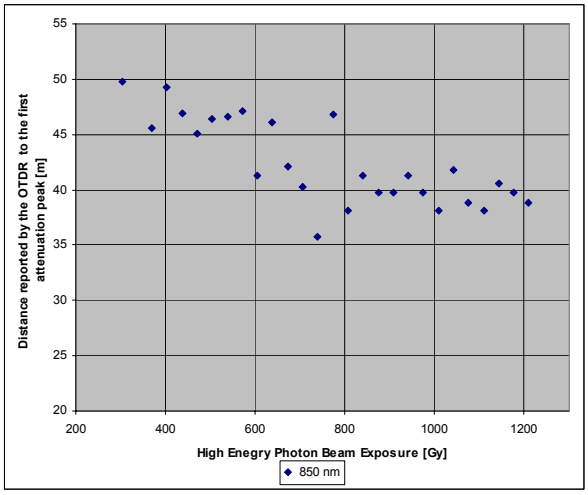

Fig. 4 – Distance reported by the OTDR to the first attenuation peak.

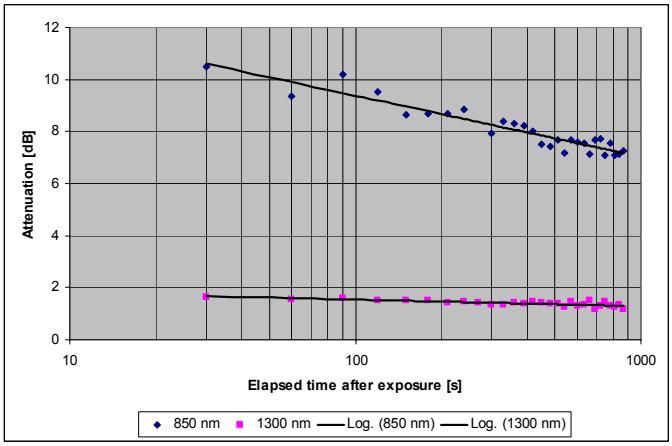

Fig. 5 – Optical fiber attenuation after an elapsed time [s].

Continuing to measure the attenuation after the high energy photon beam has been stopped reveals a decrease in the values observed values (Fig. 5).

3. CONCLUSION

In this paper, the effect of high energy photon beam exposure on the optical fiber attenuation was investigated. The presented results show a linear sensitivity on increment of attenuation due to photon beam exposure. The radiation induced attenuation a while after exposure tends to have slightly greater values than those before irradiation. This effect leads to the idea of reusing the fiber after a certain time, after its exposure. The obtained results show a greater sensitivity for the 850 nm reading than for the 1300 nm wavelength. Further work will consist in extending investigation on the influence of the electron beam on the optical fiber attenuation.

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