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Dose Reassessment by using PTTL Method in Ge-doped SiO₂ Optical Fiber Thermoluminescence Dosimetry

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Abstract. In this paper, the characteristics of PTTL after irradiation with 60Co gamma rays as a function of UV light exposure wavelength, gamma irradiation dose, and UV light exposure time were determined for Ge-doped SiO₂ optical fibers. The efficiency of dose reassessment for this fiber was compared to standard thermoluminescence detector, TLD100. Experiments show that the method works well with the UV lamp of 254 nm within regions of doses between 3 to 50 Gy, but could be applied for higher and lower doses as well. The effect of exposure time of UV radiation on the PTTL signal was studied from 5 to 120 minutes to determine the highest sensitivity and the limit of the dose. The efficiency of dose reassessment with 10 Gy of gamma irradiation exposed to UV light for 15 minutes relative to PTTL values of about 27.0% and 2.3% for Ge-doped SiO₂ optical fiber and TLD 100.

Introduction

Photo-transferred thermoluminescence (PTTL) refers to thermoluminescence (TL) induced by light as a result of photo transfer of charge carriers from one or more charge trap level to other charge trap levels. PTTL is useful for dose reassessment in radiation dosimetry. Reassessment is needed in cases of loss of initial data or for quality control purposes. After TL readout, the deep traps of the TL dosimeter are not fully emptied. With UV light exposure, PTTL arises from trapped charges transferred from deep trap levels to shallow ones.

The most commonly used dosimeter to study the PTTL characteristics is LiF (TLD100) because of its daily application in dosimetry. Early report on dose reassessment using TLD 100 showed that TL response increased with radiation dose and also upon exposure to ultraviolet light after the initial TL measurement [1]. This report demonstrated the use of TLD 100 in dose reassessment using the PTTL principle.

The lowest re-assessable doses of 7.5 mGy and 20 mGy respectively for TLD 100 disc and TLD 100 extruded ribbon type after gamma irradiation specifically was reported by Mason et al. [2]. Mukherjee el al. [3] reported that an annealing treatment of 400 °C for 1 h was carried out before using the dosimeters again. This is due to the optimum time and temperature to completely erase the traces of the previous irradiation history.

TL dosimeter based on Ge-doped SiO₂ optical fiber has been widely researched. However, study on the PTTL properties of this material is rare. In this paper, we report a study on the PTTL properties of Ge-doped SiO₂ optical fibers. The fibers were subjected to the gamma irradiation and TL yield was read using Harshaw 3500 TLD reader. After the first measurement, the fibers were exposed to the UV lamp and the measurement was repeated using the same parameters.