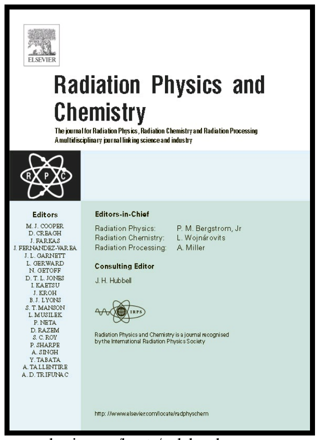
Author's Accepted Manuscript



www.elsevier.com/locate/radphyschem

Influence of Optical Fiber Diameter on Thermoluminescence Response

Ghafour Amouzad Mahdiraji, Mostafa Ghomeishi, Faisal Rafiq Mahamd Adikan, D.A. Bradley

PII: S0969-806X(17)30392-4
DOI: http://dx.doi.org/10.1016/j.radphyschem.2017.04.001
Reference: RPC7511

To appear in: *Radiation Physics and Chemistry*

Received date: 1 November 2016
Revised date: 3 April 2017
Accepted date: 5 April 2017

Cite this article as: Ghafour Amouzad Mahdiraji, Mostafa Ghomeishi, Faisa Rafiq Mahamd Adikan and D.A. Bradley, Influence of Optical Fiber Diamete on Thermoluminescence Response, *Radiation Physics and Chemistry* http://dx.doi.org/10.1016/j.radphyschem.2017.04.001

Influence of Optical Fiber Diameter on Thermoluminescence Response

Ghafour Amouzad Mahdiraji[1,2*], Mostafa Ghomeishi[3], Faisal Rafiq Mahamd Adikan[2,3], D.A. Bradley[4,5]
[1]School of Engineering, Taylor's University, 47500 Subang Jaya, Malaysia
[2]Flexilicate Sdn. Bhd., University of Malaya, 50603 Kuala Lumpur, Malaysia
[3]Integrated Lightwave Research Group, Department of Electrical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia
[4]Department of Physics, Surrey University, UK
[5]Sunway University, Institute for Healthcare Development, 46150 PJ, Malaysia
[*]Correspondence author. ghafouram@gmail.com

Abstract:

Detailed investigation is made of the thermoluminescence (TL) response of various sizes of optical fiber, fibers being developed with either a fixed core-to-cladding ratio or various core-to-cladding ratios. Two Ge-doped optical fiber preforms have been used to reconfirm the experimental findings. For further clarification, a pure silica rod has also been used to fabricate different diameter rods. Experimental investigations show the main TL signal to be generated from the fiber core within which the Ge is doped, the fiber cladding producing insignificant TL signal. Prior to normalization, the results show that in doubling the fiber diameter the TL signal quadruples. Conversely, subsequent to normalizing the different sizes of optical fiber to their mass or fiber cross sectional area, the smaller diameter fibers show slightly greater sensitivity compared to the larger diameter fibers. Relating to the fiber drawing-down process, this is due primarily to the greater shearing effect that the smaller fibers experience compared to the larger fibers within the fiber preform neck-down region.

Keywords: optical fiber dosimeter, thermoluminescence based dosimeter, fiber size, fiber fabrication

1. Introduction

Over the past several years interest has grown significantly in optical fiber dosimetry, a passive form of dosimetry, initially at least, based on the luminescence yield that the doped fibers present, either promptly upon irradiation (radioluminescence, RL) or stimulated from the stored energy of trapped electrons (thermoluminescence, TL or optically stimulated luminescence, OSL), responding to the needs of different ionizing radiation applications. The inherent advantages of these doped fibers include their high spatial resolution, immunity to electromagnetic interference, and capability to be used in real time or in offline monitoring systems, as well as other interesting dosimetry characteristics such as linear response over a wide range of applied dose, high sensitivity and energy independence within the MV external-beam radiotherapy regime. They are also temperature independent, below through to above room temperature, reusable providing reproducible results, suffer low thermoluminescence (TL) signal fading, are impervious to water, are of significantly lower cost compared to current commercially available passive dosimeters and are able to detect a variety of radiations, from fast to heavy particles.

The irradiation performance of different types of commercially available optical fibers such as standard single mode fibers (SMFs) (Mahdiraji et al., 2015b) and multimode fibers (MMFs) (Girard et al., 2013) doped with different rare earth materials, for instant germanium (Benabdesselam et al., 2013, Mahdiraji et al., 2015b, Girard et al., 2013), phosphorus (Girard et al., 2006, Paul et al., 2009, Ghosh et al., 2011, Girard et al., 2013, Lu et al., 2000), aluminum (Polf et al., 2004, Yaakob et al., 2011), Ge-boron (Mahdiraji et al., 2015a), fluorine (Alessi et al., 2012b), have all been demonstrated. Performance comparison between the SMFs and MMFs in terms of sensitivity towards radiation dose detection suggests the greater performance of the MMFs to be due mainly to the larger fiber core area; however, currently there does not exist any classical report that clearly evaluates the performance of such optical fibers, neglecting the influence of the fiber manufacturing process and the elemental doping concentrations since most of those reports have used optical fibers fabricated by different manufacturers using different recipes.

Zahaimi et al. (2014) compared the thermoluminescence (TL) response of Ge-doped optical fibers of different core diameters, from 8 to 50 µm, showing the larger core fibers to generate greater TL; however, the optical fibers used in that study were fabricated by different manufacturers, almost certainly with different Ge concentrations, leaving unclear the effect of the manufacturing process and elemental concentrations. Reports of the effect of fiber drawing condition on characteristics of optical fibers date back to the 1970s, as an example showing absorption induced at wavelengths of 215 nm and 248 nm (Lee et al., 1998), 630 nm (Hibino and Hanafusa, 1986, Hanafusa et al., 1987), and 1530 nm (Sakaguchi et al., 1985) at higher