

**THE ASSESSMENT OF TAILOR-MADE OPTICAL FIBRE SUBJECTED TO  
IONIZING RADIATION**

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IONIZING RADIATION

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*I dedicate this work*

*To my lovely dear parents*

*Che Omar Bin Ibrahim*

*Siti Eshah Binti Che Mat*

*Whose love, kindness, patience and prayer have brought me this far*

*To my siblings*

*Siti Nur Hadis and Khairul Anuar, Muhammad Tasyriq and*

*Nur Syuhanis, Siti Shafiyyah, Muhammad Askari, Siti Nur*

*Sabwah and Muhammad Ali Fariddatul*

*For their love, understanding and support through my endeavor*

*To my grandparents*

*Ibrahim Ariffin and Siti Rahmah*

*Whose always prayer for me*

*To my niece*

*Nur Qurratulain Zahraa, Nur Shiana Asyiqin and Fatimah*

*Whose presence fills my life with joy*

*To my friends*

*For their endless laughs and tears*

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## ABSTRACT

The dosimetric properties of thermoluminescence (TL) dosimeter such as dose response, linearity, sensitivity, fading, minimum detectable dose (MDD), glow curve and reproducibility of optical fibres in comparison with TLD-100 (rod types) have been investigated. The samples used were Dummy Flat Fibre (DFF), Flat Fibre (FF), Photonic Crystal Fibre (PCF), Multi Photonic Crystal Fibre (MPCF) of 2 mm and 220  $\mu\text{m}$  diameter, Photosensitive Flat Fibre (PFF), Single Mode Optical Fibre (SMF), Germanium - doped (Ge), Erbium - doped (Er) and Aluminum doped Thulium (Al: Tm). The TL samples were placed in solid phantom and irradiated with 6, 9 and 12 MeV electrons beam with dose ranging from 1.0 Gy to 4.0 Gy by using linear accelerator (LINAC) machine. Investigations were also conducted for X - rays with mean energies of 30, 60 and 70 kV, and gamma rays ( $^{60}\text{Co}$ ) from 1.0 mGy up to 24.0 Gy. The glow curves were observed between 155  $^{\circ}\text{C}$  to 287  $^{\circ}\text{C}$ . The results of TL dosimeter subjected to 6, 9 and 12 MeV electrons clearly showed that PFF was superior in terms of TL response and sensitivity. This was followed by Ge, DFF, TLD-100, FF, PCF, Er, Al: Tm, MPCF 2 mm and MPCF 220  $\mu\text{m}$ . For X-ray irradiation, the SMF showed 10 and 8 times more sensitive than TLD-100. The MDD obtained from optical fibres subjected to electron irradiation were between 0.53- 0.60 mGy for PFF, 0.78-0.81 mGy for TLD-100, 1.00-1.26 mGy for Ge and 1.44-1.64 mGy for DFF. The results showed that PFF and SMF have great potential to be considered as a radiation dosimeter.

## ABSTRAK

Sifat dosimetri bagi dosimeter luminesens terma (TL) seperti sambutan dos, kelinearan, kepekaan, kepudaran, dos minima berkesan (MDD), lengkung berbara dan kebolehulangan bagi gentian optik telah dibandingkan dengan TLD-100 (jenis rod) telah dikaji. Sampel yang digunakan adalah Gentian Datar Palsu (DFF), Gentian Datar (FF), Gentian Hablur Fotonik (PCF), Gentian Hablur Fotonik Berbilang (MPCF) berdiameter 2 mm dan 220  $\mu\text{m}$ , Gentian Fotosensitif Datar (PFF), Gentian Optik Mod Tunggal (SMF), Germanium terdop (Ge), Erbium terdop (Er) dan Aluminium terdop Thulium (Al: Tm). Sampel TL diletakkan di fantom pepejal dan disinari dengan alur elektron bertenaga 6, 9 dan 12 MeV mempunyai julat dos dari 1.0 Gy ke 4.0 Gy dengan menggunakan mesin pemecut linear (LINAC). Kajian turut dijalankan bagi sinaran - X dengan tenaga purata 30, 60 dan 70 kV, dan sinar gamma ( $^{60}\text{Co}$ ) dari 1.0 mGy hingga 24.0 Gy. Lengkung berbara dicerap di antara 155 °C – 287 °C. Dapatan bagi dosimeter TL tertakluk kepada 6, 9 dan 12 MeV elektron jelas menunjukkan bahawa PFF adalah baik dari segi sambutan TL dan kepekaan. Ini diikuti oleh Ge, DFF, TLD-100, FF, PCF, Er, Al: Tm, MPCF 2 mm dan MPCF 220  $\mu\text{m}$ . Bagi dedahan kepada sinar - X, SMF menunjukkan 10 dan 8 kali ganda lebih peka berbanding TLD-100. MDD yang diperoleh daripada gentian optik tertakluk kepada sinar elektron adalah di antara 0.53 – 0.60 mGy bagi PFF, 0.78 - 0.81 mGy bagi TLD-100, 1.00 - 1.26 mGy bagi Ge dan 1.44 - 1.64 mGy bagi DFF. Dapatan menunjukkan bahawa PFF dan SMF mempunyai potensi besar untuk dipertimbangkan sebagai dosimeter sinaran.