Fabricated germanium-doped optical fibres for computed tomography dosimetry: Glow curve characteristics

ABSTRACT

Fabricated germanium (Ge)-doped optical fibre glow curve characteristics are investigated with respect to computed tomography (CT) dosimetry. 2.3 mol% and 6 mol% Ge-dopant concentration preforms have been used to produce flat and cylindrical fibres (FF and CF) of various size and diameter. The fibres are irradiated to doses of 20, 30 and 40 mGy for each of the beam qualities RQT 8 (100 kV), RQT 9 (120 kV) and RQT 10 (150 kV). The thermoluminescence (TL) kinematic parameters studied are maximum temperature (Tmax), activation energy (Ea) and peak integral (PI). The glow curve formations are reconstructed from the Windows®–based radiation evaluation and management system (WinREMS), deconvoluted using glow curve deconvolution (CGCD) analysis software. The structures of the glow curves are broad single or double-peaked, occurring at relatively high glow peak temperatures, TL response increases with radiation dose and peak height decreases with increasing energy, showing clear photoelectric dependence. The deconvoluted glow curves for all fibres are seen to consist of five individual glow peaks, P1 to P5, P1 being dominant in all cases other than for 6 mol% Ge-FF for which P3 is dominant due to the formation of a double-peaked glow curve. Tmax increases from P1 to P5 for all fibres, throughout the energy range used. P1 and P3 (6 mol% Ge-FF) have the lowest Ea, while P4 shows the greatest Ea for all fibres. The results indicate that electrons in P1 and P3 (6 mol% Ge-FF) are occupied at low energy traps while for P4, the electrons are trapped at a deeper energy level. The lowest PI value, indicative of the least number of electrons, is shown to be that of the deeper trap P4 for all energies investigated. This study provides support for the use of 6 mol% and 2.3 mol% preform fibres for CT dosimetry, each with similar kinetic parameters.

Keyword: Ge-doped optical fibre; CT dosimetry; Glow curve