Radiotherapy dosimetry and the thermoluminescence characteristics of Ge-doped fibres of differing germanium dopant concentration and outer diameter

ABSTRACT

We examine the influence of elevated dopant concentration on the thermoluminescence characteristics of novel Ge-doped silica fibres. Basic dosimetric characteristics of the TL media were obtained, including linearity, reproducibility, energy dependence, fading, minimum detectable dose and glow curve analysis, use being made of a ^{60}Co gamma irradiation facility (mean energy 1.25 MeV) and an electron linear accelerator producing photons at an accelerating potential of 6 and 10 MV. The 6 mol% Ge-doped fibres were found to provide TL response superior to that of 8- and 10 mol% Ge-doped fibres, both for fibres with outer diameter of 241 µm and 604 µm. Concerning reproducibility, obtained under three different test conditions, at <10% the 6 mol% Ge dopant concentration was observed to provide the superior coefficient of variation (CV). In regard to energy dependence, the 10 mol% Ge doped cylindrical fibres produced the largest gradient values at 0.364 and 0.327 for the 241 µm and 604 µm diameter cylindrical fibres respectively and thus the greatest energy dependency. Measured 33 days post irradiation; the 6 mol% Ge doped cylindrical fibres showed the least TL signal loss, at 21% for the 241 µm cylindrical fibre and <40% for the 604 µm cylindrical fibres. The results also revealed that the 6 mol% optical fibres provided the lowest minimum detectable dose, at 0.027 Gy for 6 MV photon beams. Evaluations of these characteristics are supporting development of novel Ge-doped optical fibres for dosimetry in radiotherapy.

Keyword: Dopant concentration; Ge-doped; Linearity; Energy dependence; Fading