Environmental monitoring through use of silica-based TLD

Siti Rozaila Zahrinalm, M Khandaker, Siti Fairus Abdul Sani, Siti Sabita, Yusoff Amin, Mohd Jamil Maah and David Bradley

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Abstract

The sensitivity of a novel silica-based fibre-form thermoluminescence dosimeter is tested off-site of a rare-earths processing plant, investigating the potential for obtaining baseline measurements of naturally occurring radioactive materials. The dosimeter, a Ge-doped collapsed Photonic Crystal Fibre (PCFGe) co-doped with B, has been calibrated against commercially available TLD (TLD-200 and TLD-100) using a bremsstrahlung (tube-based) x-ray source. Eight sampling sites within 1 to 20 km of the perimeter of the rare-earths facility have been identified, TLDs (silica- as well as TLD-200 and TLD-100) in each case being buried within soil at fixed depth, allowing measurements to be obtained, in this case for protracted periods of exposure of between two to eight months. The values of dose have then been compared against values projected on the basis of radioactivity measurements of the associated soils, obtained via HPGe gamma-ray spectrometry. Accord is found in relative terms between the TL evaluations at each site and the associated spectroscopic results. Thus said, in absolute terms, the TL evaluated doses are typically less than those derived from gamma-ray spectroscopy, by ~ 50% in the case of PCFGe. Gamma spectrometry analysis typically providing an upper limit to projected dose, the Marinelli beaker contents being formed from sieving to provide a homogenous well-packed medium. However, with the radioactivity per unit mass typically greater for smaller particles, with preferential adsorption on the surface and the surface area per unit volume increasing with decrease in radius, this makes for an elevated dose estimate. Prevailing concentrations of key naturally occurring radionuclides in soil, \( {\text{Ra, } {\text{Th and }} K} \) were also determined, together with radiological dose evaluation. To-date the area under investigation, although including a Rare-Earths processing facility, gives no cause for concern from radiological impact. Current study reveals the suitability of the optical fibre based micro-dosimeter for all-weather monitoring of low-level environmental radioactivity.

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