The 15th International Symposium on Radiation Physics (ISRP-15)
Kuala Lumpur – Malaysia
6 – 10 December 2021

Dose rate mapping in an industrial ^{60}Co irradiator using an online photodiode-based dosimetry system

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Abstract

In the radiation processing field, any irradiation process is designed to irradiate products uniformly, but in practice, a reasonable variation in the absorbed dose through the product is accepted. However, the irradiation of inhomogeneous or irregularly shaped products gives rise to complex dose variations only assessed through dose mapping. It requires complementary dosimeters bearing good spatial resolution, prompt and easy readout, and cost-effectiveness. These features are found in silicon diodes that, despite all these advantages, are prone to radiation damage. This damage is mitigated with photodiodes whose thicknesses are much smaller than the minority carrier diffusion length at the anticipated accumulated dose. In this work, an in-house dosimetry system based on a thin photodiode is applied for online mapping dose rates, between 3.7 and 52.8 Gy/h, delivered by a Panoramic ^{60}Co industrial facility. The operational principle of these dosimeters relies on the real-time acquisition of the induced currents from the irradiated diode operating in the short-circuit mode without externally applied voltage. Under this condition, the dose is assessed offline via the integration of these current signals. The radial mapping of the radiation field is performed by rotating the diode around the central axis of the panoramic irradiator, covering 360º at intervals of 10º. For comparative purposes, alanine dosimeters are also irradiated together with the diode. The experimental results are benchmarked with Monte Carlo simulations of the dose rate curves. Good agreement between the simulated values and the readings of both dosimeters is found. It reveals that the photodiode-dosimetry system is a reliable alternative to map dose rate fields and the effectiveness of Monte Carlo simulations as a predictive tool for dose rate measurements in an irradiator.