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# An Infrared Inorganic Scintillating Detector Applied in Radiation Therapy

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**Abstract :** Purpose: Inorganic scintillating dosimetry is the most recent promising technique to solve several dosimetric issues and provide quality assurance in radiation therapy. Despite several advantages, the major issue of using scintillating detectors is the Cerenkov effect, typically induced in the visible emission range. In this context, the purpose of this research work is to evaluate the performance of a novel infrared inorganic scintillator detector (IR-ISD) in the radiation therapy treatment to ensure Cerenkov free signal and the best matches between the delivered and prescribed doses during treatment. Methods: A simple and small-scale infrared inorganic scintillating detector of 100 µm diameter with a sensitive scintillating volume of 2x10-6 mm3 was developed. A prototype of the dose verification system has been introduced based on PTIR1470/F (provided by Phosphor Technology®) material used in the proposed novel IR-ISD. The detector was tested on an Elekta LINAC system tuned at 6 MV/15MV and a brachytherapy source (Ir-192) used in the patient treatment protocol. The associated dose rate was measured in count rate (photons/s) using a highly sensitive photon counter (sensitivity ~20ph/s). Overall measurements were performed in IBATM water tank phantoms by following international Technical Reports series recommendations (TRS 381) for radiotherapy and TG43U1 recommendations for brachytherapy. The performance of the detector was tested through several dosimetric parameters such as PDD, beam profiling, Cerenkov measurement, dose linearity, dose rate linearity repeatability, and scintillator stability. Finally, a comparative study is also shown using a reference microdiamond dosimeter, Monte-Carlo (MC) simulation, and data from recent literature. Results: This study is highlighting the complete removal of the Cerenkov effect especially for small field radiation beam characterization. The detector provides an entire linear response with the dose in the 4cGy to 800 cGy range, independently of the field size selected from 5 x 5 $cm^2$ down to 0.5 x 0.5 $cm^2$. A perfect repeatability (0.2 % variation from average) with day-to-day reproducibility (0.3% variation) was observed. Measurements demonstrated that ISD has superlinear behavior with dose rate (R2=1) varying from 50 cGy/s to 1000 cGy/s. PDD profiles obtained in water present identical behavior with a build-up maximum depth dose at 15 mm for different small fields irradiation. A low dimension of 0.5 x 0.5 $cm^2$ field profiles have been characterized, and the field cross profile presents a Gaussian-like shape. The standard deviation (1σ) of the scintillating signal remains within 0.02% while having a very low convolution effect, thanks to lower sensitive volume. Finally, during brachytherapy, a comparison with MC simulations shows that considering energy dependency, measurement agrees within 0.8% till 0.2 cm source to detector distance. Conclusion: The proposed scintillating detector in this study shows no- Cerenkov radiation and efficient performance for several radiation therapy measurement parameters. Therefore, it is anticipated that the IR-ISD system can be promoted to validate with direct clinical investigations, such as appropriate dose verification and quality control in the Treatment Planning System (TPS).

**Keywords :** IR-Scintillating detector, dose measurement, micro-scintillators, Cerenkov effect
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