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(I) Stemless Plastic Scintillation Detectors - A Novel Radiation Dosimeter with a Bright Future

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Approximately half of all cancer patients require radiation therapy at some point during the management of their disease. Radiation detectors are tools for the quantitative characterization of fields of ionizing radiation used for radiation therapy and are essential for their safe and effective use. The goal of dosimetry measurements is to quantify the amount of energy deposited in the body (dose). Therefore, a perfect detector would respond to radiation the same way as human tissue. However, most radiation detectors are not tissue equivalent, which poses a major challenge.
Organic electronics are attractive candidates for radiation detectors due to their ability to have highly customizable configurations, can be made flexible, and can be fabricated with a wide selection of materials (i.e. tissue equivalent). In this talk I will present our investigation of a novel detector, the stemless plastic scintillation detector (SPSD), which couples an organic photodiode to a plastic scintillator. Plastic scintillation detectors (PSDs) offer properties that are ideal for the measurement of small fields (high spatial resolution, tissue equivalence, real-time measurements, etc.). However, a limitation of PSDs is Cerenkov radiation (created in the optical fiber), which contaminates the signal and requires a correction. The SPSD detector eliminates the need for an optical fiber to carry the signal, which could allow it to have the benefits of a PSD, while removing the main drawback.
The development of this detector will be presented in 4 steps. First, an organic photodiode was operated as a direct radiation detector, exhibiting linearity with dose rate and output factors which agreed with commercial detectors. Second a novel method for the correction of extraneous signal (Compton current) in the organic photodiode will be described. Third, an organic photodiode was coupled to an organic scintillator, creating a single-element SPSD. Several radiation dependencies of the SPSD were measured, which included: linearity with dose, instantaneous dose rate, energy dependence, and directional dependence. The dependencies measured were promising for employment as a radiation detector. Lastly, the culmination of this work was the fabrication of a 1D SPSD array. The array accurately measured small field profiles and output factors.

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