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Organic semiconductor radiation dosimeters

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Accurate, quantitative measurements of radiation fields are essential prerequisites for the safe and effective use of ionizing radiation in diagnostic and therapeutic medical applications. Common examples of radiation detectors include: ionization chambers, thermoluminescent dosimeters (TLDs), films and various electronic devices. Semiconductor dosimeters such as p/n type silicon diodes and MOSFETs have found widespread adoption due to their high sensitivity and easy processing. A significant limitation of these devices, however, is their lack of tissue equivalence. The high atomic number (relative to soft tissue) of silicon causes these devices to over-respond to photon beams that include a significant low energy (e.g. kilovoltage) component due to an enhanced photoelectric interaction coefficient.
This work presents preliminary measurements with organic semiconductor diodes and organic floating gate (FG) transistors as dosimeters capable of providing a tissue equivalent response to ionizing radiation. The direct detection of X-rays from a medical linear accelerator using Phthalocyanine/C60 based organic planar heterojunction diodes is presented. The diodes produce a linear increase in current with increasing dose rate and show a stable response after exposure to doses up to 5000 cGy. The Pentacene-based organic floating gate transistors have also been investigated for dosimetry applications. The possibility of resetting the transistors for repeated use and sensitivity optimization by electrical charging of floating gate through Fowler-Nordheim tunneling is currently being investigated. The sensitivity of these devices has been determined from the transistor threshold voltage shift as a function of accumulated dose. After negative or positive pre-charge of floating gate the average sensitivity was 0.09V/Gy, 0.045V/Gy, 0.02 V/Gy, 0.01 V/Gy at 10 Gy, 20Gy, 30 Gy, 40 Gy, 50 Gy, 60 Gy, respectively. The sensitivity of FG pentacene transistors was stable after two pre –charge cycles of the FG.

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