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(I) Use of Light Absorbing Polymers for Quantitative Measure of Ionizing Radiation Dose: Challenges and Opportunities

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Diacetylene molecules can self-assemble into crystals, with three-dimensional packing and separation between molecules dictated by the chemical groups on either side of the carbon-carbon triple bonds. When exposed to ionizing radiation, like photon, electron and proton beams used in radiotherapy applications, some diacetylene crystals undergo a radical solid-state polymerization reaction, resulting in a long polymer chain with alternating triple- and double- carbon bonds. The π-electrons along the conjugated chain undergo transitions between energy states, absorbing light in the UV-VIS in the process. This radiochromic material becomes deeply coloured, where the absorbance, or optical density, in the visible range of the spectrum is a function of the absorbed ionizing radiation dose. Thus, radiochromic materials have been used for several decades as two-dimensional films for quantitative measure of dose and have been more recently investigated for real-time in vivo dosimetry using optical fibres. Packing of diacetylene monomers within the crystal affects not only probability of polymer chain initiation, but also the rate at which polymerization takes place. Understanding the mechanism for this self-assembly and the effect of different side groups on behaviours relevant to dosimetric applications is of great interest. This talk will first discuss the implications of side group selection on usability of radiochromic material in real-time dosimetry, as illustrated in commercially available films to date. Secondly, we will explore challenges with current commercially available radiochromic materials and finally will consider how they can be improved to meet the required criteria for real-time use in patient dosimetry.

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