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(G*) Characterization of modified radiochromic materials for measuring ionizing radiation

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Purpose: A quantitative measure of delivered ionizing radiation is recommended for quality assurance and quality control purposes for patients undergoing radiotherapy treatments. Current dosimeters are not well suited for direct measurements due to atomic composition and size limitations. We are developing a fiber optic probe dosimeter based on radiochromic material for in vivo dosimetry. Through measuring the change in optical absorption of the radiochromic sensor, we can quantify the absorbed dose of ionization radiation delivered in real-time. The radiation-sensitive material is composed of lithium-10,12-pentacosa diynoate (LiPCDA), which upon exposure, polymerizes and results in an increased optical density. We observed that monomers of LiPCDA can have two distinct crystalline morphologies, with aspect ratios 10:1 producing hair-like structures and 2:1 resulting in platelets, with polymerized absorbance peaks typically centred at 635 nm and 674 nm, respectively. We aim to characterize and compare the dose-response of the two crystal morphologies achieved through desiccation and Li+ concentration.

Method: The hair-like LiPCDA in commercial film was desiccated, producing crystals with an absorbance peak at 674 nm. Both materials were exposed to 50-3000 cGy using a clinical linear accelerator with a 6MV X-ray beam; samples of varying Li+ concentration were exposed to 200-400 cGy. Absorbance spectra for all samples were collected and were imaged with a scanning electron microscope to compare their crystal morphology.

Results: Differences in crystal morphology were not observed when hair-like LiPCDA was desiccated. However, varying the molar ratio of Li+ to PCDA to produce crystals with either 635 nm or 677 nm absorbance peak, differentiable crystal morphologies were observed. The platelet form is ~3x less sensitive to dose but with a more extensive dynamic range relative to hair-like.

Conclusion: Crystals can be preferentially grown and exhibit differing dose-response. The macrostructure effect on radiation sensitivity in the context of radiotherapy will be explored.

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