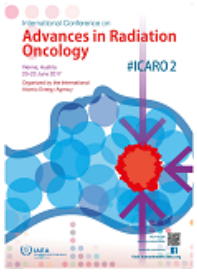

Contribution ID: **266** Type: **Poster**

Reduction of signal quenching in PRESAGE® dosimeters irradiated with protons

Thursday, June 22, 2017 3:45 PM (5 minutes)

Introduction of the study:

As radiotherapy techniques have advanced over the last two decades, dose planning has become significantly more complex. This is explicitly seen in proton therapy where the Bragg peak produces extremely steep dose gradients, enabling highly conformal treatment plans. Limitations in characterizing these plans using conventional QA systems has led to increased interest in 3D dosimetry systems. One such 3D system, PRESAGE® (Heuris Pharma, LLC, Skillman, NJ), is a radiochromic polyurethane that has shown potential in conventional radiotherapy systems. When irradiated by protons, however, signal quenching is observed in regions of high LET making accurate dosimetry so far impossible. This work investigated the relationship between the formulation and signal quenching to determine if PRESAGE® can be further optimized to minimize or eliminate quenching.

Methods:

PRESAGE® was manufactured in-house under standardized conditions using a method described by Alqathami et al (2016) and consisting primarily of a Leuco Malachite Green (LMG) dye, a chloroform (CHCL3) radical initiator (RI), and a polyurethane resin (Crystal Clear 204, Smooth-On, Easton, PA, USA). Sixteen formulations were manufactured with selected concentrations of RI (3-30 wt%) and LMG concentrations of 2 % and 4 % (wt%). The formulations were poured into spectrophotometer cuvettes (1x1x4.5 cm3) and stored at <3 ℃ prior to irradiation.

Irradiations were performed in a solid water phantom using a passive-scattered 225 MeV proton beam with a 10 cm spread-out Bragg peak (SOBP). The cuvettes were placed at four points along the beam depth profile. One point in the plateau region was used to measure low-LET signal response while the other three points were taken along the SOBP to measure the response in a uniform dose region of varying LET. The photo-absorption spectra were measured for each formulation and the optical attenuation coefficients at the photopeak were compared. The dose responses were normalized using cuvettes irradiated with the 6 MV beam from a clinical linear accelerator and were compared to ion chamber measurements of the proton beam to determine the quenching magnitudes.

Results:

At the plateau region dose measurement point, all formulations demonstrated quenching <1%. In the proximal-most SOBP region, ≤3% quenching was measured for all formulations with RI concentrations between 10-21%. All formulations demonstrated increased quenching with greater depth in the SOBP. The distal-most points in the SOBP showed the largest quenching variation between formulations (Figure 1). Formulations with RI concentrations below 12 % showed less quenching with 2 % LMG than with 4 % LMG; formulations with ≥ 12 % RI showed more quenching with 2 % LMG. At the distal-most point, the least quenching of all formulations was 8.4 % as measured by the formulation with 4 % LMG/10 % RI. The greatest quenching was 73.8 % and was observed in the 2 % LMG/30 % RI formulation.

Conclusion:

This study has demonstrated that changes to the formulaic composition of PRESAGE® is a method of reducing signal quenching in PRESAGE® when irradiated with a proton beam. While a lower quenching limit was

found for composition ranges investigated in this work, this demonstrates that further reduction maybe possible with continued study and an optimized PRESAGE® formulation may eventually allow accurate proton dosimetry.

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