Chemical Engineering Thesis Defense

Hydrogel Nanosensors for Colorimetric Detection and Dosimetry in Proton Beam Radiotherapy

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abstract

Proton beam therapy (PBT) is a state-of-the-art radiotherapy treatment approach that uses focused proton beams for tumor ablation. A key advantage of this approach over conventional photon radiotherapy (XRT) is the unique dose deposition characteristics of protons, resulting in superior healthy tissue sparing. This results in fewer unwanted side effects and improved outcomes for patients. Current available dosimeters are intrinsic, complex and expensive; hence cannot be used to determine the dose delivered to the tumor routinely. Here, we report a hydrogel based plasmonic nanosensor for measurements of clinical doses in ranges between 2-4 GyRBE. In this nanosensor, gold ions, encapsulated in a hydrogel, are reduced to gold nanoparticles following irradiation with proton beams. Formation of gold nanoparticles renders a color change to the originally colorless hydrogel. The intensity of the color can be used to calibrate the hydrogel nanosensor in order to quantify different radiation doses employed during treatment. The potential of this nanosensor for clinical translation was demonstrated using an anthropomorphic phantom mimicking a clinical radiotherapy session. The simplicity of fabrication, detection range in the fractionated radiotherapy regime and ease of detection with translational potential makes this a first-in-kind plasmonic colorimetric nanosensor for applications in clinical proton beam therapy.

November 3, 2017; 1:30 PM; ECA 219