Purpose:

Gold nanoparticles (AuNP) have been proposed to be utilized for local dose enhancement in radiation therapy. Due to a very sharp spatial fall-off of the effect, the dosimetry associated with such an approach is difficult to implement in a direct measurement. This study is aimed at establishing a micro-dosimetry technique for experimental verification of dose enhancement in the vicinity of gold-tissue interface.

Methods:

The spatial distribution of the dose enhancement near the gold-tissue interface is modeled with Monte Carlo (MC) package MCNP5 in a 1-dimentional approach of a thin gold slab placed in an ICRU-4 component tissue phantom. The model is replicating the experiment, where the dose enhancement due to gold foils having thicknesses of 1, 10, and 100µm and areas of 12.5x25mm2 are placed at a short distance from clinical HDR brachytherapy (Ir-192) source. The measurements are carried out with a thin-film CdTe-based photodetector, having thickness <10µm, allowing for high spatial resolution at progressively increasing distances from the foil.

Results:

Our MC simulation results indicate that for Ir-192 energy spectrum the dose enhancement region extends over ~1 mm distance from the foil, changing from several hundred at the interface to just a few percent. The trend in the measured dose enhancement closely follows the results obtained from MC simulations.

Conclusions:

AuNP's have been established as promising candidates for dose enhancement in nanoparticle-aided radiation therapy, particularly, in the energy range relevant to brachytherapy applications. Most researchers study the dose enhancement with MC simulations, or experimental approaches involving biological systems, where achievable dose enhancements are difficult to quantify. Successful development of micro-dosimetry approaches will pave a way for direct assessment of the dose in experiments on biological models, shedding some light on apparent discrepancy between physical dose enhancement and biological effect established in studies of AuNP-aided radiation therapy.

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No conflict of interest