Dependence of Gold Nanoparticle Radio-enhancement on Lineal Energy in Microdosimetric-Kinetic Model

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Numerous experiments have strongly supported the application of gold nanoparticles (GNPs) as radio-enhanced agents. The local effect model was subsequently developed to predict the cell survival for GNP-mediated radio-enhancement (GNP-LEM). However, their microscopic dose distributions cannot be measured and verified. Thus, we developed microdosimetric kinetic model for GNP radio-enhancement (GNP-MKM), which uses the measurable concept of lineal energy. Using Monte Carlo simulation tool Geant4, we estimated the dose-mean lineal energy, 4.5 keV/μm, with secondary radiations from GNPs. For 150 kVp x-ray, we calculated the radial dose distributions around a GNP. The key parameters in GNP–MKM were compared to those calculated by GNP–LEM in terms of sensitizer enhancement ratio (1) (1), defined as the ratio of the area under the survival curve of control cells to GNP-mediated cells. The SER predicted by GNP–MKM and GNP–LEM was 1.32~2.13 and 1.29, respectively. The GNP–MKM is able to provide another method to predict survival fraction for the GNP radio-enhancement.

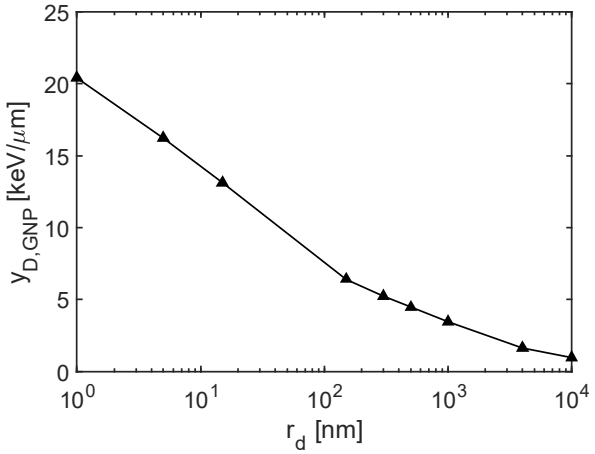

Fig. 1. Dose mean lineal energy with different domain sizes

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