X-RAY SPECTROSCOPY OF GOLD NANOPARTICLES

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Inner shell transitions, such as 1s-2p, in heavy elements can absorb or produce hard X-rays, and hence are widely used in nanoparticles. Bio-medical research for cancer treatment has been using heavy element nanoparticles, embeded in malignant tumor, for efficient absorption of irradiated X-rays and leading emission of hard X-rays and energetic electrons to kill the surrounding cells. Ejection of a 1s electron during ionization of the element by absorption of a X-ray photon initiates the Auger cascades of emission of photons and electrons.

We have investigated gold nanoparticles for the optimal energy range, below the K-edge (1s) ionization threshold, that corresponds to resonant absorption of X-rays with large attenuation coefficients, orders of magnitude higher over the background as well as to that at K-edge threshold. We applied these attenuation coefficients in Monte Carlo simulation to study the intensities of emission of photons and electrons by Auger cascades. The numerical experiments were carried out in a phantom of water cube with a thin layer, 0.1mm/g, of gold nanoparticles 10 cm inside from the surface using the well-known code Geant4.

We will present results on photon and electron emission spectra from passing monochromatic X-ray beams at 67 keV, which is the resonant energy for resonant K_α lines, at 82 keV, the K-shell ionization threshold, and at 2 MeV where the resonant effect is non-existent. Our findings show a high peak in the gold nanoparticle absorption curve indicating complete absorption of radiation within the gold layer. The photon and electron emission spectra show resonant features.[ab]

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[b] "Resonant X-ray Irradiation of High-Z Nanoparticles For Cancer Theranostics" (refereed presentation), A Pradhan, S Nahar, M Montenegro, C Sur, M Mrozik, R Pitzer, E Silver, Y Yu, *50th Annual Meeting of the American Association of Physicists in Medicine in Houston, Texas, July 27 - 31, 2008*