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Applicability assessment of Fe3O4-SiO2-Au nanoparticles for the cancer radiotherapy

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The object of our research is a Fe3O4-SiO2-Au nanoparticles. The electron microscopy study showed that the nanoparticles had a core-shell structure. The average size of the magnetite core was 227±7 nm, the thickness of the protective shell made of SiO2 was 2 nm, the average size of gold nanoparticles covering the core was 16±0.6 nm.
To estimate the output of secondary electromagnetic radiation during irradiation of the Fe3O4-SiO2-Au nanoparticles, an experimental unit was constructed.
A scintillation gamma-ray spectrometer based on a NaI(Tl) 78×78 crystal was used as a detector. The relative efficiency of registration at the 137Cs 662 keV line was 25%, and the resolution at the 137Cs 662 keV line was 9%. A collimated beam of gamma radiation from 137Cs was directed to the cuvette perpendicular to the axis of the spectrometer. The activity of the 137Cs radionuclide source was 99 MBq.
To take into account the background component of the obtained data, we measured the energy spectrum of the blank sample. A water sample was used as a blank. Measurements were carried out sequentially –replacing the test and blank samples. In the end of each measurement stage, the energy spectra of the standard gamma-ray sources (241 Am, 137 Cs) were measured.
To process the experimental data obtained, the measured energy spectra were conditionally divided into several ranges. The width of ranges was selected in accordance with the energy resolution of the spectrometer.
The intensity of the analytical signal of secondary radiation of the Fe3O4-SiO2-Au nanoparticles generated by gamma-ray of the 137Cs source was determined in accordance to the equation:

where: –the intensity of the analytical signal of secondary electromagnetic radiation; –the median value of the intensity of the analytical signal in the spectrum of the sample, –the median value of the intensity of the analytical signal in the spectrum of the blank sample, –the number of the energy range.
The absolute error of the data obtained was determined by the method of calculating the errors of indirect measurements according to the equation:

where: –the absolute error of determining the intensity of the analytical signal of secondary electromagnetic radiation; –the absolute error of determining the median value of the intensity of the analytical signal in the spectrum of the sample; –the absolute error of determining the median value of the intensity of the analytical signal in the spectrum of the blank sample.
As a result, the spectrum of secondary electromagnetic radiation generated by irradiation of Fe3O4-SiO2-Au nanoparticles was obtained. It was shown that the secondary radiation is caused by the photoelectric and the Compton effects.

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