Activation Study of the Metal-Organic Composite Using DT Neutrons

Skorkin V.M.

Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

The metal-organic composites containing nanoparticles of gold, rare earth elements, lead are used to increase the effectiveness of radiation therapy, diagnostics and personal radiation protection. The composite structures of DNA macromolecules and Gd^{3+} ions were irradiated with neutrons from the source based on NG-400 DT neutron generator and the combined moderator from W, Pd, Bi, CH_2 materials. Samples with gadolinium composite of various weights immobilized on "Sigma" filter were activated by fast neutrons in the moderator with a flux density of 2×10^9 neutron/(cm^2·s). The gadolinium radionuclide emitted photons with the energy of 363.6 keV with a half-life of 18.6 h was formed in ^{160}Gd (*n*, 2*n*) ^{159}Gd reaction. The sample activity of was measured with IGC-45 coaxial Ge detector (ORTEC). Determined by fast neutron activation analysis, the average weight concentration of gadolinium in the composite was about 44%. Thus, there are 3 Gd^{3+} ions per 2 DNA nucleotides.

The radiobiological efficiency of the slow neutron capture reaction in Gd composite was also investigated. The composite, containing about 0.5 mg of the natural gadolinium, was injected into the biological samples, containing about 0.1 ml of a cell suspension. The resulting gadolinium concentration is about 5 mg/ml. The biological samples have been irradiated into the cavity by slow neutrons. The integral thermal, epithermal, fast neutron and gamma ray fluxes in the biological samples was estimated using NCNP4B Monte-Carlo program. The neutron flux density measured by the activation method with the help of Mn, Nb and In samples was 1.5×10^8 neutron/(cm^2·s) for thermal and 0.3×10^8 neutron/(cm^2·s) for fast neutrons, respectively. Irradiation time of the biological samples was about 1 h. When gadolinium composite was present into biological samples, was the killing of all cells when irradiation.