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On the possibility of observing a change in the probability of 99mTc nuclei isomeric transition in a metal matrix during its dissolution

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The probability Pc of a conversion transition of 2.17 keV energy in isomeric nuclei of 99mTc (T1/2 ≈ 6.02 h) decreases by up to 0.3% upon transfer of 99mTc atoms from the surface of metals into the depth of metal matrices [1, 2]. A change in Pc can also be expected during the reverse process –destruction of metal matrices with 99mTc. In the present work, we investigated the possibility of observing such an effect upon dissolution of metal matrices with 99mTc and simultaneous measurement of the intensity of 140 keV gamma quanta emitted by 99Tc nuclei after isomeric transitions.

For the experiments, 99mTc pertechnetate with an activity of ~ 100 MBq was used. 99mTc matrices were created by fusing gold foils with 99mTc electrolytically deposited on them and 100 mg of metallic Sm or Yb. These metals were chosen due to their low melting point and good solubility in weakly acid aqueous solutions. In some cases, metallic Sm plates irradiated with 15 MeV protons in a cyclotron were added to the matrices during their fusing. In these cases, the matrices emitted 121 and 197 keV gamma quanta of the 147Eu isotope, which were used to monitor the change in the efficiency of detecting 140 keV gamma quanta upon dissolution of the matrices.

The 99mTc matrixes were dissolved in plastic cuvettes 10 mm in diameter with 0.5 ml of 1M hydrochloric acid solution. The gamma spectra from the cuvettes were measured periodically with an exposure of 30 s and the gamma line intensities were determined. The cuvettes were placed above the sensitive window of a semiconductor gamma detector and the change in the counting rates in the 140 keV gamma line and in the references gamma lines 121 and 197 keV was determined. The cuvettes with the dissolving matrices were also placed between two NaI(Tl) detectors located one above the other and the change in the 140 keV gamma quanta counting rate was determined by each of the detectors. It was found that to observe a change in the Pc probability of less than 1% during the dissolution of 99mTc matrices, it is necessary to have an initial 99mTc activity of more than 1 GBq.

1. V.V. Koltsov, D.N. Suglobov et al., Bull. Russ. Acad. Sci.: Phys., 64, 451 (2000).
2. V.V. Koltsov, St. Petersburg State Polytechnical University Journal. Physics and Mathematics, 16(1.2), 302 (2023). doi: 10.18721/JPM.161.246.

Primary author: KOLTSOV, Vladimir (Khlopin Radium Institute, Saint-Petersburg.)

Presenter: KOLTSOV, Vladimir (Khlopin Radium Institute, Saint-Petersburg.)

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