Contribution ID: **61** Type: **Oral**

Detection and Distinguishing of Uranium Particles and Plutonium Particles by Using Alpha Autoradiography

Wednesday, 9 July 2014 09:40 (20 minutes)

The purpose of work is the development of the analytical procedure for the detection of rare uranium and plutonium microparticles on the surfaces of different objects and for determination, is the detected particle uranium or plutonium. Detection of uranium and plutonium particles and determination of the particle component: uranium or plutonium, are based on the results of analysis of the orientation and the shape of tracks, which had been caused by alpha-particles in polycarbonate detector. Besides the number of tracks allows to estimate the amount of uranium or plutonium in particle.

Clusters of tracks from uranium particles and from plutonium particles were investigated for experimental confirmation of validity of suggested approach. Both materials, original for microparticles: uranium and plutonium, were none monoisotopic. Uranium was HEU. Main alpha-emitter of that material is U-234. It emits alpha-particles with the energy about 4.8 MeV. The yield of alpha-particles from U-235 with the energy about 4.4 MeV could contain several percents. The yield of alpha-particles from U-238 could contain less than 1%.

Main isotopes of the used plutonium were Pu-239 and Pu-240, these isotopes provided alpha-particles with energy about 5.15 MeV. Minor, but much more alpha-radioactive Pu-238 and Am-241 could provide no more than 20% of alpha-particles with energy about 5.5 MeV.

Track-detectors TASTRAK CR-39 (Track Analysis Systems Limited, UK) were used for registration of alpha-particles in this work.

Prolongation of the large axis R of the track reconstructs the trajectory of emitted alpha-particle from the surface of the uranium or plutonium particle. The crossing of the several tracks trajectories of the same cluster allows to localize microparticle on the surface of investigated subject. Implemented experiments demonstrate that binding accuracy for such technique is less than 10 μm.

Shape and size characteristics of the track are the functions of the energy of the emitted alpha-particle in the case of optimal mode of etching of the detector [1, 2]. The study of the geometry parameters of alpha-tracks from thin modeling layers of U-235, Pu-239 and Am-241 [2] shown that diameter d of the curvature of cone top of the track is most dependent on the energy of the alpha-particle. Therefore main attention in this work was paid to investigation of this characteristic of the tracks.

Comparison of histograms for uranium and plutonium particles allows to conclude, that alpha-autoradiography of suspicious objects can provide information not only about location of alpha-emitting microparticles on the surface of object, but about material: HEU or plutonium also.

Smallest sizes of detectable particles can be estimated by vales: 2 μm for particles of HEU and 0.2 μm –for plutonium particles. Smallest sizes of particles of HEU and plutonium oxides are larger approximately on 10%.

REFERENCES

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Session Classification: Technical Session 3A