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HIGH-SPEED DETECTOR OF ALPHA PARTICLES AND ELECTRONS

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Abstract–The present paper is devoted to investigation of creation of new-generation detectors of alpha particles and electrons. The investigation is based on study of the phenomena of birth, drift and multiplication of secondary electrons within the synthesized new porous media at the presence of an external accelerating field. The results of experimental investigation of parameters of the developed detectors are presented.

The experimental study of possibility of creating detectors for α-particles and electrons registration similar to the gamma-quanta detectors [1-3], operating on the bases of the phenomena of delta electrons birth, drift and multiplication, has been carried out on the synthesized materials with different relative density and degrees of periodicity. The investigations were conducted on synthesized new composite porous materials CsIAgSiO and $CsIAgSiO_2$ with relative densities of 1–3% and different concentrations of compounds.

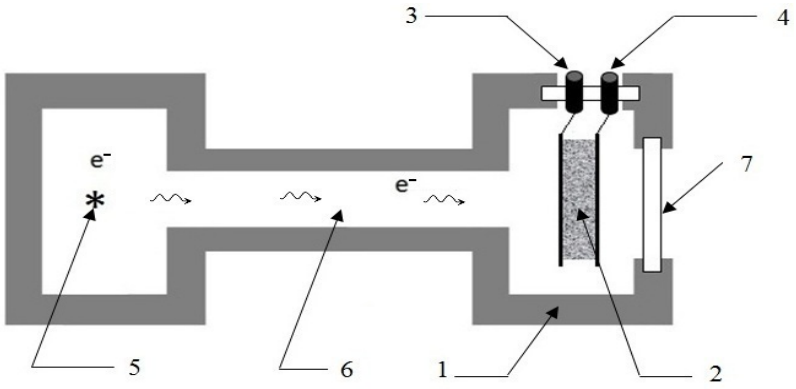

Fig1. 1– vacuum chamber of stainless steel, 2 – porous layer, 3,4 – electrodes, 5,6 – elementary particle source and beam, correspondingly, 7 – window.

An experimental setup providing vacuum ~10^{-5} torr was developed. The schematic view of the experimental setup including the recording system constructed on the basis of porous layer is presented in Fig.1. The investigations have been carried out on electron beam with energy 1 MeV and α-particle source with energy 5 MeV. The beam of elementary particles passed the distance of 30 cm in the vacuum and fell on the surface of porous layer. Due to interaction of elementary particles with the layer material delta electrons were produced. By applying appropriate voltage on the electrical contacts of electrodes an accelerating field was created. Birthed delta electrons in the

presence of external field were accelerated and avalanchely multiplied up to 10^9 times. The formed useful signal was outputted from the anode electrode and was feed into the signal proceeding and data recording electronic systems. For comparative analysis similar registration were conducted with proportional counters.

In Fig.2 the dependence of registration efficiency of the alpha particles η_α on the value of applied external accelerating field is presented. As shown, the increase in the value of applied external accelerating field U leaded to monotonous increase in the efficiency and reaches the level of 100% registration efficiency at the value of applied external accelerating field $U = 750$ V. With the increase in the value of the accelerating field up to $U = 1350$ V, the efficiency remains unchanged.

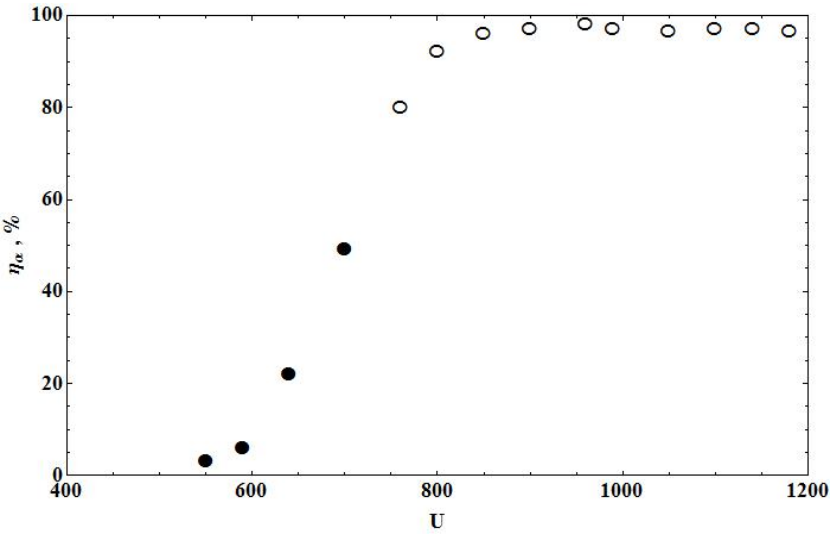

Fig.2. Registration efficiency of α-particles η_α versus the value of applied external accelerating field.

Figure 3 presents the dependence of the registration efficiencies of electrons for three detectors of different thickness of porous layers on the value of applied external accelerating field. Dots, circles and crosses correspond to utilized porous layers of different thicknesses (0.5 mm, 1 mm and 2 mm respectively). As shown in the figure, after the values of accelerating field $U = 850$ V reliable detection of electrons takes place and the 100% registration efficiency of electrons was obtained by increasing the thickness of the utilized layer up to 2 mm.

Due to comparative analysis of the obtained experimental data, shown in Figures 2 and 3, a shift of the value of the accelerating field in recording capability is observed. The difference of energy losses in the utilized working layer caused this shift between the value of the accelerating field for electrons and alpha particles registrations. Consequently, for obtaining the same number of birth delta electrons, in the case of electron registration, it is required a higher value of the accelerating field. However, the presence of the shift increased the selectivity of the developed registration systems.

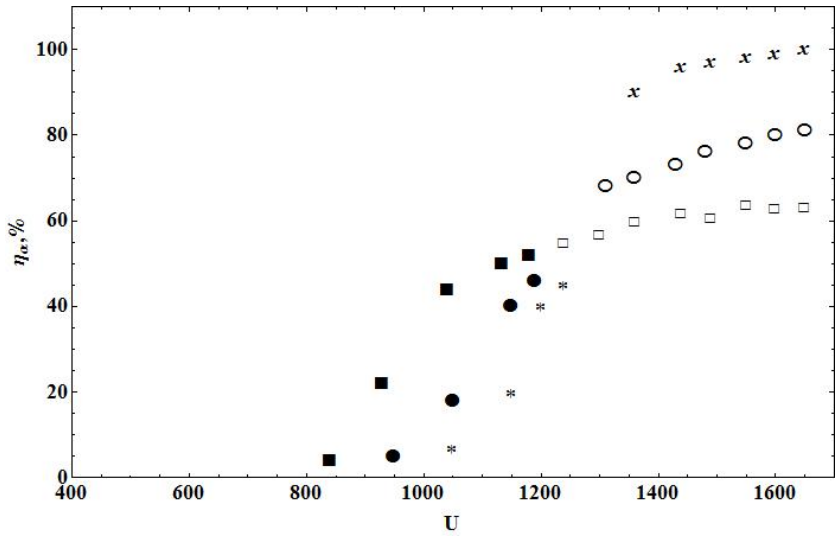

Fig.3. Dependence of the registration efficiency of electrons on the value of applied external accelerating field for three registration systems of different thicknesses of porous layer. Dots, circles and crosses correspond to the thicknesses 0.5 mm, 1 mm and 2 mm of utilized porous layers, respectively.

The increase in the value of applied external field more than 1800 V leads to breakdowns in the working layer, which stops the operation of the detectors.

Thus, on the basis of the experimental results it can be argued that the synthesized porous media can be used as a basis for developing systems detection of alpha particles and electrons with an efficiency of ~98% over a wide energy range, and the ability to register about ~10^9 particles per second.

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