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Some geometrical-optical properties of micro- and nanopores obtained by computer analysis of micrographs of plastic detectors CR-39 etched after irradiation with a beam of accelerated 12C ions

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Abstract

This work was carried out on the basis of the etched pore recognition method published in our work. Eight CR-39 plastic plates were fixed at various distances from the ion beam entry window into a bio-chamber filled with water. Then they were etched, dried and scanned by the computer-MPE-1 microscope system with an integrated video camera. About fifty micrographs were done from each side of the plates and recorded in img-files. The modified code of inscribed ellipses into the image contours of the found pores and calculated the sizes of their major and minor axes. The definition of reduced pore radius was introduced and a formula was obtained for its calculation. Knowing *r*, the bulk etching rate of the material and the etching time of the plastic, one can find the depths *L* of micro- and nanopores. Thus, the distribution of pores over the reduced radii *r* and depths *L*, their values averaged on each surface of the plates, were found as functions of their distances *S* from the window of entry of ions into the chamber. Then the formulas for macrodensitometry, microdensitometry and nanodensitometry were derived. The dependences of the distributions and average optical densities on the distance *S* in the water chamber were calculated. Pairwise fittings by linear functions of the mutual dependencies of the averaged values and on (dE/dS) were carried out. The most accurate fit was achieved for the dependence of the averaged optical density <*D(S)*> on the average pore depth <*L(S)*>. The worst fit is the approximation of the found average values by a linear dependence on the specific energy loss. This confirms the fact that the probability of the appearance of the response of detectors with high sensitivity is a nonlinear function of the specific energy loss. It is known that CR-39 plastic refers specifically to such detectors and to calculate its local response it is necessary to use the many-hit model.

Biography:

Valery Ditlov works in the direction of the Unified Theory of Robert Katz, who wrote the probability of local many-hits responses of the detector to the dose of energy released by ionization in any nuclear solid-state track detector. This class of detectors includes almost any solid material, and even not quite solid: nuclear photoemulsions, biological tissues, polymers, glasses, crystals, and so on. The theory of the response of solid-state detectors developed by Valery Ditlov avoids the use of any absorbed dose of energy, since in many cases there is no adequate dose-effect relationship. He deduced the probabilities of a local response using the differential spatial and energy distribution functions of delta electrons knocked out by radiation: charged particles, ions, or photons. This report is devoted to the study of the effect of radiation on the most sensitive polymer detector - CR-39 plastic. The research results obtained in this work can be used in nanotechnology

Speaker Publications:

1. A. V. Bakhmutova, V. A. Ditlov, and M. A. Kolyvanova (2018) Measuring the Beam Density of Accelerated 12C Ions Using Computer Analysis of Microscopic Photographic Images of Etched CR-39 Plastic Surfaces. Instruments and Experimental Techniques Vol. 61, No. 5:730–739.

2. Ditlov V.A. (2001) The evolution of track theory throughout the history of the international solid state detector conferences. Radiation Measurements 34:19-26.

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