STUDY OF STRUCTURAL PROPERTIES IN POLYMERIC MATRIX WITH TUNGSTEN PARTICLES FILLER BY MEANS OF POSITRON ANNIHILATION LIFETIME SPECTROSCOPY

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Scientific research regarding interaction of ionizing radiation with matter is widely conducted in fields such as physical sciences, medicine and nuclear energy. It is extremely important to ensure the safety of both professionally exposed individuals and the general population. In order to maintain the highest possible safety when working under exposure, it is necessary to adhere to many principles of radiological protection, where the most important are: increasing the distance from the radiation source, shortening the time of work under exposure and using shields appropriate for the type of source used. Over many years, lead and its alloys have been a commonly used material in radiation shielding. Unfortunately, lead has a number of disadvantages, including heavy weight, toxicity and high price. Currently, new materials are being sought, especially composite materials, which will provide appropriate shielding properties while reducing the weight of the material and bypassing other disadvantages attributed to lead materials. Good candidates seem to be plastics, which, when filled with metal particles, can reduce the cost of using raw materials and provide the desired shielding properties. The properties of composites depend to a large extent on structural properties. The structure of free volumes in the polymer matrix, the distribution of the filler inside the composite and its ability to form agglomerates affect the macroscopic properties of the material. A well-known and commonly used non-destructive method for examining the internal structure of materials based on plastics is positron annihilation lifetime spectroscopy (PALS). This method allows for determining the distribution and size of free volumes in the composite matrix, as well as determining the changes occurring in the material structure under the influence of added elements. In this work, composites with a matrix of recycled plastics (PET, PP) with a filler based on tungsten microparticles were examined. The samples were made using 3D printing and were examined using the PALS method. The structure of pure polymer samples was compared with the structure of composite samples. The effect of filler content on the structural properties of the composite was examined. Various models describing free volumes were compared, including the Tao-Eldrup model and a model using the newly created algorithm,,x3-x2-CDA, which allows for approximating changes in the structure of the composite material, in relation to the pure material. The results were related to the shielding properties of the tested samples and the prospects for their use in radiation shields.

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