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Simulation and experimental results of electron beam interaction with 3D-printed samples made of modified plastics

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One of the important parameters characterizing the interaction of electron beams with matter is the deep dose distribution. To develop a new approach for shaping electron beams using specially created materials suitable for the manufacture of complex 3D-printed devices, it is necessary to analyze the features of ionizing radiation propagation.

In this work, numerical simulations and experimental studies of the interaction between electron beams and plastic materials weighted with metallic impurities of different concentrations, suitable for fabricating samples using the rapid prototyping method, were carried out. Sets of plates made from the investigated plastics were created using the fused filament fabrication (FFF) technique.

Since the FFF sample fabrication process involves forming objects from a thermoplastic mass through layer-by-layer alignment, a distinctive feature of the printed samples is their lower actual density compared to the density of the material (filament) from which they are made. Taking this fact into account, the actual density of the polymer plates was calculated. Based on this data, numerical models of the plastic materials weighted with metallic impurities were developed, and virtual models of the experimental setup were created to calculate the electron beam deep dose distributions in the materials.

In the next step of the investigation, experimental studies were performed using electron beams with energies of 6 and 10 MeV. Pre-calibrated GafChromic EBT3 dosimetry films were used as detectors to obtain the experimental data on the electron beam deep dose distributions in the materials under consideration.

It was observed that with an increasing concentration of metal impurities in the plastic base, the deep dose distribution moves into smaller thicknesses. It was observed that the simulation and experimental results are in good agreement.

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