Abstract

Title of the dissertation *Easily formable ionizing radiation shielding materials containing nano- and microparticles*

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Ionizing radiation is utilized in various sectors, such as industry, medicine, science, yet unintended human exposure to it leads to diverse health consequences. Depending on the absorbed dose, radiation can induce changes in the structure of genetic material (triggering a cascade of cellular repair mechanisms) or, in extreme cases, cause radiation sickness. Regarding gamma and X-ray radiation, traditional lead shields effectively serve their purpose but have a limitation: they are impractical for certain applications. This dissertation focuses on developing a composite material for protection against ionizing radiation (gamma and X) that allows for the creation of shapes tailored to specific applications — meaning the geometry can be defined independently of extensive laboratory infrastructure (such as complex manufacturing processes or equipment requiring highly skilled personnel). Additional design criteria include a straightforward manufacturing procedure (utilizing relatively simple, intuitive equipment to eliminate the need for extra laboratory technicians) and the use of readily available, low-toxicity components. The doctoral dissertation comprises a theoretical section — presenting information on gamma and X-ray radiation (including their everyday applications, effects on the human body, and traditional shields) alongside a literature review on shielding nano- and microcomposites — and an experimental section, which describes the used materials, the sample manufacturing process, the measurement methodology, and the obtained results. The study aimed to design a composite and experimentally investigate its shielding properties regarding the attenuation of gamma radiation (using a ^{60}Co source) and X-rays (using a clinical diagnostic X-ray system, model PROTEUS). Subsequently, the composite exhibiting the best gamma-ray attenuation selected from a range of materials varying in the type and mass fraction of nano- and microparticles was subjected to further analysis to determine other physical properties crucial for practical application. Additionally, the study of the selected material included the development of a recovery procedure for one of the utilized components, in line with the concept of a closed product life cycle. The qualitative aspect of the proposed recycling procedure was complemented by a quantitative assessment using digital techniques (analysis of images captured via light microscopy). This work advances the field of radiation protection by proposing a safer alternative to conventional lead-based materials and provides experimental data that can facilitate future theoretical research. The proposed shielding composites could potentially be used as personalized shields for patients or staff, or could serve as passive shielding integrated into a finished structure.