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CALCULATION OF MASS ATTENUATION COEFFICIENTS OF POLYMERS OF INTEREST IN DIAGNOSTIC RADIOLOGY USING THE FLUKA CODE

SANTOS, S.M.[1], SILVA, J.O.[1]

[1]Instituto de Física, Universidade Federal de Goiás, 74690-900 Goiânia, GO, Brazil, samuelmafra@discente.ufg.br

Introduction: In diagnostic radiology, mass attenuation coefficient (μ/ρ) is one of the main quantities that describes the interaction of photons with matter, and it can be obtained through computational simulations. The polymer PMMA is utilized in the calibration of radiology equipment, and the use of 3D printers allows polymers PLA and ABS to have increasing applicability in the field with custom shaped phantoms. In this research, we seek to obtain μ/ρ and other quantities of interest, such as half-value layer (HVL), mean free path (MFP) and effective atomic number, of the mentioned polymers using the FLUKA code, a general purpose Monte Carlo code that shows optimized performance comparing with particle production data at the single interaction level.

Material and method: For narrow beam geometry, Lambert-Beer's law dictates $(\mu/\rho)=(\log(I_0/I))/(\rho*t)$, in which I_0, I are the initial and final beam intensity respectively and ρ and t are the density and thickness of the material. Therefore, the angular coefficient obtained from the plot of $\log(I_0/I)$ by t for each energy and material results in their respective μ/ρ.

A simulation geometry containing a x-ray tube with a tungsten (W) target placed within vacuum, a lead (Pb) housing and a beryllium (Be) window was described in the code, in addition to a collimation and filtration system for the photon beam after leaving the tube and reaching the sample with the polymer surrounded by air, according to Figure 1. Electron beams with 1×10^8 particles under tube voltages of 100 kV and 150 kV were simulated hitting the W target. The generated x-ray spectrum was analysed. USRBDX estimator card was used to obtain I_0/I for each t of the samples.

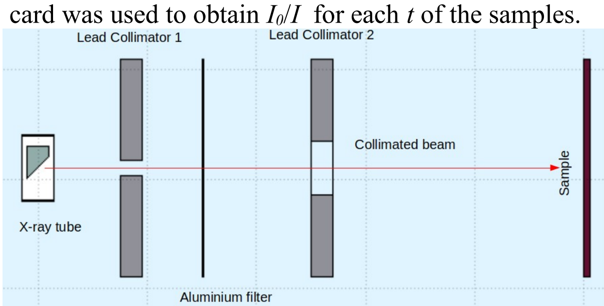

Figure 1: Simulation geometry.

Results:

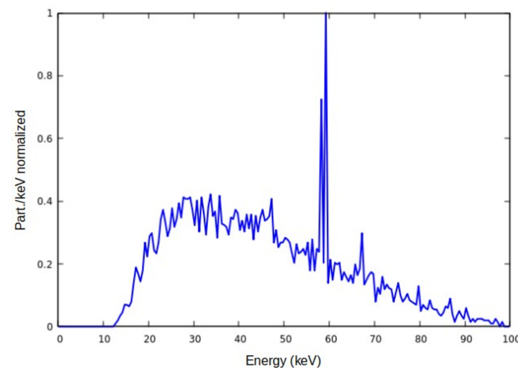

Figure 2: X-ray 100 kV spectrum after filtration and collimation.

Tube Voltage(kV)	μ/ρ (cm²/g)		
	PMMA	PLA	ABS
100	0,2317	0,2278	0,2420
150	0,1770	0,1808	0,1788

Table 1: Mass attenuation coefficients for the polymers and tube voltage simulated.

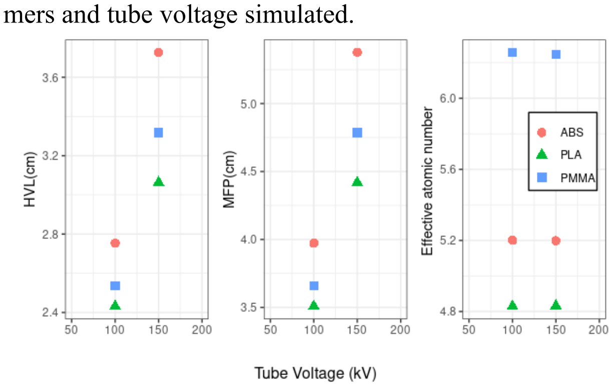

Figure 3: Quantities calculated for each material.

Conclusions: The x-ray spectrum produced in the simulated geometry is consistent to the ones found in the literature for W targets. The results show the applicability of this method for studying these polymers, although further validation of the generated beam is necessary to compare the mass attenuation coefficients obtained with reference values from databases and experimental results.