First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

SIMULATED INVESTIGATION OF THE RADIOLOGICAL PROPERTIES OF POLYMERIC FILAMENT USED IN THE MANUFACTURE 4.0

MANGUSSI, A.[1] and SCHWARCKE, M.[2]

[1]Curso de Física Médica, Universidade Federal de Ciências da Saúde de Porto Alegre, 90050-170 Porto Alegre, RS, Brazil, arthurm@ufcspa.edu.br
[2]Departamento de Ciências Exatas e Sociais Aplicadas, Universidade Federal de Ciências da Saúde de Porto Alegre, 90050-170 Porto Alegre, RS, Brazil

Introduction: With the evolution of manufacture 4.0 and its variety of applications, it allows the medical physics professional the development of customized phantoms for the practice of quality control in radiodiagnostic equipment. Its application is limited by the concern to realize physical processes in the same way that materials already used for the same purpose. The purpose of this work is to assess by computational simulation the performance of these polymers at the expense of materials already used in quality control in radiodiagnostics.

Material and method: To assess the radiological properties of polymer materials, the Monte Carlo Penelope simulation code, version 2014, was used. Where a simulator object has been developed that has a desired geometry for the study and allows its subsequent manufacture to conduct comparative experimental studies.

A search in the literature of the chemical composition and density of the main polymers used in manufacturing 4.0 was carried out in the literature, the results are presented in Table 1. These data allowed the material file of each filament to be compiled and used in the computer simulation.

To perform the simulation, the irradiation geometry described in the TG195[1] was used and the irradiation spectrum used was removed from IPEM Report78[2], for the irradiation beams of 60 kV, 70 kV and 80 kV. The irradiation field used was 10cm x10cm on the surface of the phantom, primary particles $1x10^9$ were used and the detector was positioned after the phantom, the Gd_2O_2S:Tb.

For comparison of material performance, half-value layer values, linear attenuation coefficient, deposited energy spectrum and attenuated spectrum were used as comparison parameters.

Results: The values for HVL and μ for the 60 kV spectrum irradiation are presented in Table 1. The same behavior is observed for the 70 kV and 80 Kv spectrum irradiation.

Table 1: Results for irradiation beam of 60 kV spectrum.

Name	Chemical Formula	Density ($g.mL^{-1}$)	HVL (cm)	μ (cm^{-1})
PMMA	$H_8C_5O_2$	1.18	31.59	0.0219
PETG	$C_{14}H_{20}O_5S$	1.27	16.94	0.0409
ABS	$C_{15}H_{15}N$	1.04	42.00	0.0165
PLA	$C_3H_4O_2$	1.24	28.73	0.0241
TPU	$C_{27}H_{36}N_2O_{10}$	1.27	31.09	0,0222
ASA	$C_{18}H_{23}NO_2$	1.05	39.02	0.0177
Nylon	$C_{12}H_{22}N_2O_2$	1.52	26.15	0.0265

Conclusions: The present work demonstrates that even the polymeric filaments used in manufacture 4.0 have similar properties, their attenuation-related behavior is considerably different, making these materials interesting options in phantom manufacturing for radiodiagnostic fields.

References:

1. I. Sechopoulos, et al., *Medical Physics 42(10)*, 5679-5691 (2015).
2. K. Cranley, et al., *Catalogue of diagnostic x-ray spectra and other data,* York:IPEM (1997).