Calculation of mass attenuation coefficient of polymers using gamma densitometry and MCNPX code

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Studies of attenuation and absorption properties of materials have been conducted due to the growing interest in nuclear techniques. Simulation and experiments of these properties include several material types, such as tissues, shielding and building materials, iron-boron alloys, polymers, salt solutions, among others. Therefore, the aim of this report is to calculate mass attenuation coefficient of some polymers (Perspex, Bakelite, Polypropylene, Polyethylene, Teflon, Polycarbonate and Nylon 6-6) using gamma densitometry and simulation. Measurement geometry consists of a NaI(Tl) detector, a ^{137}Cs radiation source (narrow beam) and samples of the chosen polymers, as follows Figure 1 [1]. It is worth noting that a narrow beam is a mathematical representation of a collimator.

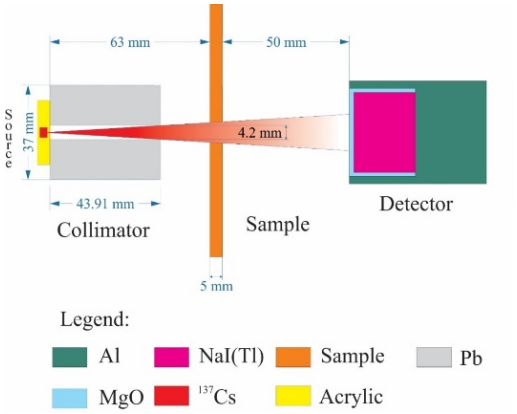

Figure 1. Measurement geometry to calculate mass attenuation coefficient

Mathematical models were developed using MCNPX code [2]. Detailed information about the composition of these polymers can be found in SANTOS et al., (2020) [1]. Results of mass attenuation coefficient are available in Table 1 and the relative error (RE%) was calculated in order to compare the results with reference values from NIST [3].

Table 1 - Mass attenuation coefficients from MCNPX code and NIST

Mass attenuation coefficient ($cm^2.g^{-1}$) (661.6 keV)			
Polymers	**NIST**	**MCNPX**	**RE_1 (%)**
Perspex	0.08331	0.08254	0.92
Bakelit	0.08154	0.08078	0.93
Polypropylene	0.08807	0.08688	1.35
Polyethylene	0.08807	0.08700	1.21
Teflon	0.07418	0.07395	0.31
Polycarbonate	0.08139	0.08054	1.04
Nylon 6-6	0.08462	0.08382	0.94

Maximum RE found was 1.35%, which means that the results obtained with this methodology are in a good agreement with reference values from NIST. In addition, the results were compared with values available in the literature (MCNP4C code), as follows in Table 2. In the worst case the RE was 1.81%.

Table 2. Mass attenuation coefficients from MCNPX and literature (MCNP4C code)

Mass attenuation coefficient ($cm^2.g^{-1}$) (661.6 keV)			
Polymers	**MCNP 4C**	**MCNPX**	**RE_2 (%)**
Perspex	0.083	0.08254	0.5
Bakelit	0.082	0.08078	1.51
Polypropylene	0.088	0.08688	1.29
Polyethylene	0.087	0.08700	0.00
Teflon	0.074	0.07395	0.07
Polycarbonate	0.082	0.08054	1.81
Nylon 6-6	0.085	0.08382	1.41

More results and details are available in SANTOS et al., (2020) [1].

References

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