



Congresso Brasileiro de Engenharia e Ciência dos Materiais
24 a 28 de Novembro de 2024 | Fortaleza - CE - Brasil

Data e hora: 27/11/2024 | 18:00

Sessão: Sessão de Poster 5

Tipo: poster

Ref.: MCoMnu02-001

DEVELOPMENT OF AN EPOXY/CARBON FIBER COMPOSITE WITH BISMUTH TRIOXIDE (Bi₂O₃) MICROPARTICLE DISPERSION AND DETERMINATION OF THE MASS ATTENUATION COEFFICIENT THROUGH PRACTICAL TESTING AND SIMULATION

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Resumo:

The objective of this research was the development of an epoxy/carbon fiber composite with bismuth trioxide (Bi₂O₃) dispersion in the polymeric matrix for application as a low-energy photon barrier and to determine the mass attenuation coefficient of this composite through simulation and laboratory tests. The quantitative and experimental methodology was used for this research. The mass ratios of the bismuth (III) oxide in the composite were approximately 0.1, 0.2, 0.3 and 0.4. The software Topas MC (version 3.7) was

choiced for the simulation. About the practical experiment, the Pantak/Seifert irradiator model Isovolt HS 160 was used as an X-radiation source and as a radiation detector, a Radcal Corporation model 9010 radiation meter with a 1.8 L Radcal model 10x5 – 1800 ionization chamber was used. The photon energy was 48, 65, 82 and 118 keV, with radiation doses of the 471, 1912, 92,6 and 74,2 $\times 10^{-3}$ mGy.min⁻¹ respectively, energies and doses radiation typical X-ray (diagnostic radiography). The results of the mass attenuation coefficient obtained in the practical experiment were approximately 60% lower than those obtained through simulation, probably due to the difference in density, as the density of the composite in practice was approximately 30% lower than estimated theoretically and used for simulation. However, for an energy of 118 keV, the dispersion of Bi₂O₃ in the polymeric matrix increased the mass attenuation coefficient from 0.15 g.cm⁻¹ (without dispersion) to 1.28 g.cm⁻¹ (39.13% by mass of Bi₂O₃). This is an increase of approximately 753%. For an energy of 82 keV, the percentage increase was approximately 582%. For an energy of 65 keV, there was also an increase of 739% and for photons with an energy of 48 keV, the percentage increase in the mass attenuation coefficient was 1262%. In conclusion, for future research about simulation with mass coefficient attenuation for the composite epoxy/carbon fiber with a dispersion of oxide de bismuth (III) will be necessary a density correction is required, however, through practical experiments, a composite epoxy/carbon fiber, with bismuth (III) oxide dispersion, is an excellent option as compared to a lead plate. The composite studied can attenuate photon energy and does not present an acute or chronic danger to the environment or health. Also, it is non-carcinogenic, and does not cause reproductive toxicity, both clear advantages over lead. Finally, it should be noted that composite applications would be radiological shields for the X-ray, aerospace industries, among others.