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Investigation of Gamma Radiation on the properties of Polymethyl Acrylate

Madhav Namdev Rode

Department of Physics, Vaidyanath College, Parli-Vaijnath, Dist. Beed - 431515 (MS), India

Abstract: Mass attenuation coefficient (μ_m), effective atomic numbers (Z_{eff}), electron densities(N_{eff}),total cross-section(σ_t) & electronic cross-section(σ_e) have been computed for poly methyl acrylate using NaI (Tl) detector. Results of gamma radiation parameters such as μ_m, σ_t, σ_e, decreases with increasing gamma ray energy. Z_{eff} values of the polymethyl acrylate almost constant as a function of energy. It is clearly observed from the results that the polymethyl acrylate have good absorption capability of gamma photons in low energy region. We believe that some high Z elements dope with polymethyl acrylate may have potential applications in the shielding against gamma rays. An experiment has been done to investigate the new gamma ray shielding material that can be used at large scale and available easily having non-toxic.

Index Terms **– Mass Attenuation Coefficient, Electron Densities, Gamma Radiation, Effective Atomic Numbers**

INTRODUCTION

Since last few decades as the use of ionizing radiation increases in many fields such as medical field, structure modification, agriculture industry etc. The study on the effects produced by ionizing radiation on new materials for the dosimetry and radiation shielding is increased. As we know ionizing radiations are harmful for living tissues thus there is need to study and investigate a new gamma ray shielding material which can be used at large scale are nonhazardous and are inexpensive. Traditionally used lead shows neuro-toxicity. Many researchers studied and investigated the effects and properties produced by gamma-ray using various research methods [1-6]. Radiation damage in many materials studiedand investigated the results produced by it [9-10]. The poly methyl acrylate is C, H and O based low-Z material, which is tissue equivalent material and can be used as phantom to understand the radiation attenuation.

To study gamma-ray attenuation properties of materials the mass attenuation coefficient (μ_m) is the fundamental parameter to derive other parameters as atomic cross-sections (σ_t), electronic cross-sections (σ_e), effective atomic numbers (Z_{eff}) & effective electron densities (N_{eff}). An attempt is made in the present work to check the availability of poly methyl acrylate as gamma ray shielding material and to find out its interaction properties using NaI (Tl) detector. The investigated results in the present work could be useful in the dose rate measurement and radiation shielding against gamma radiation.

EXPERIMENTAL

Radioactive sources having energies 122, 279, 320, 364, 637, 1115, 1408 keV were used for irradiation. The gamma ray photons were detected using NaI (Tl) detector with resolution of 0.101785 at 662 keV. Signals from the detector were enlarged and analyzed with 8K multichannel analyzer. The effectiveness of NaI (Tl) detector is higher at low source energy (Mohamed Abd-elzaher). The uncertainty in determined experiment is found to be 1-4 % (Mustafa RacepKacal) Topoly methyl acrylate as radiation target we use KBr press machine to prepare tablets having same thickness (0.13 g/cm2) and then filled in a cylindrical plastic container having the same diameter as that of sample tablets. To determine the diameters of these samples we use a traveling microscope. We done some experiment with the empty sample container and found that attenuation of photons of the empty containers were negligible. The experimental part is discussed in [8]. In this work mass attenuation coefficient (μ_m) , atomic cross-sections (σ_t), electronic cross-sections (σ_e), effective atomic numbers (Z_{eff}) & effective electron densities (N_{eff}).were calculated from formulas reported elsewhere [7-8, 11].

RESULT AND DISCUSSION

The values of μ_m (cm2/g) are shown in figure 1, the values of μ_m from energy range 122 keV to 1170 keV decreases but from energy range 1115 to 11408 keV the values are constant. The σe, σt, Zeff, and Neff, values for poly methyl acrylate are shown in the table1.The values of all parameter studied initially decreased and then reached a constant value at higher photon energies as seen in table1. The experimental values were in good agreement with the XCOM values. From the values for effective atomic number of poly methyl acrylate depends on the number of elements in the materials.

Table1. Gamma-ray parameters for poly methyl acrylate

PMA	122 keV		279 keV		320 keV		364 keV		637 keV		1115 keV		1408 keV	
	Exp.	The.	Exp.	The.	Exp.	The.	Exp.	The.	Exp.	The.	Exp.	The.	Exp.	The.
μ_m	0.1575	0.1564	0.1226	0.1219	0.1084	0.1071	0.1022	0.1031	0.0866	0.0850	0.0640	0.0649	0.0563	0.0571
σ_t	22.5054	22.3482	17.5185	17.4184	15.4894	15.3037	14.6035	14.7321	12.3772	12.1458	9.1450	9.2736	8.0448	8.1591
σ_e	5.8710	5.8300	4.5700	4.5439	4.0407	3.9923	3.8096	3.8432	3.2288	3.1685	2.3857	2.4192	2.0986	2.1285
Z_{eff}	3.8333	3.8264	3.8333	3.8231	3.8333	3.8219	3.8333	3.8213	3.8333	3.8204	3.8333	3.8194	3.8333	3.8191
N_{eff}	3.2192	3.2134	3.2192	3.2106	3.2192	3.2097	3.2192	3.2092	3.2192	3.2084	3.2319	3.2075	3.2192	3.2073

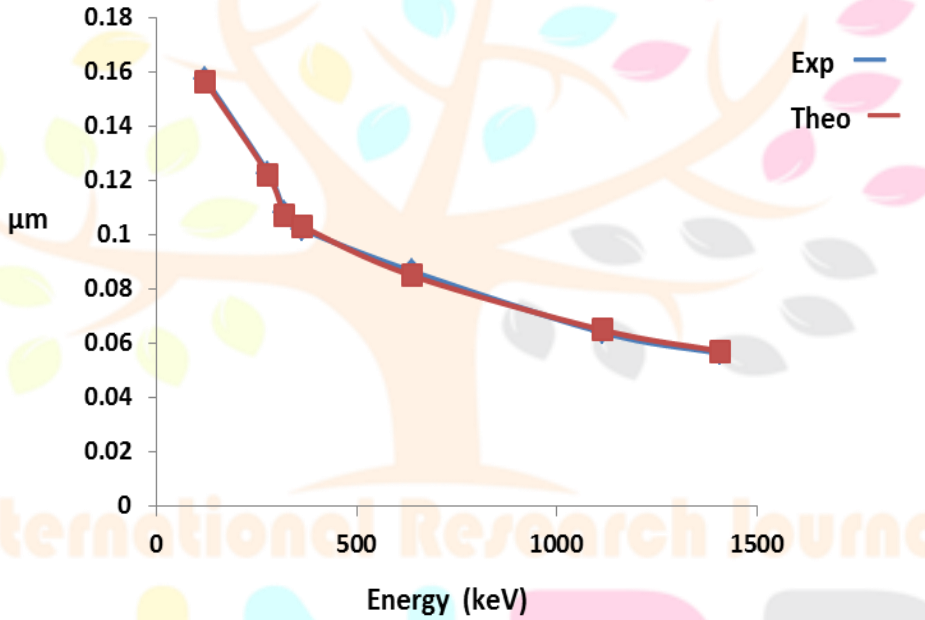

Fig. 1: Variation of μ_m with photon energy

CONCLUSION

It can be concluded from the present work that the poly methyl acrylate used in this investigation shows significant attenuation of low energy photons and can find use as gamma ray shielding material in electronics industry, construction, plastic industry, and agriculture. The calculated and investigated values of poly methyl acrylate are useful in medical field.

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