The Attenuation Of Gamma-Ray By Doped Azo Polymers With Nano Oxide Metals

Dhamiaa H. Muhsen, Asaad F.Khattab, Anwar M. Ezzat

Abstract: The mass attenuation coefficient (μ_m) for pure polyamide $C_{26}H_{26}N_6O_2$and pure polyazomythen $C_{26}H_{18}N_6$ were measured at 59,511 and 622 keV photon energies. The samples were separately irradiated with^{241}Am, ^{22}Na, ^{137}Cs, radioactive gamma sources. The mass attenuation coefficient (μ_m) for composites materials from this polymers and nano oxide CuO and Co_3O_4were measured using the same gamma sources. The relationship between the values of (μ_m) versus gamma energies, and exist the attenuation of gamma ray increases with increasing the doping ratio specially at energy 59 keV.The samples that dope with two nano oxide best from samples that dope with one nano oxide.

Keywords: Attenuation coefficient. Nano Oxide. Azo Polymers.Gamma-ray.

Introduction:

A growing interest in radiation of polymers and organic materials has been reported recently in the literature (1). The interest in polymers comes from the wide use of these materials industry and ionizing radiation dosimeters. High energy radiation to polymers produce ionization and excitation, subsequently the rupture of chemical bonds yield fragments of large polymers molecules which will retain unpaired electrons from the broken bond. The free radicals thus produced may lead to change in the chemical structure of the polymer and alter the physical properties of the material, the polymer thus may undergoes cross linking depending on the polymer(2-3-4).From a practical point of view, many of the polymers are extremely ductile and pliable, which means they are easily formed into complex shapes. In general, they are relatively inert chemically and unreactive in a large number of environments. A composite material is composed of two (or more) individual materials that come from the categories such as metals, ceramics, and polymers. (5). In this paper we used polymeric material as matrix filled by nano oxide metals. The mass attenuation coefficients (μ_m) is a measure of probability of the interaction that occurs between incident photons and matter in a given mass-per-unit area thickness of the material encountered. It is a basic quantity used in the calculation of photon penetration and energy deposition in biological ,shielding and other dosimetric materials (6). The magnitude of (μ_m) depends on the incident photon energy, the chemical structure and bonding in the absorbing material and parameters such as thickness and density.Accurate values of (μ_m)for gamma rays in several materials are of great importance for industrial ,biological, agricultural and medical studies(6).

- *Dhamiaa H. Muhsen, Asaad F.Khattab, Anwar M. Ezzat*
- *Department of Radiation, Northern Technical University*
- *Department of Chemistry, College of Science, Mosul University*
- *Department of Physics, College of Science, Mosul University*

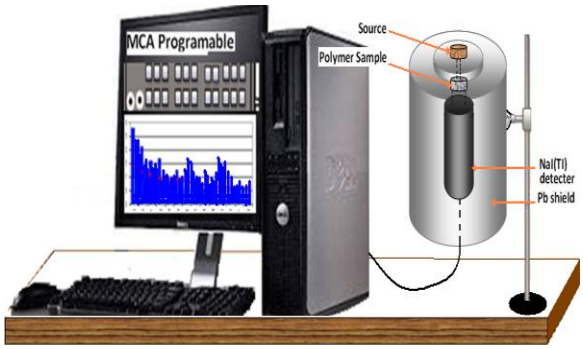

Figure 1. *The schematic arrangement of the experimental setup.*

Experimental method:

In this study.The some samples prepared from pure polyamide $C_{26}H_{26}N_6O_2$(PA)and impurity polyamid with CuO nano oxide and Co_3O_4 nano oxide at ratio (0.5%-1%-1.5%-2%) respectively.The other samples of polyamide contain mix for two nano oxide ($CuO+Co_3O_4$) with ratio ($1.5\%CuO+1.5\%Co_3O_4$), ($1.5\%CuO+0.5\%Co_3O_4$) and ($0.5\%CuO+1.5\%Co_3O_4$). Another polymer used as the matrix of nano oxide (CuO,Co_3O_4) is polyazomythen with the same ratios in above. Thus, the total samples are: 11samples to polyamide and 11 samples to polyazomythen $C_{26}H_{18}N_6$. All samples fabricated as tablets by compression pressure 2ton /cm^2 at room temperature. By using the percentage of intensity difference determined the homogenous of some samples at energy 59KeV, as benefit from incident and travelled intensity through samples. The samples were separately irradiated with ^{241}Am (59keV), ^{22}Na (511keV) , ^{137}Cs (662keV),radioactive gamma sources. The arrangement of the experimental show in figure (1).The samples were placed one by one between the source and detector, and this detector is cylindrical NaI(Tl)(6). Figure 1 show we used multi channel analyzer system(MCA) to record the spectra after a gamma ray pass through the sample. For each sample, we calculated the peak area from spectra. The attenuation of gamma ray by doped azo polymers with nano oxide metals determined by measuring a mass attenuation coefficient for samples which irradiated with 59KeV,511KeV,and 662 KeV energies respectivily.

Calculations:

To ensure best homogeneity of the samples a few calculations were made through the percentage of intensity difference.

$$\Delta I\% = \frac{I' - I}{I'} \times 100\% \quad \text{----------1-}$$

I is intensity of gamma ray that transmitted from special position on sample.

I' is average values intensity for all positions

And according to the Beer law: If the sample with (x) thickness is placed in the path of a beam of gamma radiations, with intensity $I_\circ$, thus the intensity permeative:

$$I = I_\circ e^{-\mu x} \quad \text{----------2}$$

Where $I_\circ$ is the intensity of incident beam,

I is the intensity of permeative beam, and μcm^{-1} is the linear attenuation coefficient of sample.

The equation (2)can be rewrite as function of mass attenuation coefficient.

$$I = I_\circ e^{-\mu_m d} \quad \text{----------3}$$

Where μ_m is mass attenuation coefficient and equal to $\frac{\mu}{\rho}$ (linear attenuation coefficient divided by density). $d(g\ cm^{-2})$ is the mass per unit area and equal to $\frac{m}{x^2}$.(7)

Results and discussion:

Figures (6 to 11) revealed that the photon energy and compositional dependence of μ_m is remarkable in low incident energy due to predominant photoelectric absorption mechanism. Compositional effects and incident photon energy dependencies are reduced in the high energy since Compton scattering and pair production processes start to dominate the photon absorption process, respectively. (as in ref.6) The values ofμ_m increases with increasing the doping ratio for both polymers if compared with pure polymers, thus nano oxides lead to increase the attenuation of gamma ray, especially in the low incident energy 59 keV, but the values of μ_m are corresponding to all doping ratio in the high-energies. The relationship between gamma energies and μ_m to the composites material which contain two nano oxides illustrate :the better attenuation of gamma ray occurs ,this means a polymer doped with two oxide best from polymer doped with one nano oxide because the complex structure which will interact with gamma ray ,and this specially in energy 59KeV. The relationship between the average of mass attenuation coefficient for each impurity ratio for four different positions and energy gamma ray were plotted in figs. (6-11) where arbitrary positions were selected for the calculations.

Conclusions:

1- All samples nearly homogeneous and the chemical compositions of the samples effect on the attenuation of gamma rays.
2- Photon energies for gamma rays play an important role in the interaction with polymer samples, where in the low incident energy range the photoelectric absorption mechanism dominant but at high energy range, Compton scattering and pair production processes dominant on photon absorption process.

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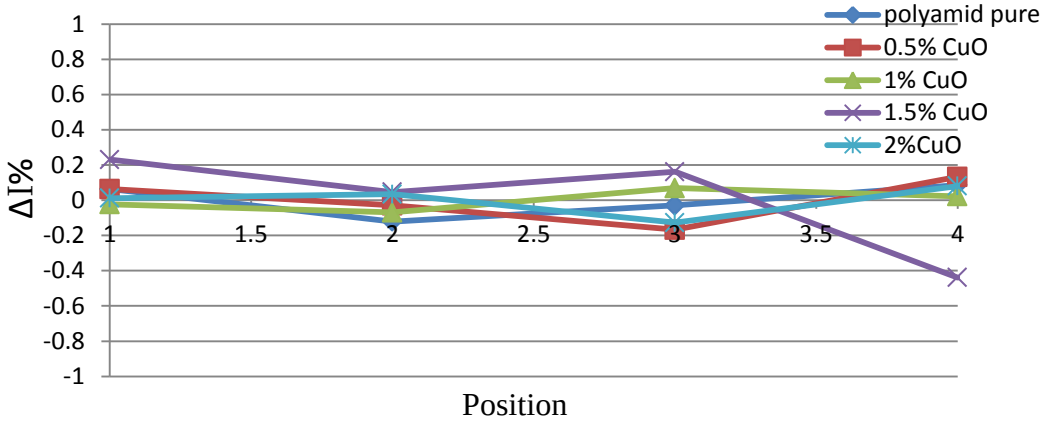

fig.(1) *the ratio percent of intensity difference for polyamid +CuO as afunction of four positions upon energy 0.059MeV*

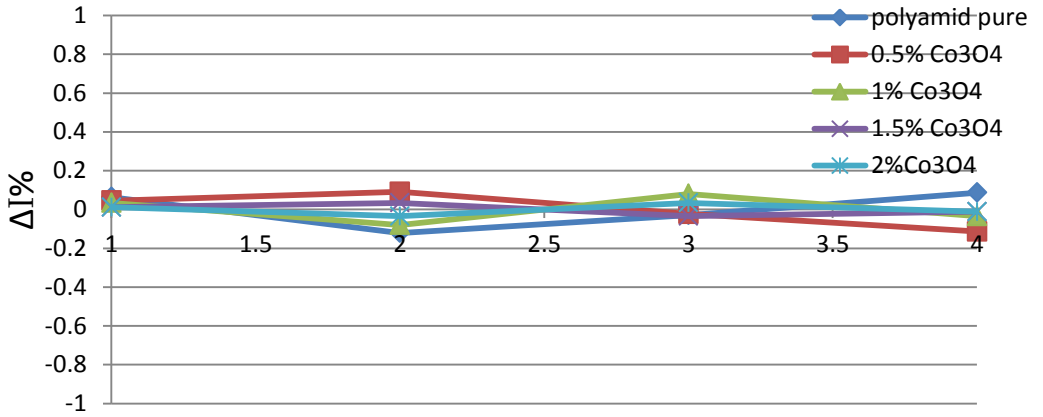

fig.(2) *the ratio percent of intensity difference for polyamid +Co_3O_4 as afunction of four positions upon energy 0.059MeV*

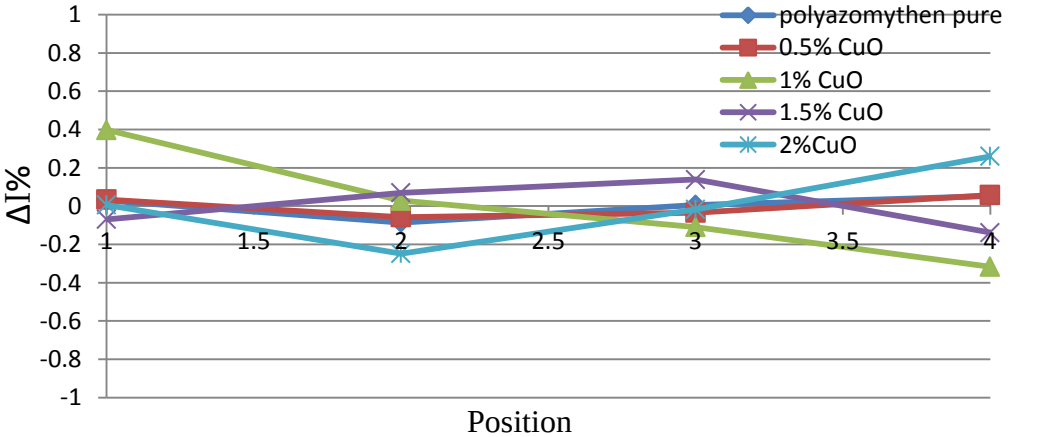

fig.(3) *the ratio percent of intensity difference for polyazomythen +CuO as afunction of four positions upon energy 0.059MeV*

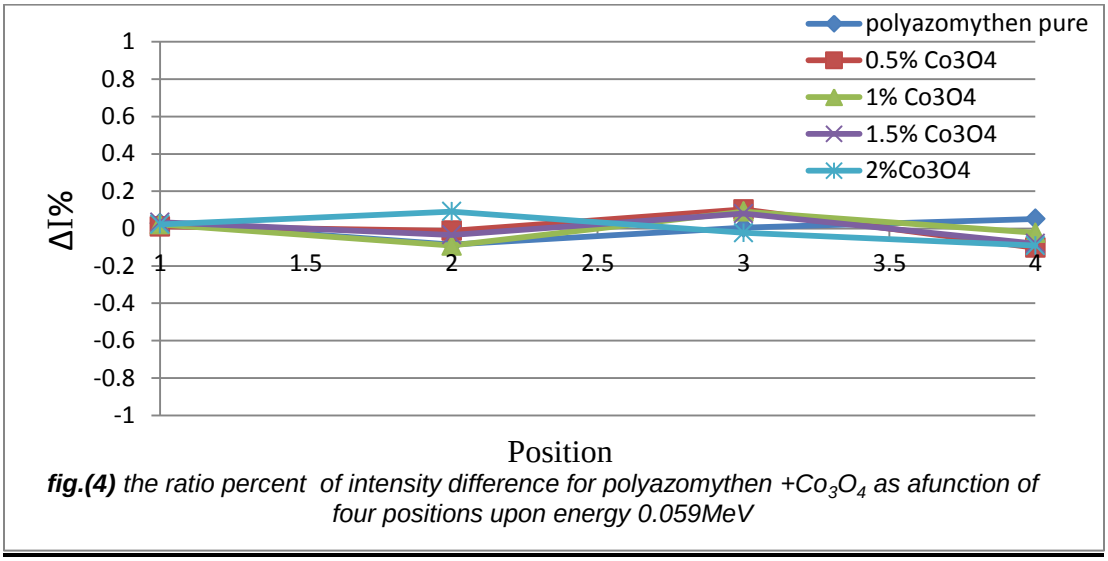

fig.(4) *the ratio percent of intensity difference for polyazomythen +Co_3O_4 as afunction of four positions upon energy 0.059MeV*

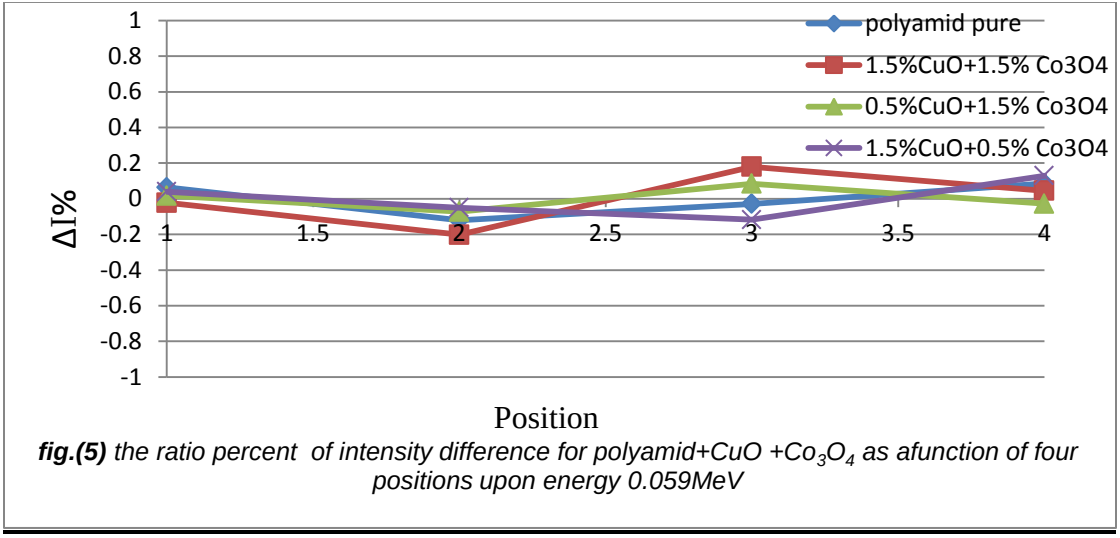

fig.(5) *the ratio percent of intensity difference for polyamid+CuO +Co_3O_4 as afunction of four positions upon energy 0.059MeV*

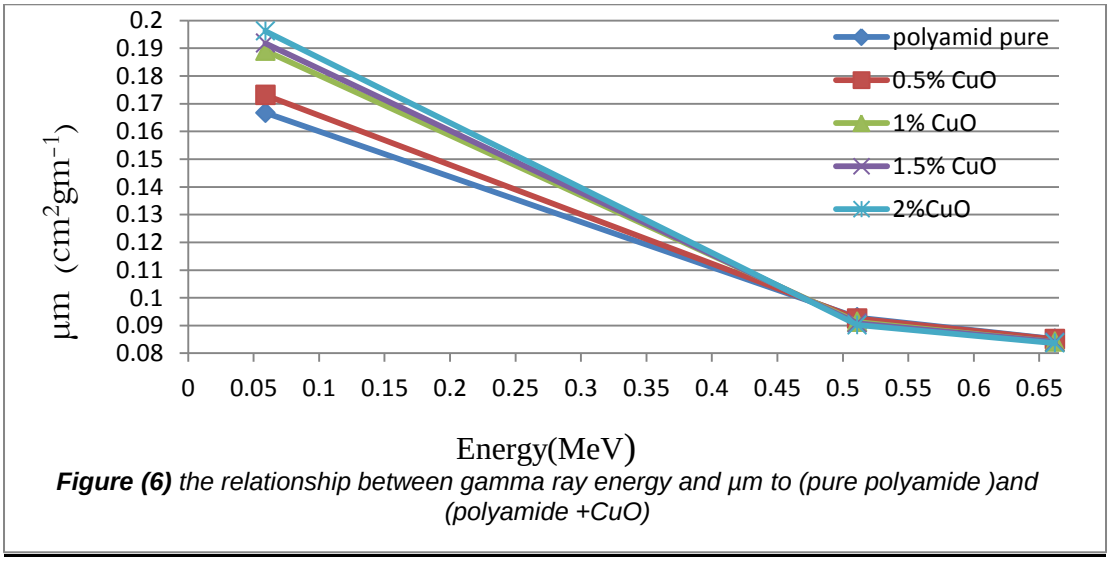

Figure (6) *the relationship between gamma ray energy and μm to (pure polyamide)and (polyamide +CuO)*

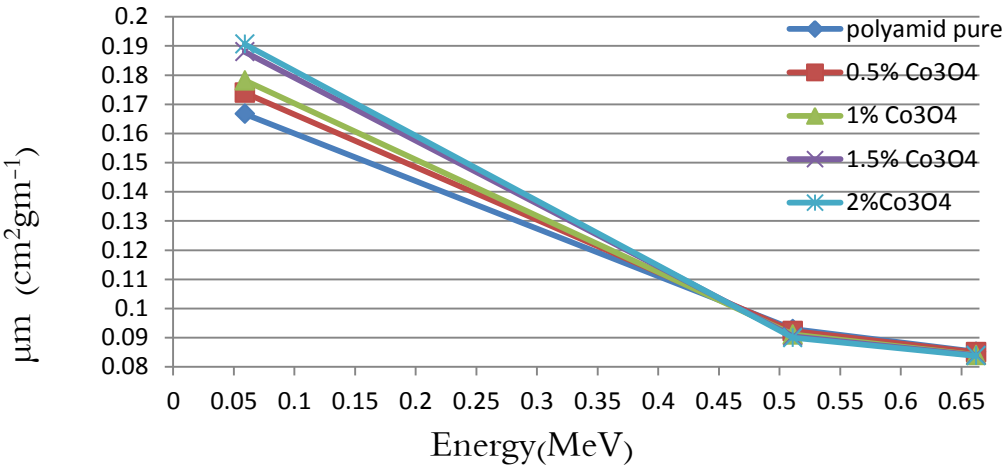

Figure (7) *the relationship between gamma ray energy and μm to (pure polyamide)and (polyamide +Co_3O_4)*

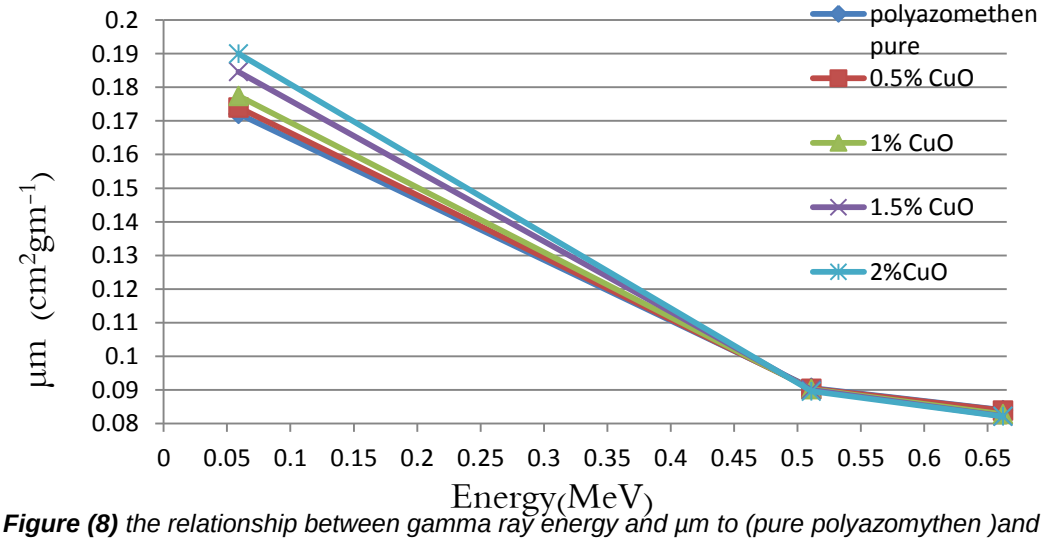

Figure (8) *the relationship between gamma ray energy and μm to (pure polyazomythen)and (polyazomythen +CuO)*

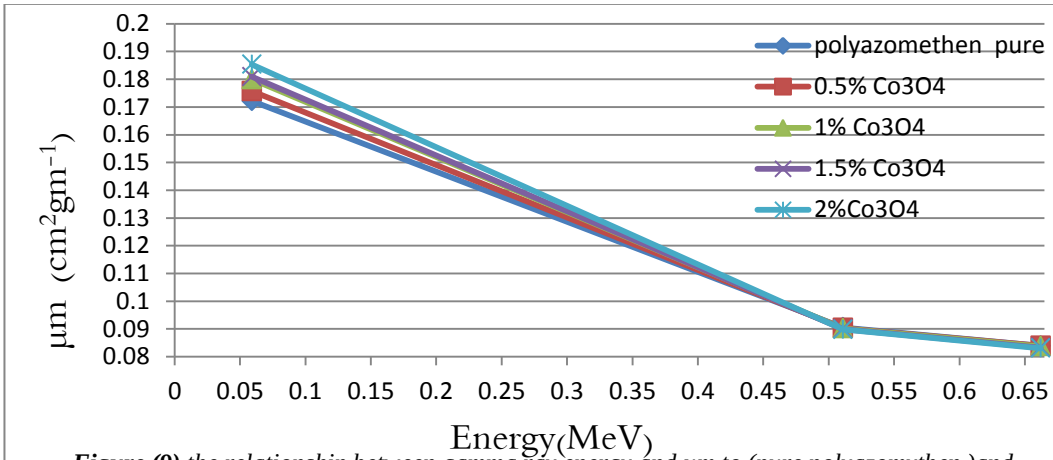

Figure (9) *the relationship between gamma ray energy and μm to (pure polyazomythen)and (polyazomythen +Co_3O_4)*

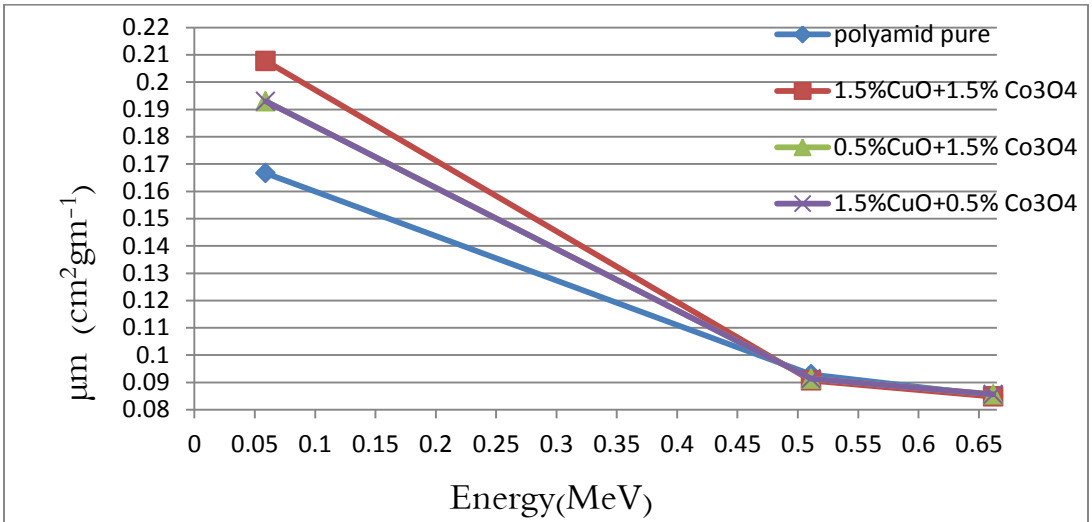

Figure (10) *the relationship between gamma ray energy and μm to (pure polyamide)and (polyamide +CuO+Co_3o_4)*

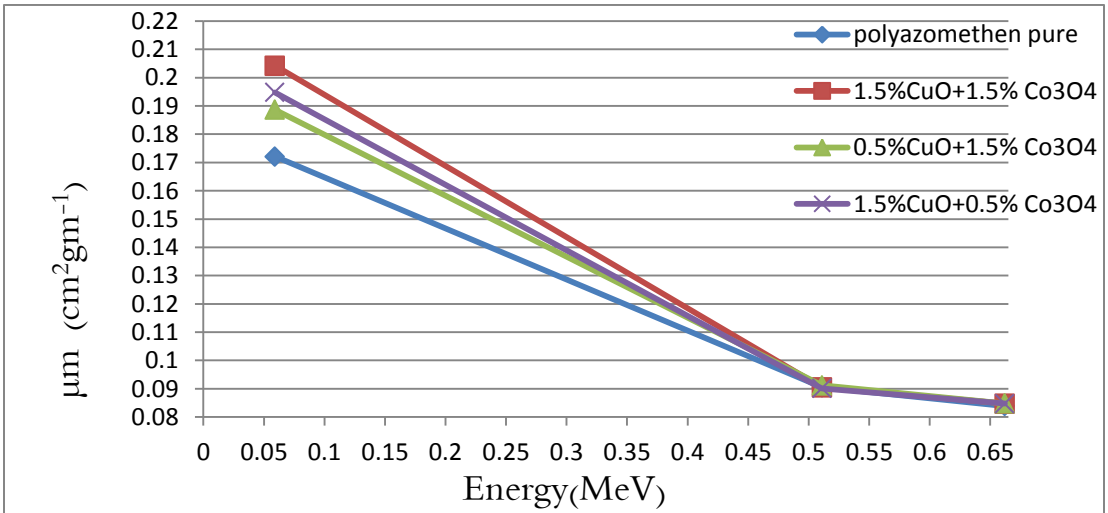

Figure (11) *the relationship between gamma ray energy and μm to (pure polyazomythen)and (polyazomythen +CuO+Co_3O_4)*

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