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The Mass Attenuation Coefficients of synthesized Nano structural composite $Zn_{1-x}(Y_x\ Ni_{0.06})O$ material

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Abstract: *The total mass attenuation coefficients of the synthesized Nano structural composite general formula are $Zn_{1-x}(Y_x\ Ni_{0.06})O$ were used with the variation of composition percentage is X=0.01, 0.03, 0.05, 0.07, 0.09. These samples are extracted gamma-ray scintillation process at the energies 30.85 KeV, 42 KeV, 59.54 KeV, 512 KeV, and 661.6 KeV. The obtained data from the detector were calculated with the help of slandered formulas and methods. The resultant information has been compared with the theoretical values of XCOM. It was observed that well matched together.*

Key Words: *Citrate gel auto curbstone method, mass attenuations, Nano composites, XCOM.*

1. INTRODUCTION:

Recent Years, the study of photon-atom interaction in alloys and compositions has gained more importance, it is just because of the extensive use of the photon interactions with matter. The common advantages [1, 2] of mass attenuation coefficients are in the fields like agriculture, medical, biological, and industrial. Also, the study of the total photon interactions with the matter has tremendous space applications, which are radiation shields, and as protectors etc.

In the early 19th century, the most important changes happen in the field of nuclear and radiation physics. The scientist Hubbell has done a lot of experiments to find mass attenuation coefficients and the mass energy absorption coefficient, and Hubbell published an article in 1982 with the details of the mass attenuation coefficients and the mass energy absorption coefficients of 40 elements and 45 mixtures at the energy from 1KeV to 20MeV. Later Hubbell and Seltzer were tabulated for all elements from z=1 to 92 [3]. A Computer program which is called XCOM has developed by Berger and Hubbell together to calculate the photon interactions of all pure elements and compositions and they tabulated theoretical values [4, 5] for photon energies from 1KeV to 100 GeV.

In the present work, we have measured mass attenuation coefficients of zinc, nickel, yttrium composition samples at the five different photon energies such as 30.85 KeV, 42 KeV, 59.54 KeV, 512 KeV, and 661.6 KeV. These photon energies are produced by using different types of radioactive isotopes as sources. Obtained data were calculated and tabulated. Graphs are drowned for the obtained experimental data and theoretical data of the XCOM program [6-9]. The results of comparing theoretical values and experimental values are agreed with each other.

2. EXPERIMENTAL METHODS:

a) Preparation of samples:

We employed a citrate gel auto combustion method to synthesize samples which we need to extract experiment [10-14]. High purity zinc, nickel, yttrium are used at different mixing percentages. The general formula is $Zn_{1-x}(Ni_{0.06}Y_x)O$ and the varying with x=0.01,0.03,0.05,0.07,0.09 percentage. Initially, preparation of samples are stats with required calculations and according to the calculation, we weight the chemicals individually and mixed together with, the minimum quantity of double distilled water like a solution. The prepared solution will be stirred continuously by placing it on a magnetic stirrer with a hot plate. By adding ammonia the pH of the solution was maintained at 7. After confirmed that all salts well mixed together then the temperature was increased to 100 degree Celsius. Because of the continuous temperature, the solution will reduce to one-third of the initial volume, it indicates the gel formation. When the solution was formed gel then the temperature was increased to 180 degree Celsius. Then the gel has burnt and undergone to combustion in a self-propagation manner resulting in the formation of powder. The resulting powder was ground to the nano in size and sintered at 500 degree Celsius for four hours in a muffle furnace. Latter the sample powder was taken and pressed as required pellet with the help of hydraulic pellet press.

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b) Transmission experiment:

Transmission experiments using a good geometry setup in conjunction with a PC based multi-channel analyzer (MCA) was conducted in this laboratory [15-22]. When a beam of X-rays or gamma rays passes through a thin slab of matter, the intensity decreases exponentially, this is said to be the basic property of electromagnetic radiation. It is observed that, when a homogeneous beam of gamma radiation passes through an absorber, the intensity of the beam is attenuated in such a fashion that the change in intensity is proportional to the thickness of the absorber and is given as

$$\Delta I = -\mu I_0 \Delta t \qquad \text{-----------(1)}$$

Where ΔI = charge in intensity,
I = Incident intensity,
Δt = Thickness of the absorber
μ = Proportionality constant usually referred to as the attenuation constant of the absorbing material.

μ is a measure of the probability for removal of a photon from the incident beam, of each unit of the distance traversed in the material. The integration of eq.1 yields.

$$I = I_0 \exp(-\mu t) \qquad \text{-----------(2)}$$

Where I_o is the primary intensity of the incident beam of gamma rays and I is the attenuated intensity after passing through a thickness t of the absorber, μ is called the linear attenuation coefficient if it is measured in units of length^{-1} and is given by

$$\mu = \frac{\ln(I/I_0)}{t} \qquad \text{----------(3)}$$

The attenuation coefficient can also be expressed as mass attenuation coefficient $\mu_m=\mu/\rho$ (length^2/mass) and also as total atomic cross sections (σ_{tot}) given by

$$\sigma_{tot} = \frac{\mu}{\rho} \times \frac{A}{N_0} \qquad \text{----------(4)}$$

Where N_0 and A are Avogadro's number and atomic weight of the absorber respectively and A is expressed in length^2/atom and the units σ_{tot} are barns/atom.

In this transmission experiment, we have used five gamma sources were used in the present work so that the above parameters were studied at five different energies. The radioactive isotope sources are Barium (^{133}Ba), Cesium (^{137}Cs), Europium ($^{152+154}$Eu), Cerium (^{141}Ce) and Americium (^{241}Am) were used in the present study. Two types of sources were used in the present investigation. Sources in the form of radiographic capsule each of strength approximately 1mCi to 30mCi were used as a source of gamma energies. For X-energies the sources were prepared by drop deposition and evaporation of a liquid source of a high specific activity. In the method, a small cylindrical grove drilled in Perspex container. The source is covered on the top with a thin Mylar foil to avoid contamination.

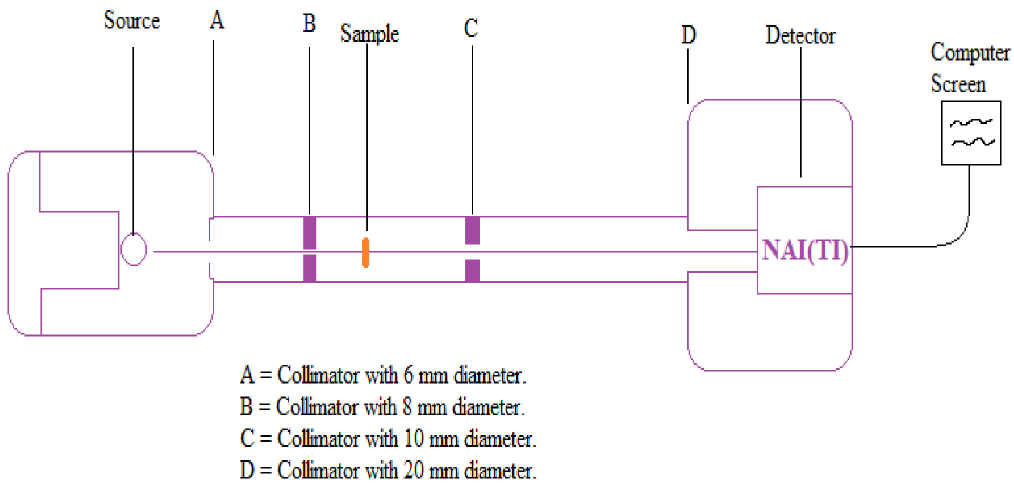

Figure 1: Geometry setup of Gamma ray scintillation process.

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3. RESULT AND DISCUSSION:

The mass attenuation coefficients were obtained by doing a photon beam interaction experiment in the good geometry setup shown in figure1. The samples **$Zn_{0.93}(Ni_{0.06}Y_{0.01})O$,$Zn_{0.91}Ni_{0.06}$ $Y_{0.03})O$, $Zn_{0.89}(Ni_{0.06}$ $Y_{0.05})O$, $Zn_{0.87}(Ni_{0.06}$ $Y_{0.07})O$, $Zn_{0.85}(Ni_{0.06}$ $Y_{0.09})O$** were extracted in the narrow beam scintillation process and the resulting data obtained by the good shield NaI(TI) detector.

Obtained data were calculated by using standard procedure and compared with theoretical data which is from the XCOM program. The experimental resulting data and theoretical data were tabulated and its graphs were drowned.

Table1: Mass Attenuation Coefficients of synthesized Nano Material $Zn_{0.93}(Ni_{0.06}Y_{0.01})O$.

S.No	Energy in KeV	Mass Attenuation Coefficients in (gm/cm^2) X 10^2	
		Theoretical Values from XCOM	Practical Values
1	30.85	576.4	575.6
2	42	247.4	246.7
3	59.54	99.55	98.87
4	512	8.503	8.486
5	661.6	7.533	7.496

Graph 1: Graph for the sample of $Zn_{0.93}(Ni_{0.06}Y_{0.01})O$.

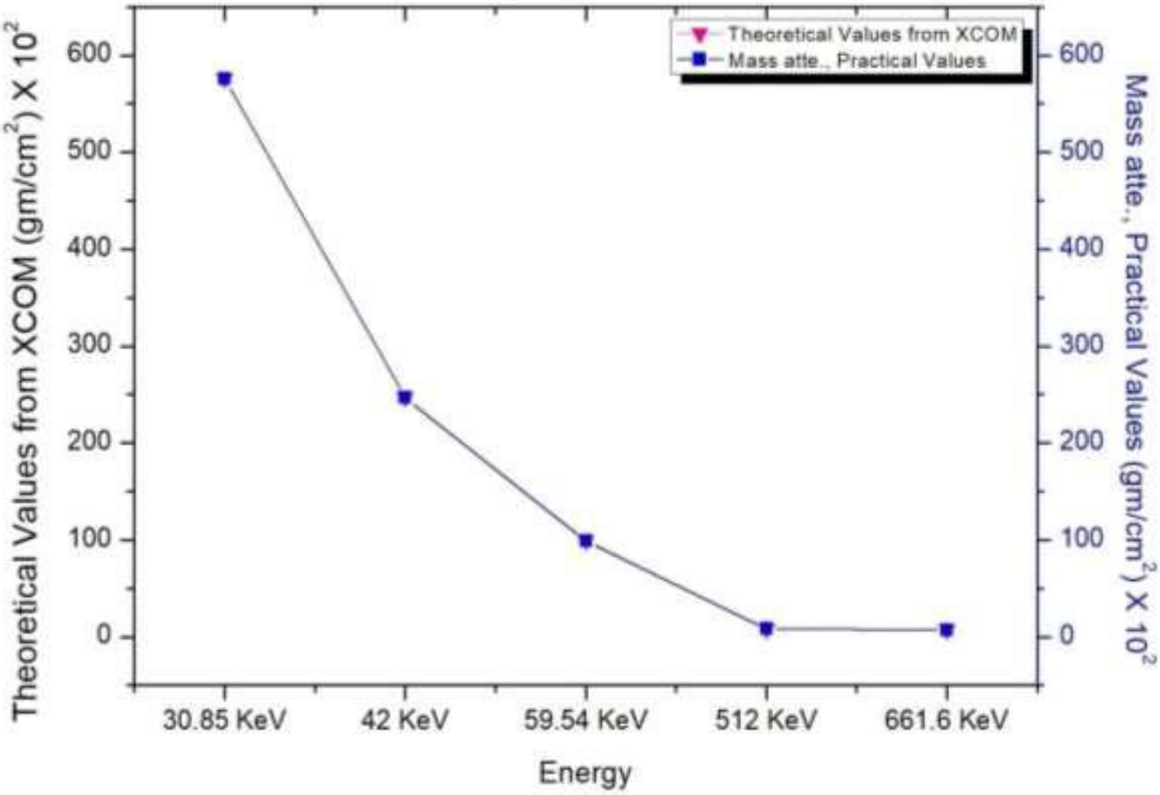


Table2: Mass Attenuation Coefficients of synthesized Nano Material $Zn_{0.91}Ni_{0.06}$ $Y_{0.03})O$.

S.No	Energy in KeV	Mass Attenuation Coefficients in (gm/cm^2) X 10^2	
		Theoretical Values from XCOM	Practical Values
1	30.85	586.8	585.4
2	42	252.0	249.7
3	59.54	101.3	100.9
4	512	8.504	8.486
5	661.6	7.532	7.412

Graph 2: Graph for the sample of $Zn_{0.91}Ni_{0.06}\ Y_{0.03})O$.

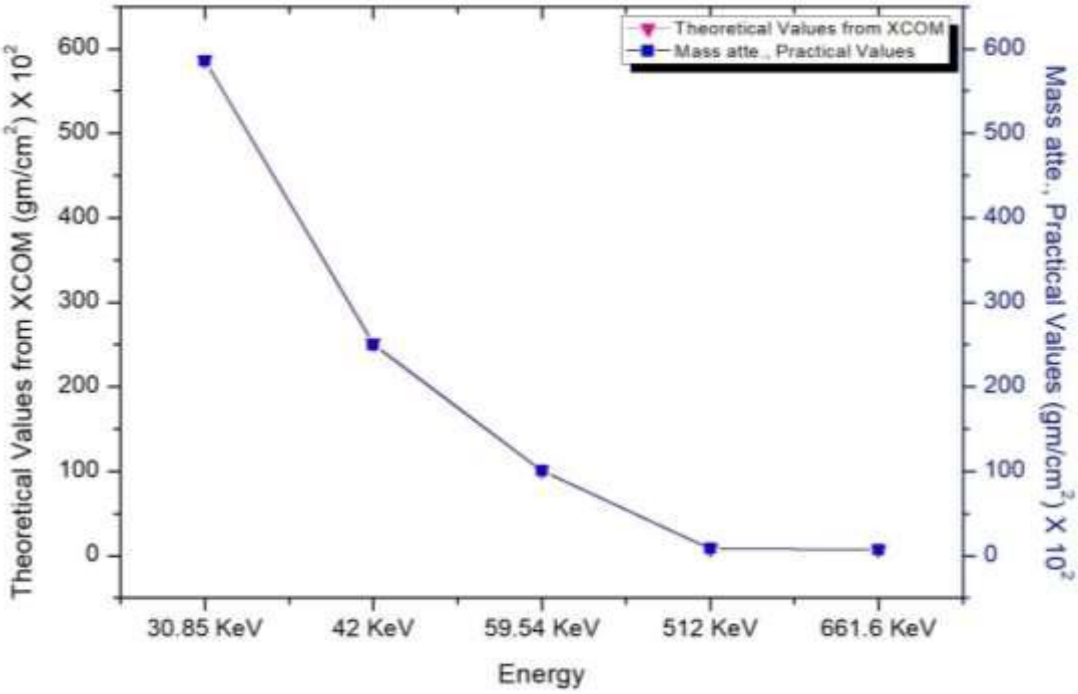


Table3: Mass Attenuation Coefficients of synthesized Nano Material$Zn_{0.89}(Ni_{0.06}\ Y_{0.05})O$.

S.No	Energy in KeV	Mass Attenuation Coefficients in (gm/cm^2) X 10^2	
		Theoretical Values from XCOM	Practical Values
1	30.85	597.3	596.5
2	42	256.6	254.4
3	59.54	103.1	102.7
4	512	8.505	8.501
5	661.6	7.532	7.416

Graph 3: Graph for the sample of $Zn_{0.89}(Ni_{0.06}Y_{0.05})O$.

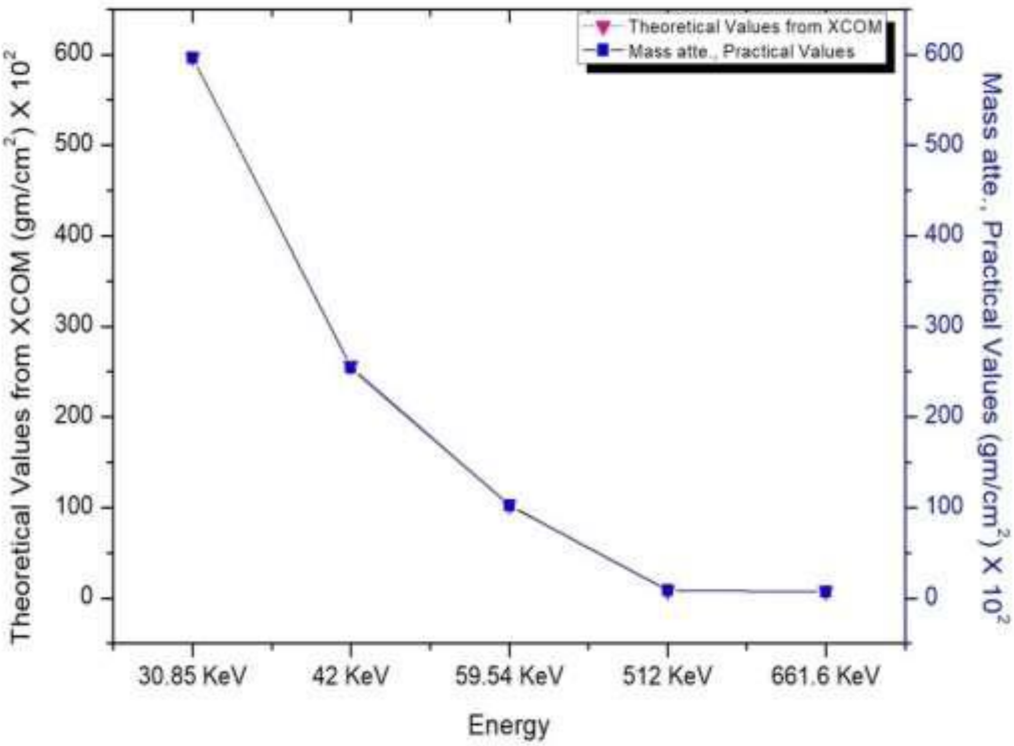


Table. 4: Mass Attenuation Coefficients of synthesized Nano Material $Zn_{0.87}(Ni_{0.06}\ Y_{0.07})O$.

S.No	Energy in KeV	Mass Attenuation Coefficients in (gm/cm^2) X 10^2	
		Theoretical Values from XCOM	Practical Values
1	30.85	607.7	603.9
2	42	261.2	256.4
3	59.54	104.9	103.4
4	512	8.507	8.497
5	661.6	7.532	7.501

Graph 4: Graph for the sample of $Zn_{0.87}(Ni_{0.06}Y_{0.07})O$.

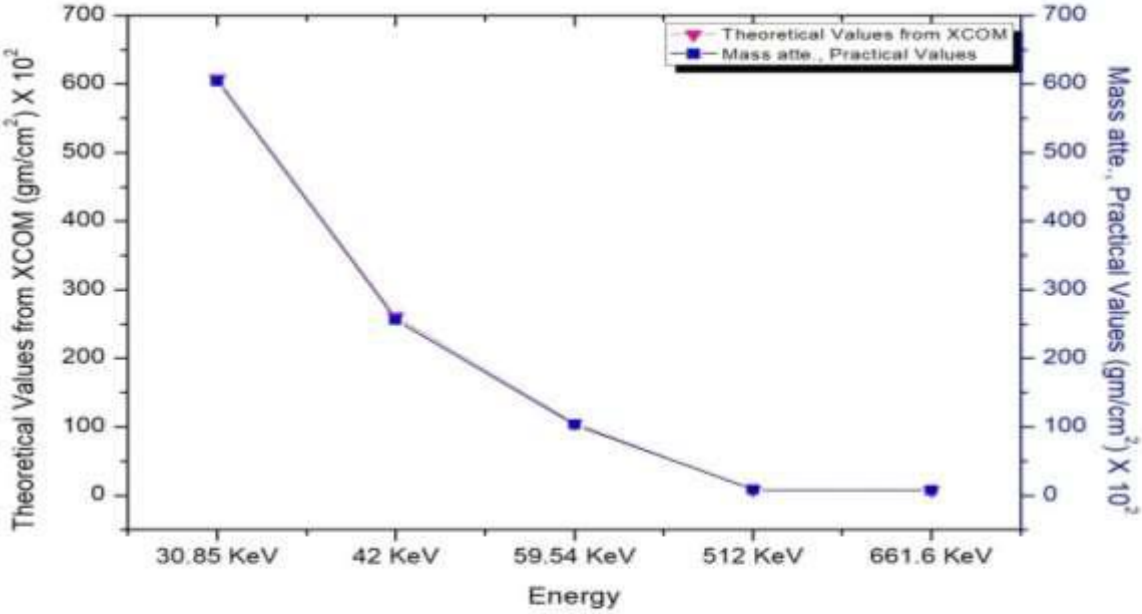
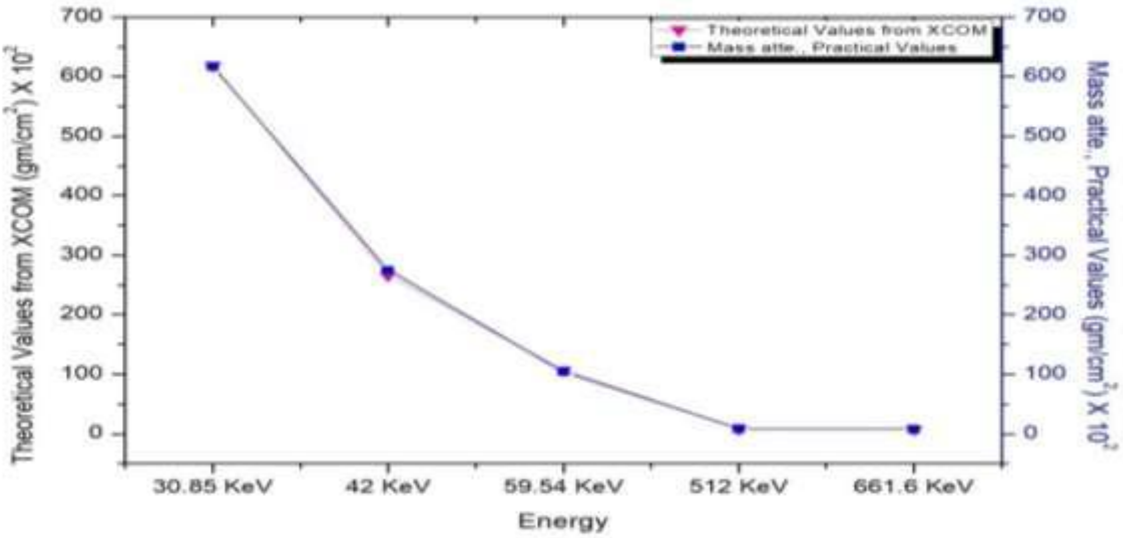


Table. 5: Mass Attenuation Coefficients of synthesized Nano Material $Zn_{0.85}(Ni_{0.06}\ Y_{0.09})O$.

S.No	Energy in KeV	Mass Attenuation Coefficients in (gm/cm^2) X 10^2	
		Theoretical Values from XCOM	Practical Values
1	30.85	618.2	616.7
2	42	265.9	274.7
3	59.54	106.6	104.4
4	512	8.508	8.496
5	661.6	7.531	7.476

Graph 5: Graph for the sample of $Zn_{0.85}(Ni_{0.06}Y_{0.09})O$.



4. CONCLUSION:

Shielding properties against gamma radiation of five different composite alloys were studied. The properties of composite material **(**$Zn_{0.93}(Ni_{0.06}Y_{0.01})O$, $Zn_{0.91}Ni_{0.06}$ $Y_{0.03})O$, $Zn_{0.89}(Ni_{0.06}$ $Y_{0.05})O$, $Zn_{0.87}(Ni_{0.06}$ $Y_{0.07})O$, $Zn_{0.85}(Ni_{0.06}$ $Y_{0.09})O$ **)** are extracted at the energies of 30.85, 42, 59.54, 512 and 661.6 KeV. The results of gamma radiation study were drown graphs and compared with theoretical values were obtained from XCOM program. As a result, the obtained experimental values and theoretical values are matched each other with difference of ±0.05%. Therefore the calculated and the experimental results are in agreement with each other.

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