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HALF AND TENTH VALUE LAYER OF SOME SHAPE MEMORY ALLOYS IN THE ENERGY RANGE 122 KEV TO 1330 KEV

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Abstract-In this paper, we have been calculated linear attenuation coefficient (μ), half value layer (HVL), tenth value layer (TVL) and mean free path (λ) of two shape memory alloys in the energy range 122 keV to 1330 keV. From the present study, it is observed that the variation of obtained values of all parameters strongly depends on the photon energy; it decreases or increases due to chemical composition and density of the sample. These samples have been studied extensively using WinXCOM program and transmission curves have been plotted with photon energy. The results of this present study can be useful in cable sheathing, ammunition, lead wire, pigments, automatic sprinkler and other technological applications.

Keywords: Half value layer and tenth value layer

1. INTRODUCTION

During the last decade smart materials and structures have received increasing attention because due to their enormous technological and scientific consequence. Shape Memory Alloy's (SMA's) are the most important branch from the smart / intelligence materials (Satish et al., 2013). SMA's are basically functional materials which exhibit peculiar thermo mechanical properties such as shape memory effect and the super elasticity. These properties are significant as a reversible thermo elastic martensitic transformation occurring at the solid state. The martensite phase shows that the strong amplitude- dependent internal friction, when SMA is used as actuater, it can be classified into "Smart Materials" because which can be combines both actuators and sensor functions. SMA alloys are most commonly used in commercial fields such as biomedical (i.e. stents, surgical tools); sensor/actuator (valves); coupling (i.e. electric fastener, pipe fastener); sport, antennas, gadgets, manufactures etc. (Kumar and Logoudas, 2008).

The Knowledge of absorption, penetration, attenuation and photon interactions with matter is great significant. Wide use of photons interactions in many fields such as medical, industry, agriculture, nuclear technology and space research (Jackson and Hawkes, 1981). The study of absorption and scattering of gamma rays in the compound materials has become an interesting and exciting field of research (Manohara et al., 2007). Linear attenuation coefficients, half value layer, tenth value layer and mean free path are basic parameters for penetration and diffusion of x-ray or gamma ray in extended media. These parameters are valuable in many diverse fields such as radiation protection, nuclear diagnostics, nuclear medicine, and radiation dosimetry. The exact values of the mass attenuation coefficient are widely used in research for solving different problems in radiation physics and radiation chemistry (Kaewkhao et al., 2008).

few authors were represented the table in the form of tabulation for all elements and developed new computer program i.e. WinXCOM program (Hubbell, 1982, Hubbell and Seltzer, 1995, Berger and Hubbell, 1987, Gerward et al., 2004). Numbers of research papers are available in various energy ranges on theoretical and experimental investigations to determine (μ_m) values in various elements and compounds/mixtures. Many investigators have been carried out the linear attenuations coefficient and other related parameters with high energy photons such as minerals, alloys, amino acids, lipids and dosimetric materials etc. (Manohara & Hanagodimath, 2008, Pawar & Bichile, 2013, Ladhaf & Pawar, 2015, Gaikwad et al., 2016Han et al., 2009, El-Kateb, 2000, Murthy, 2004, Awasarmol et al., 2017a, 2017b, 2017c, and 2017d).

In literature, we observed that no theoretical data is available on the study of shape memory alloys. The main aim of the present study, we have calculated the linear attenuation coefficients and other related parameter in the energy region 122 keV to 1330 keV by using Win XCOM program.

2. CALCULATION METHOD

2.1 Calculation of linear attenuation coefficient (μ)

The linear attenuation coefficients for the compound materials and energies are determined by the following equation:

$$I = I_0 e^{-\mu t}$$

as
$$\mu = \frac{1}{t}\ln(Io/I) \qquad 2.1$$

where I_0 and I are the unattenuated and attenuated photon intensities, μ (cm^{-1}) is linear attenuation coefficient of the materials and t (g/cm^2) is the sample thickness.

2.2 Calculation of HVL and TVL

Half Value Layer (HVL) is the thickness of the shield at which the initial radiation intensity is reduced by one half and it is related to μ; is calculated by the following equation:

$$HVL = \frac{0.693}{\mu} \qquad 2.2$$

where μ (cm^{-1}) is the linear attenuation coefficient of the material.

Similarly, Tenth Value Layer (TVL) is defined as the thickness of shield required for attenuating a radiation beam to 10% of its radiation level and is calculated by,

$$TVL = \frac{\ln 10}{\mu} = \frac{2.3026}{\mu} \qquad 2.3$$

2.3 Calculation of mean free path (λ)

The average distance between two successive interactions is called mean free path or relaxation length and is determined by,

$$\lambda = \frac{\int_0^\infty x\exp(-\mu x)dx}{\int_0^\infty \exp(-\mu x)dx} = \frac{1}{\mu} \qquad 2.4$$

where μ is the linear attenuation coefficient and x is the absorber thickness.

3. RESULTS AND DISCUSSION

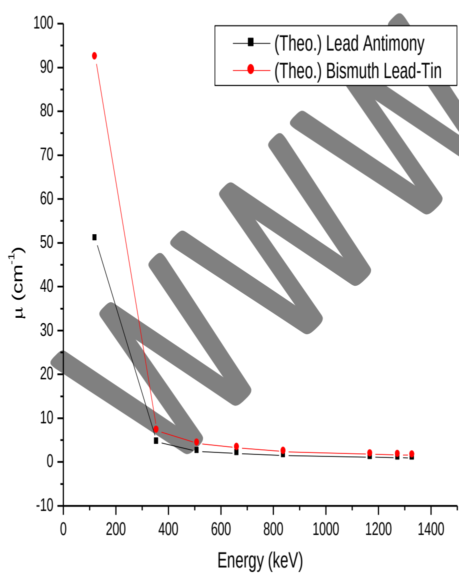

Fig. 3.1 The Typical Plots of μ versus E for Shape for Shape Memory Alloys

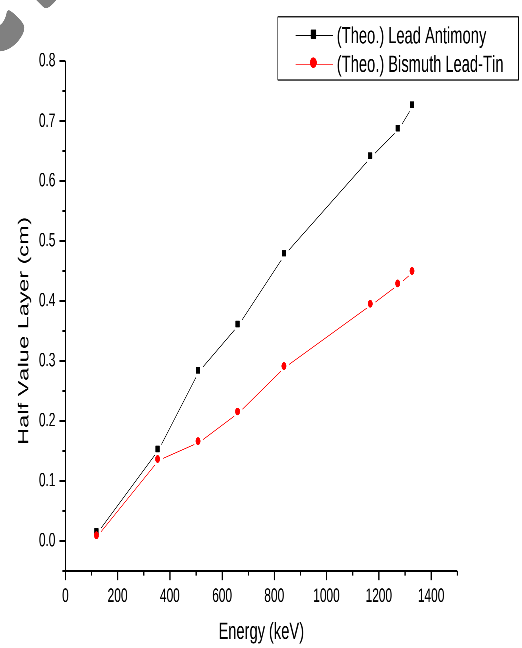

Fig. 3.2 The Typical Plots of HVL versus E Memory Alloys

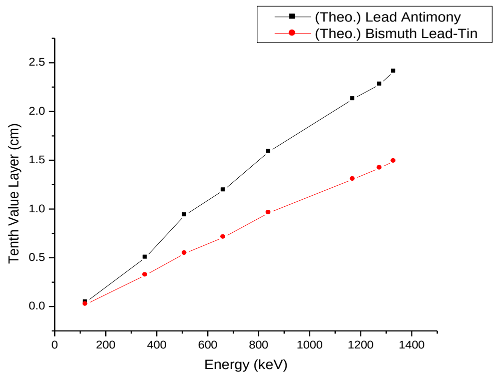

Fig.3.3 The Typical Plots of TVL versus E for for Shape Memory Alloys

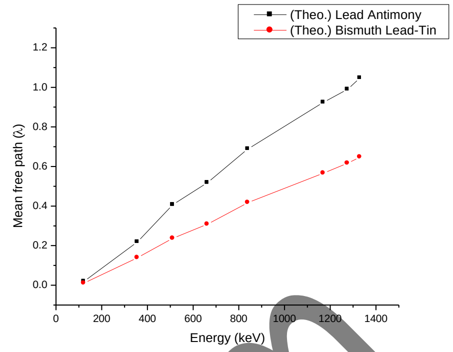

Fig. 3.4 The Typical plots of λ versus E Shape Memory Alloys

In the present study, the theoretically calculated attenuation cross sections parameters of two shape memory alloys were measured at 122 keV - 1330 keV photon energies and are shown in Tables 1, 2, 3 and 4. The μ values of two samples were calculated theoretically listed in Table 1 at given photon energies and variation with energy (E) is displayed in Fig. 1. It is observed that the μ values depends on photon energy (E) and decreases with increasing photon energy. The calculated half value layer, tenth value layer and mean free path were studied for two samples in the present case and its variation with photon energy (E) is displayed in Figs. 2, 3 and 4 and the values are tabulated in Tables 2, 3 and 4 respectively. From Figs. 2, 3 and 4, it is clearly seen that the behavior of HVL, TVL and λ with photon energy are increases with increasing photon energy. The variation of the all attenuation parameters were systematically studied in the given photon energy region. All these parameters were calculated by using WinXCOM program.

CONCLUSION

Linear attenuation coefficients, half value layer, tenth value layer and mean free path of two shape memory alloys has been calculated at 122 keV-1330 keV photon energy. These two samples have been calculated extensively using WinXCOM program. In this research Lead antimony and bismuth lead-tin were investigated to get sufficient information about μ, HVL, TVL and λ of shape memory alloys and it has been observed that the present samples can be used in ammunition, lead wire, pigments, automatic sprinkler and other technological applications. In present paper, was reported first time investigation on μ, HVL, TVL and λ parameters of shape memory alloys at different photon energy.

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