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# X-RAY TRANSMISSION THROUGH NANOSTRUCTURED AND MICROSTRUCTURED TIN OXIDE MATERIALS

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**Abstract**

In this study, the x-rays pass through the micro and Nano-metallic materials have been compared. To do this, two powder Nano tin dioxide $SnO_2$ with an aggregate of less than 50 nm and micro tin dioxide with grain size less than 63 microns were incorporated separately in different concentrations of 90%, 80%, 60%, 40% and 20% in a matter of grace. The results showed that the X-ray transient voltages 100, 80 and 60 kVp was almost equal to the structures containing Nano and micron tin and we can ignore the effects of Nano-sized particles in the high voltage. Although the low voltage 40KVp nanostructured tin could be better than the microstructure and weakening, appropriate. This could be due to the higher number of nanoparticles per unit of surface Nano-structures and Nano-particle size effect. Nano-structures are of course still need further assessment for radiation protection purposes.

**Keywords:** X-ray, Photon attenuation, Tin Nano-particles, Tin Micro-particles

## Introduction

Nanoscience is the study of the basic principles of molecules and structures with dimensions between 1 and 100 nanometers and nanotechnology is the most modern technological world and by having special characteristics is proposed to be used in all fields of science and technology (1, 2). Nano scale particles that contain many atoms, forming Nano materials. Conventional materials have particle sizes between 10 microns to 1 mm or more (3,4). Nano materials due to their small size, can be a physical or chemical properties than the same materials in the micron scale (5,6). The most important feature of these materials is that they are caused by different properties, a high surface to volume ratio (7). X-radiation (composed of X-rays) is a form of electromagnetic radiation. Most X-rays have a wavelength ranging from

0.01 to 10 nanometers, corresponding to frequencies in the range 30 petahertz to 30 exahertz ($3\times10^{16}$ Hz to $3\times10^{19}$ Hz) and energies in the range 100 eV to 100 keV. X-rays is very dangerous to humans and can create substantial environmental damage. The man's damage included burns, diseases and genetic effects are caused by receiving too much radiation (8, 9). Some experts believe that the effect of x-ray particles, increases power to the weakening of the X-ray micro-particles (10, 11). According to studies, it appears that Nano scale particles can cause greater protection against ionizing radiation (12). Including, Botelho et al study in 2011 showed that copper oxide nanoparticles at low energies (kVp 26-30) proved more powerful than Micro-particles, but did not find a significant difference at high energies (kVp 60-102) (7). Also Kunzel et al, in 2012, obtained similar results. Results of their study showed that X-ray absorption at low voltage (25  to 30 kVp), for the same concentration of polymer matrix on the Nano-structure of copper oxide was higher than the micro-structure (13). Noor azman et al study in 2013 showed that Nano tungsten trioxide are more potent in attenuation of X-rays generated at low voltage (25-35 kVp) compared to micro size, with the same values, but the effect of particle size on X-rays are negligible at higher voltages (40-120 kVp) (14). Now, lead is used extensively in radiation protection department of radiology, due to its high atomic number and density significantly (15). However, another issue that is causing concern, the toxicity of lead. The issue of lead poisoning should be noted that this is a global issue. Lead will be known as toxic substances that cause environmental pollution (16, 17).

Previous studies have also shown signs of lead poisoning in the radiology department personnel (18). Recently, according to lead to significant toxicity to human and environmental effects of the metal, has raised the necessity of protection lead transitioning to non-lead exposed by many scientists. Therefore it is extremely important to design and build a light-shielded lead-free and suitable for photon attenuation and research continues on the replacement of lead shielding with lead-free panel (19-20). Recent articles suggest the use of nanostructures and nanoparticles in different matrices such as polymers and dyes, to protect the X-rays and gamma rays (10-12, 21). Characteristics of nanoparticles that was attractive to scientists in making radiation protection, especially in the design of non-lead operon, is lightweight materials and a higher number of particles per gram of adsorbent (16). Even if this material, the better to weaken the X-rays compared to conventional materials, nanostructured materials requires further evaluation for radiation protection purposes (7). Therefore, in this study, we assessed and compared the amount of X-rays used in diagnostic radiology with different voltages, the micro-and Nano-structured metal tin, grease matrix.

**Materials and methods**

This is an experimental intervention study was carried out on a metal tin that has a high atomic number and a proper k-edge absorption energy ranging from diagnostic radiology and have well X-ray attenuation at voltage 70 Kvp. Tin is found mainly in the mineral Kasytryt tin or tin oxide. Tin alloys have many applications. The alloys used for soldering tin, metal printing, fusible metal, pewter alloy pewter, metal bearings, white metal, die casting alloy, phosphor bronze. Studies have also shown that tin can be considered a substitute for lead in x-ray protection (19). Therefore for this study were selected from two tin dioxide Nano powder with a grain size smaller than 50 nm and micro purity. A pilgrim 99% tin dioxide $SnO_2$ grain size smaller than 63 microns, with 99.9% purity. Initially, samples of different metal nanoparticles, were prepared with different percentages of Nano-tin and samples of micro metal were prepared with different percentages of micro tin with grease matrix. Chemical analysis showed that by using a 2004 Perkin-Elmer CNH grease used is hydrogen-containing% 0.03±83.17,% 0.01 ± 14.06% 0.01±0.90 carbon and nitrogen. To create a composite Grace - metal, after weighing tin metal powders and grease, grace and metal powders obtained by stirring until well mixed and a stiff dough consistency. To equalize the thickness of the samples, we used a template, which was thick 2mm with 3 × 3cm dimensions.

The obtained paste was poured in the wax template was fixed on a slide. Samples were made with the following characteristics: total weight of each sample was 5 g, thickness 2mm and a weight of grace and metals are also considered to be variable. Ratios used in the manufacture of the samples listed in Table 1. Created samples were tested for photon attenuation by device type Barracuda dosimeter RTI version 1.4 build models BC1-11030020 Sweden (Figure 1) and in terms of radiation-voltage 40, 60, 80, 100 kVp, irradiation time 0.5ms and intensity 400mA, the distance of the light source (focal spot x-ray tube anode) layer to layer attenuator and attenuator distance to the ionization chamber 33cm. The kVp produced at each voltage was calibrated by the kVp meter RTI. Exposure to different layers was determined by X-ray photon intensity passing through the layer by ionization chamber with three repetitions of the experiment. At each voltage, the layer at the specified distance relative to the X-ray tube and dosimeter, and the radiation dose was measured without absorber layer ($I_\circ$), and then recorded the transit dose (I) of the layer. Piles of layers, were compared on the basis of attenuation of each layer. In order to analyze the results of the dosimetry examples above, we used the software SPSS19.

**Results and Discussion**

Figure 2 and 3 show the results of photon attenuation test, a sample of Nano-structured Grace-Tin, and micro-structure of Grace-Tin, with a different percentage of metal tin (90%, 80%, 60%, 40% and 20% ) at various voltages (100, 80, 60 and 40 kVp), the test is repeated three times on each instance of any of Nano and micron tin. The results are shown in Figure 2 and 3, the percentage of radiation attenuation increases with an increase of tin in samples of Nano and micron-tin, with thickness of 2 mm, in the voltage applied of 40 to 100 kVp. Conversely, a reduced percentage of x-ray attenuation by increasing the applied voltage on each of the samples As a result, different samples with different percentages of tin nanostructures are significantly different from each other, in terms of x-ray attenuation ($p< 0.05$). It also was a significant difference in micro-samples of tin ($p< 0.05$). The highest percentage of attenuation in samples of Nano is 100% in 40 kVp voltage, the 60 kVp voltage with %99.96, the 80kVp voltage with %99.47 and the 100kVp voltage with %98.68 due to the 90% Nano tin, and the highest percentage of attenuation in samples of Micron, the voltage 40 kVp with %96.99, the voltage 60 kVp with %99.95, the voltage 80 kVp with %99.68 and the voltage 100 kVp with %98.60 relating to sample with %90 micro tin dioxide. As a result, the highest percentage of all the voltages on the attenuation of radiation to the sample containing the highest percentage of tin, which is 90% tin. These results suggest that a high percentage of tin in the sample, the number of particles per unit area is higher than samples with lower percentages of tin, and more likely to be struck by the photoelectric absorption of tin. These results also show that tin has a proper k-edge absorption, provides good protection against x-rays. Attenuation rate increases in k-edge absorption. Numerous studies have shown the X-ray attenuation increases with the percentage of material per unit area of the sample and the effect of particle size (7). The study Botelho et al in 2011 that compared the ray passes from nanostructured materials and micro-structure of CuO. Their results showed that X-rays were almost identical at voltages 102 and 60kVp. But for voltages 30 and 26 kVp, nanostructured CuO, was weakened to X-rays, up to 14% greater than the micro-structure of CuO. Also, with the percentage of copper per unit area of the CuO samples increased attenuation of x-rays. Figure 4 shows a comparison of two different groups of tin dioxide Nano and micro X-ray attenuation at different voltages in terms of percentage. This graph suggests that there is no significant difference between the two groups on tin dioxide Nano and micro x-ray attenuation at voltages 40 to 100 kVp ($p< 0.05$). The percentage attenuation of radiation in micro samples of tin dioxide and tin dioxide nanoparticles was approximately equal to 1 at all voltages used in diagnostic radiology (60 to 100 kVp).

As a result, we can ignore the effect of particle size on radiological voltage for tin. This is because the low energy X-rays, the photoelectric effect is a phenomenon of photon attenuation. The photoelectric effect is likely directly related to the cube of the atomic number and inversely with the cube of the photon energy. So the probability that an x-ray photons interact with matter have low voltage and absorbed by the material, the more energy is high. In addition, when the photon energy increases, the Compton Effect is likely to increase. Because this is directly related to the density of the material and inversely with the photon energy, and a small amount associated with the atomic number, Thereby decreasing the likelihood of interaction and absorption of photons produced in the tube high voltage, such as voltages used in diagnostic radiology and the absorption rate is the same in both Nano and micro size material. In general, the presence of tin oxide on the surface area of the grease composition - tin, caused attenuation of x-ray absorption k edges suitable. Other results show that Nano sized tin oxide voltage 40 kVp, has created a greater attenuation of the micro-sized tin oxide (Figure 4). The wavelength of X-rays is in the range of nanometers voltage 40kVp, resulting in materials with nanometer dimensions have better absorption of X-rays at lower voltages. In addition to Nano particle size, the main causes of the weakening of nanostructured tin oxide higher than the micro-structure of the voltage is the increase in the number of nanoparticles per unit area. The effect of particle size on the intensity of X-rays through the sample material has been mentioned by several authors in the literature (7, 13 and 14). Kunzel and colleagues conducted a study in 2012 to examine the structure and micro-structure of copper oxide CuO nanoparticles at concentrations of 5 and 30 percent from the resin and voltages 100, 45 and 25 kVp. Their results showed that at lower voltages than 40 kVp Nano-sized copper oxide has a better absorption of micro size. However, at high voltages (45 to 100 kVp) ability to absorb copper oxide Nano-size and micro size were not significantly different.

**Table-1: Used ratios in construction of composite sample of grace and Nano-Tin powder and Micro-Tin powder**

| Group | Sample | Total weight of each sample | Sample of code | Tin/Grace (%) | Tin/Grace (gr) |
|---|---|---|---|---|---|
| Nano Tin or micro Tin | 5 Nano-sample and 5micro-sample | 5 gr | 1 | 90/10 | 4.5/0.5 |
| | | | 2 | 80/20 | 4/1 |
| | | | 3 | 60/40 | 3/2 |
| | | | 4 | 40/60 | 2/3 |
| | | | 5 | 20/80 | 1/4 |

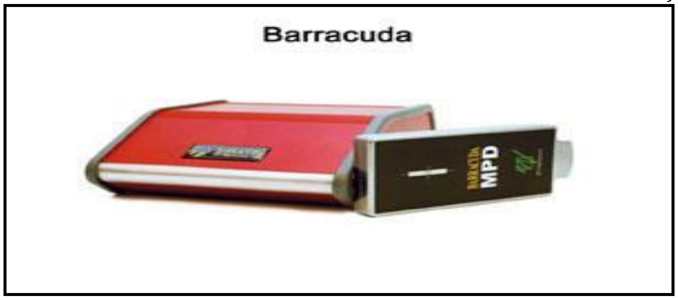


**Figure-1. Dosimeter, model Barracuda, Ver.1.4, accuracy 0.001 mGy**

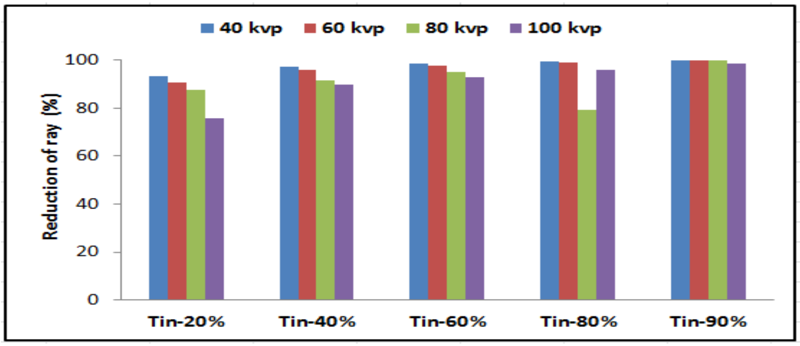


**Figure-2. The mean percentage of X-ray attenuation by different Nano size combinations of tin dioxide in voltages 100, 80, 60 and 40 kVp.**

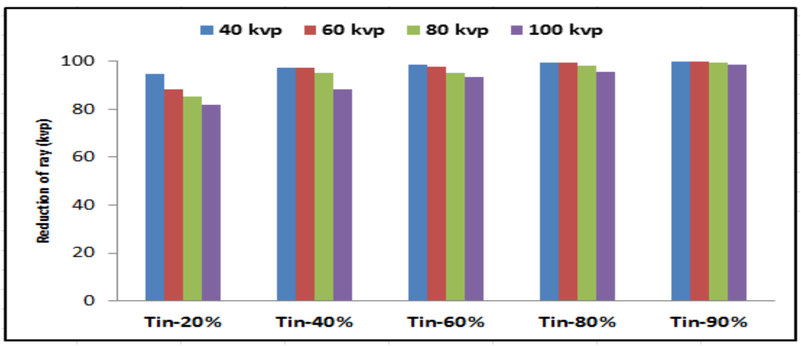


**Figure-3. The mean percentage of X-ray attenuation by different Micro size combinations of tin dioxide in voltages 100, 80, 60 and 40 kVp.**

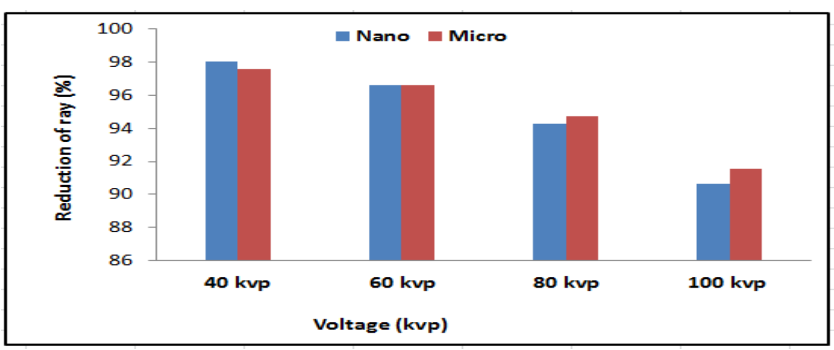


**Figure-4. The mean percentage of X-ray attenuation by different Nano and Micro size combinations of tin dioxide in voltages 100, 80, 60 and 40 kVp.**

**Conclusion**

The study was conducted to compare the X-ray attenuation by Nano structures and microstructures. X-rays were measured through energy 100, 80, 60, and 40 kVp. The results showed that, in different samples of Nano and Micro radiation absorption by increasing the tin content of each sample, the average percentage rises in various voltages. In addition, samples containing 90% Nano-tin and 90% micron tin of all samples had higher average absorption. As well as in samples with different concentrations of tin, with an increase in voltage, reduced the average absorption of X-rays. Nano and micro samples had the highest average absorption in voltage 40kVp and in absorb x-rays, nanostructured tin oxide performed better than microstructure. The various voltages (60-100 kVp) Nano and micron tin samples were not significantly different from the average absorption rate so we can ignore the role of particle size in the X-ray absorption in the high voltages. These results suggest that Nano-structured materials tin can effectively be used for radiation protection purposes so that attenuation of x-rays by these materials is almost equal and even at low voltage is greater than the micro-tin structure. In order to estimate this, we need to be compared to other Nano materials in X-ray absorption to find an answer to the question whether other Nano-structures also have the ability to weaken the X-ray or not.

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