Characterization of Nanomaterial from Medical Waste

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Abstract— Medical waste is all waste produced by hospital activities and other supporting activities in the form of a combination or mixture of water and pollutants carried by water, both in dissolved and suspended conditions that are wasted and at certain times mixed with ground water, water surface, or rainwater. Examples of medical liquid waste are from the kitchen, laundry, laboratories and seepage of septic tank tanks. Medical liquid waste can contain organic and inorganic materials which are generally measured from the parameters of BOD, COD, TSS, and heavy metals contained in medical liquid waste. Heavy metals in general are metals such as copper, selter in cadmium, mercury, lead, chromium, iron, silver and nickel. Other metals which also include heavy metals are arsenic, selenium, cobalt, manganese and aluminum. These metals in certain concentrations endanger humans. In this study, metal form of medical waste will be recovered to get useful content use plasma technology . SEM/EDS analysis show that medical waste contain silver material and material size show that the particle have a nano size analyzed use Schrerrer equation with particle size range 2.7 to 66 nm.

Index Terms— radiography waste, liquid waste, silver nanoparticle, plasma technology

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1 INTRODUCTION

The The hospital is a health service agency that has main activities in preventive, curative, rehabilitation and promotion services. These activities will generate positive and negative impacts on society and the environment. The positive impact of the hospital includes improving the health of the community, while the negative impacts include the waste produced by the hospital. One agency that produces a lot of waste is a hospital. The waste produced by the hospital is in the form of solid or liquid waste, ranging from less dangerous to dangerous ones. Waste from hospitals can be in the form of pathological waste (eg body tissues, blood and body organs),

radioactive waste, pharmaceutical waste and chemical waste. The waste can be categorized as

hazardous waste. While less hazardous waste, for example, is waste from the kitchen, paper, needles, glass and others. Thus it can be said that hospitals have different waste characteristics than household or industrial waste.[1]

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Hospital wastewater discharged into rivers or water bodies will have an impact on residents who use river water or water bodies for their daily needs. Therefore each hospital is required to have a liquid waste treatment unit (UPLC) with the final result of effluent that meets the specified standard quality standard. The stages of liquid waste treatment include: Preliminary Treatment, Primary Treatment, Secondary Treatment, and Final Treatment. The concept of plasma was first put forward by Langmuir and Tonks in 1928. They define plasma as a gas ionized in electric discharge, so plasma can also be defined as the kinetic mixture of electrons, radicals, positive and negative ions. Mixing between positively charged ions and negatively charged electrons has properties that are very different from gas in general and the material in this phase is called the plasma phase. So simply plasma is defined as ionized gas and is known as the fourth material phase after the solid, liquid, and gas phase.[2]

Nanoparticles are usually obtained by several chemical synthesis methods, such as reverse micelle method, microwave plasma synthesis, sol-gel technique, freeze drying, ultrasound irradiaton, hydrothermal method, laser pyrolysis

technique, coprecipitation method, and others[3]. The hospital's liquid waste contains several materials containing heavy metals in several work units in the hospital as inspection material or other supporting materials such as Silver and Bromium in the washing process of X Ray / Rontgen films, some reagents on clinical laboratory examinations and as ingredients dental fillings. The presence of heavy metal content in water bodies or food consumed by humans / animals does not directly cause harm to humans / animals, because some elements of heavy metals are needed by humans / animals for their life perfection such as copper, iron, cobalt, magnesium, manganese and zinc. In plants, including algae, copper (Cu) acts as a constituent of plastocyanins that function in electron transport in the process of photosynthesis. Zinc (Zn) is an essential element for living things, which functions to help the work of enzymes, besides zinc is also needed in the process of photosynthesis as an agent for the transfer of hydrogen and plays a role in protein formation. Zinc is not toxic to humans, but at high levels can cause taste in water. In this study the method to be used is the microwave plasma method. This method will use a 500 W microwave oven to generate plasma in hospital wastewater with different time variations. Analysis use EDS and Schrerrer formula as follows :

$$D = k\lambda / (B \cos\theta) \qquad (1)$$

Where,

D = mean of particle size

k = crystal dimension constants

λ = X-ray wavelength

B = 1/2 peak width on the diffractogram

Θ = diffraction angle

2 EXPERIMENTAL METHOD

This research took place in 4 (four) stages of implementation. The first stage is the making of reactors carried out in the area of the mechanical department of the Faculty of Engineering, Hasanuddin University. The second step is repairing X-ray waste samples. The second stage is the data collection carried out in the Plasma and Energy Conversion Application Laboratory majoring in Engineering, Faculty of Engineering, University of Hasanuddin. conducted at the Geology Department Sample Repair Laboratory, Hasanuddin University.
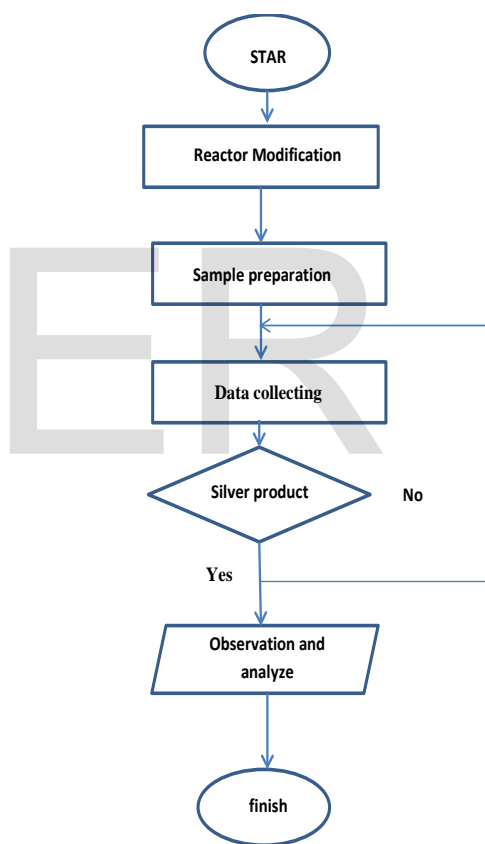

Figure 1 : Chart of Research

Hospital waste is taken in the radiology department from the hospital. The experimental equipment is shown in Figure 1. Plasma is produced using a conventional microwave oven with dimensions of 470 mm, depth of 330 mm and height of 310 mm. The microwave is modified and replaced with a waveguide. Microwave output is 85/500 Watt at 2450 MHz. A

reactor and reservoir are made of acrylic and Teflon and are used to collect radiographic liquid waste.
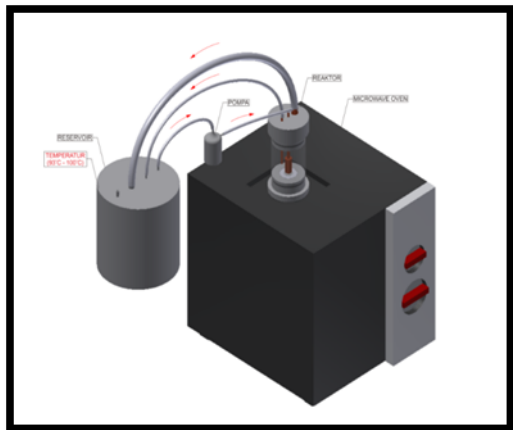

Fig.2 Experimental Apparatus

Medical waste samples that have been plastered with microwave plasma and have been deposited as shown below:

Fig.3 sample 1 (5 minute) and sample 2 (10 minute)

Then medical wastewater samples were taken with plasma ignition time of 5 and 10 minutes, the two samples were heated on electric stoves to dry and left with X-ray waste powder, then 2 samples analyzed used Scanning electron microscopy (SEM, JEOL JSM-6510 LA) and shcrerrer Formula.

3 RESULT AND DISCUSSION

3. 1 SEM/EDS Analyze

Scanning Electron Microscopy (SEM) in this study was used to see the particle size and morphology of the structure of silver nanoparticles. In Figure 3 and 4 shows the results of SEM images for sample 1 where based on manual measurements on the image with a scale of 30 μm, the particle size range is 100 - 500 nm. With this range of sizes, it has been shown that particles have been categorized as nanoparticles where particle size in that range has been found using leaf extract [4]
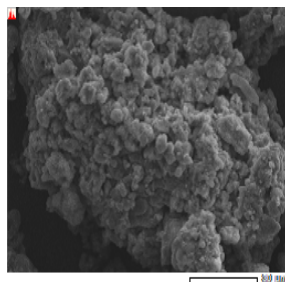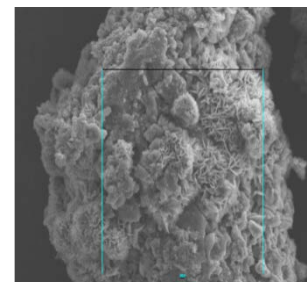

Figure 4 : Image EDS of sample 1

Figure 5 : Image EDS of sample 2

The element of material at sample 1 and sample 2 shows in table 1 and 2 as follows :

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ZAF Method Standardless Quantitative Analysis
Fitting Coefficient : 0.4532
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Element	(keV)	Mass%	Error%	Atom%	Compound	Mass%	Cation	K
C K	0.277	49.81	0.29	62.56				36.3490
O K	0.525	32.59	0.33	30.73				22.5070
Al K	1.486	0.75	0.10	0.42				1.4860
S K	2.307	10.37	0.10	4.88				26.1727
Cu K	8.040	5.19	1.49	1.23				10.8626
Ag L	2.983	1.30	0.38	0.18				2.6226
Total		100.00		100.00				

Table 1 : Element of sample 1

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ZAF Method Standardless Quantitative Analysis
Fitting Coefficient : 0.4528
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| Element	(keV)	Mass%	Error%	Atom%	Compound	Mass%	Cation	K
O K	0.525	40.97	0.37	68.28				27.7477
Na K	1.041	5.45	0.25	6.32				5.4767
Al K	1.486	2.57	0.21	2.53				2.7261
S K	2.307	23.20	0.21	19.29				32.6078
Pb M	2.342	27.81	0.99	3.58				31.4417
Total		100.00		100.00				

Table 2 : Element of sample 2

From SEM/EDS data shows that the material have a silver content with nanoparticle size as shown at figure 3 and 4.

from the EDS table data above can also be seen material composition in the following graph :
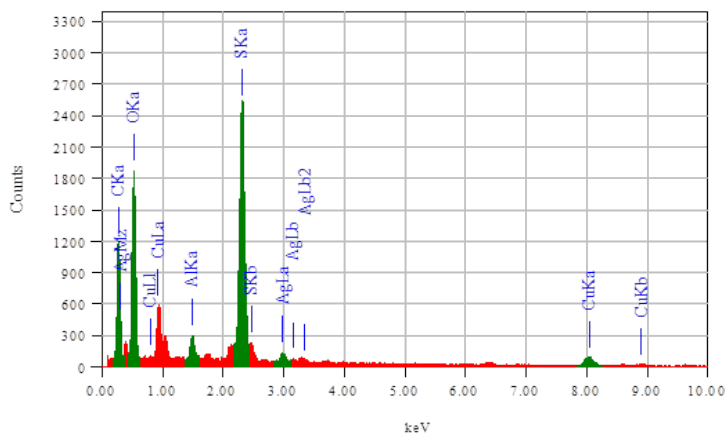

Figure 6 : EDS graph sample 1
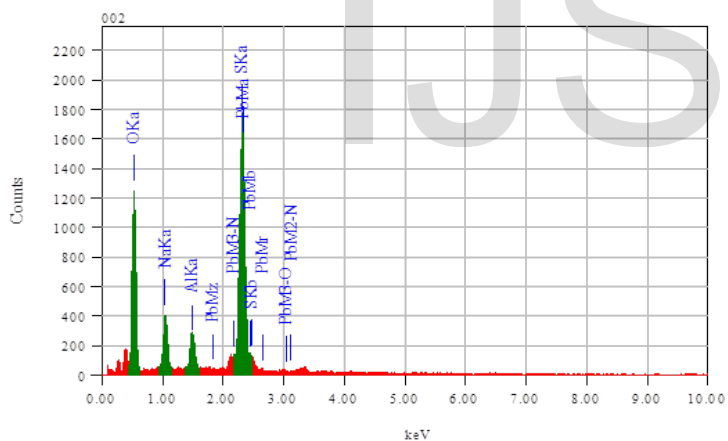
Figure 7 : EDS graph sample 1

3.2 SEM/EDS AnalyzeParticle Size Calculation use Schrerrer Formula

Through XRD diffractogram data the size of Crystal can be determined by calculating the amount of FWHM (Full Width at Half Maximum). FWHM is the half-width of the diffractogram. How to determine the value of FHWM by seeing the peak that appears. Half of the peak height is calculated by the width that appears.
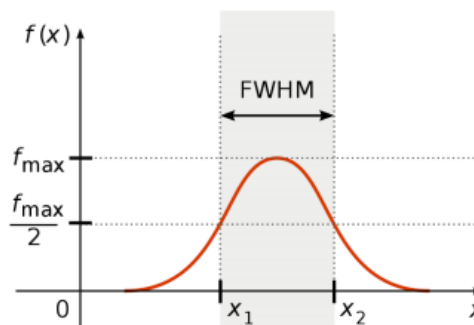
From XRD data of sample 1 and 2, particle size can be calculated as follows :

a. Crystal size at peak 18.49⁰

2θ = 18.49

FHWMinst = 0.2800

FHWMmatch = 0.3200

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2 Cos\,9.245}}$$

$D = 1.509788 / \sqrt{(\llbracket 0.280 \rrbracket ^2 - \llbracket 0.320 \rrbracket ^2 Cos\,9.245)}$

$D = 66$ nm

b. Crystal size at peak 27.7⁰

2θ = 27.7⁰

FHWMinst = 0.60

FHWMmatch = 0.16

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2 Cos\,13.85}}$$

$D = 1.509788 / \sqrt{(\llbracket 0.60 \rrbracket ^2 - \llbracket 0.16 \rrbracket ^2 Cos\,13.85)}$

D = 2.70 nm

c. **Crystal size at peak 38.90⁰**

2θ = 38.90⁰

FHWMinst = 0.4369

FHWMmatch = 0.2

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2\cos 19.44}}$$

D=1.509788/√([0.4369]^2-[0.2]^2 Cos19.44)

D = 4.1 nm

d. **Crystal size at peak 29.90⁰**

2θ = 29.90⁰

FHWMinst = 0.280

FHWMmatch = 0.20

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2\cos 14.94}}$$

D=1.509788/√([0.280]^2-[0.2]^2 Cos14.94)

D = 9.5 nm

e. **Crystal size at peak 33.6⁰**

2θ = 33.6⁰

FHWMinst = 0.280

FHWMmatch = 0.240

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2\cos 16.755}}$$

D=1.509788/√([0.280]^2-[0.240]^2 Cos16.755)

D = 15 nm

f. **Crystal size at peak 44⁰**

2θ = 44⁰

FHWMinst = 0.280

FHWMmatch = 0.160

$$D = \frac{k\lambda}{B\cos\theta}$$

$$D = \frac{0.98 \times 1.5406}{\sqrt{FHWMinst^2 - FHWMmatch^2\cos 22}}$$

D=1.509788/√([0.280]^2-[0.160]^2 Cos44)

D = 7 nm

From the calculation above shows the particle size range 2.7 to 66 nm. It shows that the particle have a nanoparticle size.

4 CONCLUSION

SEM/EDS analysis shows the particle content have a silver metal that can used in several study. The particle size range 100 to 500 nm. The size is included in the nanoparticle category where the nanoparticles are nanometer-sized particles, which are around 1–100 nm. Silver crystal structure produced in XRD analysis, namely Hexagonal.

Schrerrer formula shows that the silver particle size range 2.7 to 66 nm where in the range of sizes shows nanoparticle-sized silver particles. Nanoparticles have been intensively investigated because of their unique physical properties, chemical reactivity, and potential applications that have an impact on the academic and industrial world

From the results of sample 1 and 2 characterization with XRD analysis, sample 1 shows that there are 4 peaks identified as silver nanoparticles, namely 27.7^0, 33.6^0, 38.90^0 dan 47.9^0. While the results of XRD analysis of sample 2 showed that there were 4 peaks identified as silver nanoparticles, namely 29.90^0, 33.6^0, 38.90^0, dan 44^0

Based on the results of previous studies, the synthesis of silver nanoparticles from green algae produced silver nanoparticles identified at peak 33.6^0 and 44^0[5]. The synthesis of silver nanoparticles using Cleome viscosa L fruit extract was successfully carried out and based on the XRD test results showed a peak of 38.68^0 having a silver crystal in the form of Face-centered cubic (FCC)[6]. The last peak showing the presence of silver nanoparticles was $47,9^0$ as silver particles were found from the reference [7].

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