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Characterization of Strontium Ferrite Based on Natural Iron Sand at Banjar Beach with Co and Zn Ion Doping as Generator Material Electricity

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Abstract: This research aims to determine the characteristics of strontium-based on ferrite natural iron sand doped with Co and Zn ions as an electric generator driver. Iron sand contains minerals such as magnetite (Fe_3O_4), hematite (α-Fe_2O_4), and maghemite (γ-Fe_2O_3) which can be used to making permanent magnets. The method used is coprecipitation to produce nano-sized magnetite minerals which are used as a basic material in permanent magnets production. In order to increase the magnetic and electrical properties, Co and Zn doping is added with several concentrations (x = 0.0; 0.5; 1.0). The final result is a sample powder that has been heated at a temperature of 80 ˚C for 24 hours. More higher the calcination temperature used, made more darker result sample color. The FT-IR test results show the presence of O-H, Sr-O, Co-O, Zn-O, and Fe-O compounds at certain wavelengths ranging from 400-690 cm-1.

Keywords: Electric Generator; Iron Sand; Magnetite; Strontium Ferrite.

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Introduction

Indonesia is a country with abundant natural resources, one of which is natural iron sand (Susilawati & Doyan, 2021). Indonesia is a country rich in natural mineral resources such as iron sand and porcelain ceramics. The distribution of iron sand minerals in Indonesia is very wide, one of which is the island of Lombok. Lombok Island has sand colors that vary due to geological activity (Doyan *et al.,* 2015). Based on this situation, it can be assumed that Indonesian iron sand has unique variations and characteristics. Geologists classify iron sand as secondary iron deposits, a product of volcanoes (Yulianto *et al.,* 2010). The formation of iron sand deposits is influenced by the relatively sloping beaches and proximity to rock sources (Setiady *et al.,* 2020; Doyan *et al.,* 2020). Along the coast, there are light minerals and heavy minerals (Rumbino & Krisnasiwi, 2019). Susilawati *et al.,* (2018) said that iron sand contains a lot of iron oxide which can be refined into various products with high selling value. However, the use of natural iron sand is currently not optimal because it is only used as a cement mixture.

Iron sand is a mineral deposit that contains the element iron (Fe) in the form of the minerals magnetite (Fe3O4), hematite (α-Fe_2O_3), and maghemite (γ-Fe_2O_3) (Purnawan *et al.,* 2018; Rusianto *et al.,* 2012) which can be an industrial material because of its magnetic properties (Cornell & Schwertmann, 2003). Iron sand is formed due to the destruction of the original rock by weather, surface water, and waves. This iron sand is usually dark gray or blackish in color (Ishaka *et al.,* 2020; Andani & Octova, 2020). Iron sand also contains other compounds

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such as Fe, Ni, and Zn in smaller levels (Yulianingsih & Munasir, 2016). Fe_3O_4 is a magnetic material that belongs to the iron oxide group and has a magnetite phase (Simamora *et al.*, 2015; Saragi *et al.*, 2018). The magnetite (Fe_3O_4) content in beach sand can be processed into magnetite nanoparticles (Fe_3O_4) as the basic material for permanent magnets.(Widianto *et al.*, 2018; Ningsih *et al.*, 2019). Apart from that, the iron sand magnetite mineral also has great potential to be processed into other industrial materials based on its magnetic properties (Yulianto *et al.*, 2019). Magnetite is obtained from the ferrite characterization process.

Ferrite is a magnetic material with high intrinsic permeability and resistivity (Chakraborty *et al.*, 2013; Hosseini & Asadnia 2021). Ferrite material is divided into two types, namely hard ferrite (Namai *et al.*, 2012) and soft ferrite (Mansour, 2018). Hard ferrite is a derivative of the magneto plumb it structure which can be written as $MFe_{12}O_{19}$, where M = Ba, Sr, Pb. This material has a high coercivity and remanence field and has a hexagonal crystal structure with magnetic moments parallel to the axis direction. Soft Ferrite, has the formula MFe_2O_4 where M is Cu, Zn, Ni, Co, Fe, Mn, Mg with a cubic spinel crystal structure (Putri & Puryanti, 2020). Strontium ferrite synthesis can be carried out using several methods such as sol gel, coprecipitation, mechanical alloying, powder metallurgy and solid state reaction. (Budiman *et al.*, 2016; Hayati *et al.*, 2016). The manufacture of strontium ferrite is carried out by engineering doping in the form of transition metals such as Zn, Co, Mn, Ni and other transition metals at varying temperatures. Strontium ferrite engineering will produce material for making permanent magnets to drive electric generators.

The generator converts mechanical power into electrical power and produces alternating electrical power (Andreas *et al.*, 2020). There are two important parts to a generator, namely the stator and rotor. The stator is a stationary part of the generator which is usually used to house the coils. The rotor is the moving part of the generator (Nasrullah, 2019). Generally, the magnets used in low rotation generators are NdFeB, the constituent elements of which are difficult to obtain, so strontium ferrite ($SrFe_{12}O_{19}$) is needed as a replacement. Based on the above, it encouraged researchers to characterize natural iron sand on Banjar beach with the addition of Co and Zn ions as a driving force for electric generators.

Method

This research is a type of pure experimental research. The method used is known as the coprecipitation method. Coprecipitation is a cheap method of synthesizing a nanometer-sized substance (Saragi *et al.*, 2017) and it is easy to make magnetic nanoparticles from salt solutions (Faraji *et al.*, 2010). Another advantage of the coprecipitation method is that it uses room temperature and requires a short time in the experiment (Setiadi *et al.*, 2016). This research consists of three stages, namely the natural iron sand separation stage, the magnetite compound (Fe_3O_4) separation stage, and the synthesis stage (Z Fatimah *et al.*, 2020).

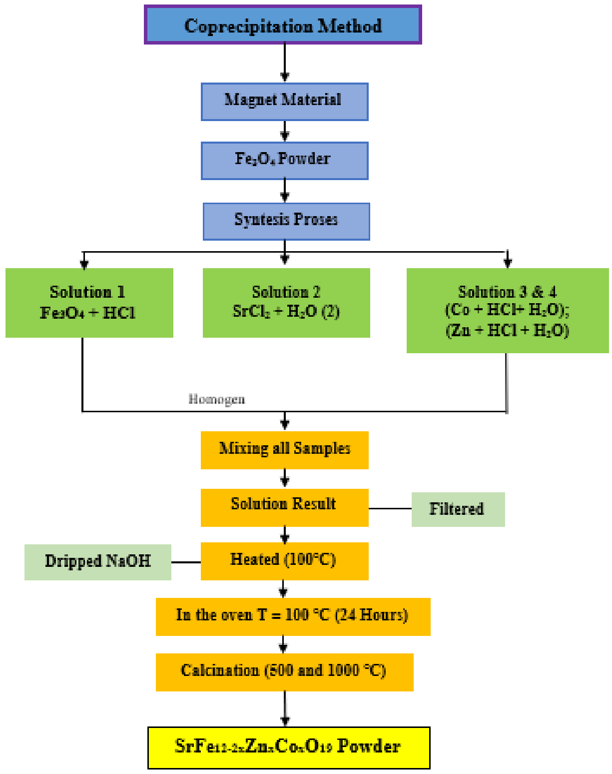

Figure 1. Synthesis process using the coprecipitation method

Result and Discussion

Synthesis of strontium ferrite with Co and Zn doping at calcination temperatures of 500 °C and 1000 °C produces darker colored powder as the temperature and doping increase. The results of the synthesis of strontium ferrite are shown in Table 1.

Table 1. Synthesis results of strontium ferrite powder with x variation of Co and Zn metal doping at calcination temperature.

Suhu Kalsinasi (°C)	Nilai x 0,0	0,5	1,0
500			

1000	

Table 1 shows that at a concentration of x = 1.0, a calcination temperature of 1000 ℃ produces a darker color than a temperature of 500 ℃. However, at a concentration of x = 0.0 it can be seen

that the sample calcined at 1000 ℃ has a lighter color than at 500 ℃. After getting the sample with a calcination of 500℃ and 1000 ℃, then the strontium ferrite powder was tested using FT-IR. The FT-IR test results used a 1000 ℃ calcination results graph because it produced a sample that was very dark in color and the water content of the impurities had been removed. The FT-IR test results graph is shown in Figure 2 and Figure 3.

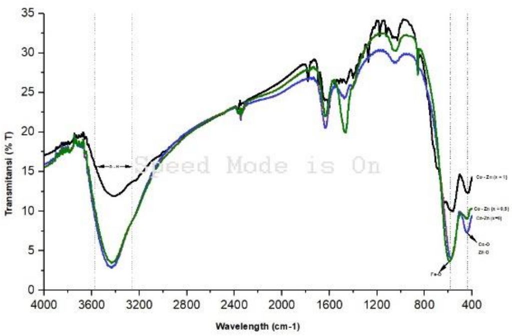

Figure 2. Graph of the relationship between transmittance percentage (%T) and wave number (cm^{-1}) at x = 0.0; 0.5; 1.0 and T = 500 ^{0}C

The graph above shows that the Fe-O metal bond is at a peak of 598 cm^{-1}. The wave number corresponds to the range of Fe-O. The wave number for Co-O and Zn-O is at a peak of 450 cm^{-1}. The wave number corresponds to the range of each bond, namely around 400 cm^{-1} to 663 cm^{-1}.

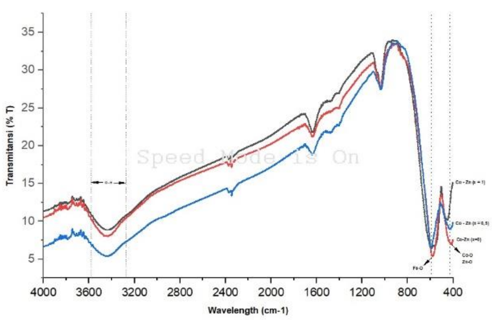

Figure 3. Graph of the relationship between transmittance percentage (%T) and wave number (cm^{-1}) at x = 0.0; 0.5; 1.0 and T = 1000 ^{0}C

The graph above shows the Fe-O metal bond at the peak of 588 cm-1. Other bonds, namely Co-O and Zn-O, are at a peak of 446 cm^{-1}. The graph above has the same range of values as the graph in Figure 2 for each bond.

Figure 2 and Figure 3 show the results of the FT-IR test with different calcination temperatures, but with the same x-doping concentration. Even though they use different temperatures, all graphs show wave numbers with a peak range between 440 cm^{-1} to 690 cm^{-1} for the Fe-O metal bond type. The characteristics of bonds that are at the peak wave number with a range between 3000 cm^{-1} to 3500 cm^{-1} indicate O-H bonds whose presence will decrease as the calcination temperature increases.

Conclusion

Based on the research results, it can be concluded that the synthesis of strontium ferrite with Zn and Co doping based on natural iron sand has been successfully carried out. Banjar beach iron sand has a high Fe content with a concentration of 4.097 mg/g in the form of magnetite (Fe_3O^4). more greater doping concentration and calcination temperature of the sample,make more darker sample color. Strontium Ferrite which has been doped at T=500℃ calcination shows the presence of Fe-O metal bonds at a peak of 588 cm-1 and Zn-O and Co-O bonds at 446 cm-1. At calcination T=1000℃, it shows that the Fe-O metal bond is at a peak of 598 cm-1 and the Zn-O and Co-O bonds are at 450 cm-1. Based on this, there is a substitution process for the dopant elements Zn and Co in strontium ferrite.

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