J. Sol. State Sci. & Technol. Lett. Vol. 23 No. 1 & 2 (2022): 6 - 12
http://myjms.mohe.gov.my/index.php/jssstl

Preparation of Magnetic Composite from Local Ferrites

Agus Yulianto and Sulhadi

Laboratory of Magnetic Materials

Department of Physics, Faculty of Mathematic and Natural Sciences

Universitas Negeri Semarang, Indonesia

E-mail: yulianto566@mail.unnes.ac.id

Received 18 October; Accepted 26 December 2021

Abstract: In this paper, a preparation of some magnetic material based on natural ferrite will be presented. Iron sand deposit can be found in the beaches and it is resulted by the explosion of volcanoes. The magnetic composite fabricated using cullet and natural rubber (polymers composite) are also presented. Some properties such as strength, Young's Modulus and others have been characterized and some analyses have been made.

The aim of this research is to process resources into functional materials such as magnetic and composite magnet by using a method of: powder metallurgy, precipitation and sol-gel. Fig. 1 shows the processing of Iron sand into a magnetic powder. A basic material of Fe_2O_3 obtained directly from the sand is mixed up with $BaCO_3$ or $SrCO_3$. It is then grinded to homogenize the mixer before being calcine at 1200^{o}C to 1350^{o}C depending on the composition. [1]. To reduce the particle size, the mixture is milled for several hours before it is drying and then casting. Then the mixture is sintered at the same temperature and the final product is ready for further characterization. Some modification during sintering can also be applied as shown in Fig. 2. In this case, during the production of magnetite, the calcination can go through to several stages at different temperature rate. Meanwhile, the synthesis of Mn-Ferrite can also be prepared using precipitation [ref 2]. In this method, the precursor must be prepared before being added with hydroxide solution to get the precipitation of magnetite may be obtained. Then it can be heated at low temperature around 90^{o}C to get magnetic composite. Here, the precursor used are;

$$MnO_2+4HCl \rightarrow MnCl_2+2H_2O+Cl_2$$

$$Fe_3O_4+8HCl \rightarrow FeCl_2+2FeCl_3+4H_2O$$

and the precipitation can be obtained with an addition of base NaOH and NH_4OH. The sample can be obtained by heating at low temperature, 90°C before being characterized. Fig. 3 (a) shows the hysteresis loop of Ba/SrO.5,6 Fe_2O_3, without additive while Fig. (b) shows the

hysteresis loop of Ba/SrO.3,5 Fe_2O_3, using 0,75% CaO and 0,6% SiO_2. The additives or doping also affects the properties of ferrite. [3].

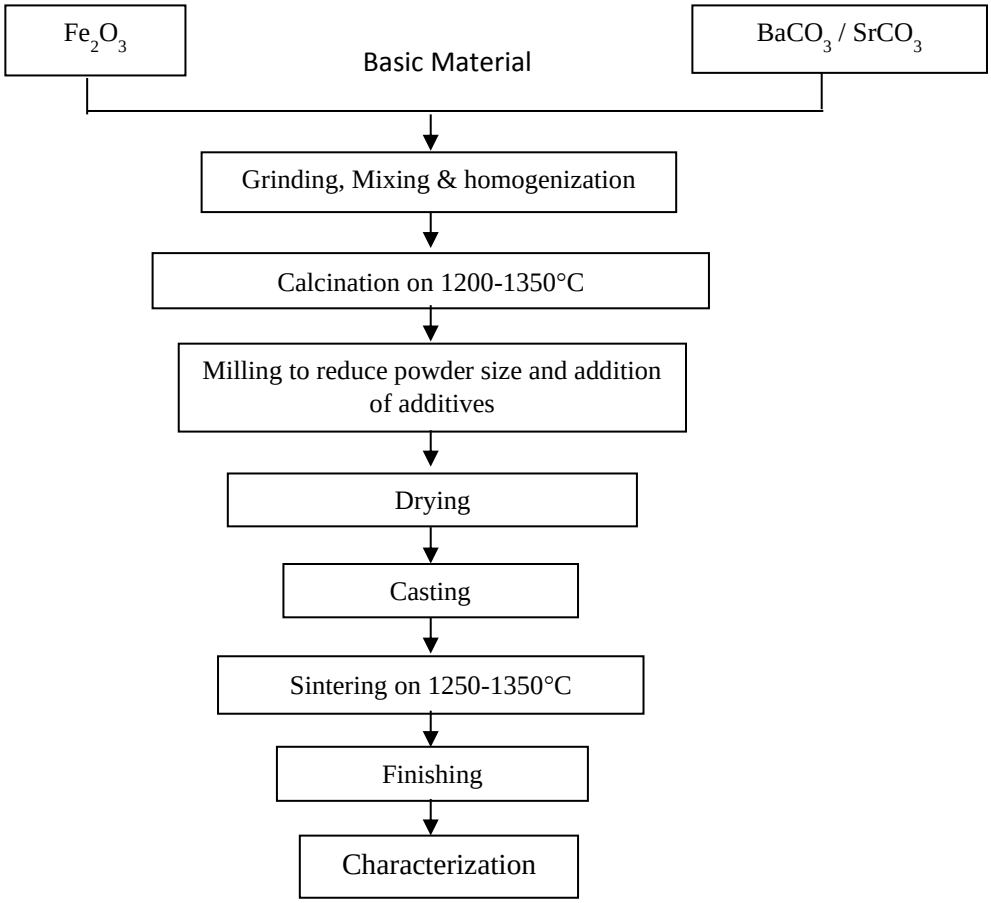


Figure 1: The processing procedure to fabricate magnetic composite from sand

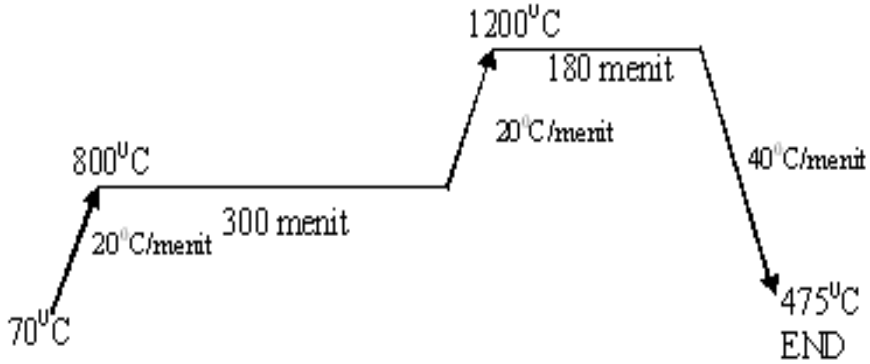
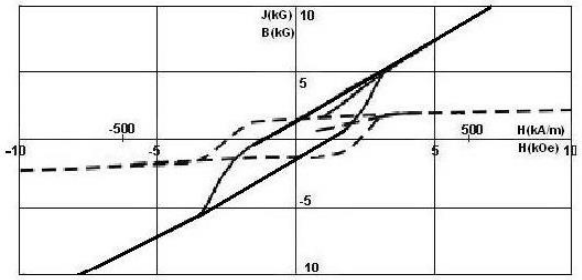


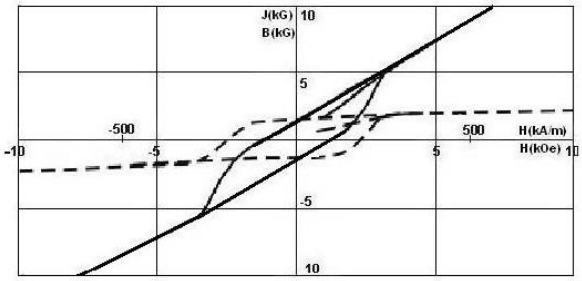
Figure 2: The modification of calcination procedure to fabricate magnetic composite from sand

The composite magnet can also be manufactured using Ferrite magnetic powder synthesized from iron sand, natural materials, Industrial products or industrial wastes such as glass, rubber, and others [4]. Meanwhile, the magnetic composite using Portland cement is preferable since it is simple mixing, no heating and low temperature drying (room) [5]. Table 1 shows the magnetic composite properties based on ferrite and Portland cement.

Meanwhile, the magnetic composite using cullet is manufactured using used glass where it is ground and mashed to a micron size before being mixed with magnetic powder which is also micron in size. Then the mixture is heated to the melting temperature of the glass before the glass are rapidly cooled. Fig. 4 shows the magnetic composite using various level of cullet content.



(a)



(b)

Figures 3: Magnetic hysteresis types of ferrite samples Ba/Sr-Ferrite using different portion of additives. (a) Ba/SrO.5,6 Fe_2O_3, without additive (b) Ba/SrO.3,5 Fe_2O_3, using 0,75% CaO and 0,6% SiO_2

Fig. 5 shows the mechanics properties of magnetic composite using cullet. As can be seen, the tensile strength is very much depended on the amount of cullet that is added in the composition. As the cullet is added, the strength is systematically increased but hen drastically decreases as the amount of cullet is further added. This characteristic is almost similar to the magnetic glass reported elsewhere [6]. Another magnetic composite can also be fabricate using natural rubber.

In this case, a watery rubber is mixed with magnetic powder which is micron in size before being stirred until the required homogeneity is obtained. To prevent clumping, an ammonia with the ratio of 1 g of ammonia to 100 g of rubber is added. The process is carried out at room temperature. The solidified sample is then casted and pressed at a pressure of 2 tons. Table 2 shows some characteristics of the magnetic composite using rubber.

Table 1: Properties of Magnetic Composite (Ba-Ferrite and Portland Cement)

Ba ferrite portion/%	Bt/kg		iHc/kOe		Hc/kOe		BH_{max}/MGOe		ρ/gcm^{-3}	
	Ms	Mc	Ms	Mc	Ms	Mc	Ms	Mc	Ms	Mc
86	0.56	0.59	1.708	1.703	0.708	0.509	0.07	0.07	3.33	3.26
88	0.62	0.64	1.709	1.708	0.738	0.471	0.08	0.08	3.26	3.36
90	0.66	0.67	1.712	1.709	0.606	0.540	0.09	0.07	3.29	3.38
92	0.61	0.65	1.703	1.703	0.688	0.549	0.08	0.10	3.25	3.27

Ms: using Ferrite synthesized from iron sand; Mc: using commercial Ferrite

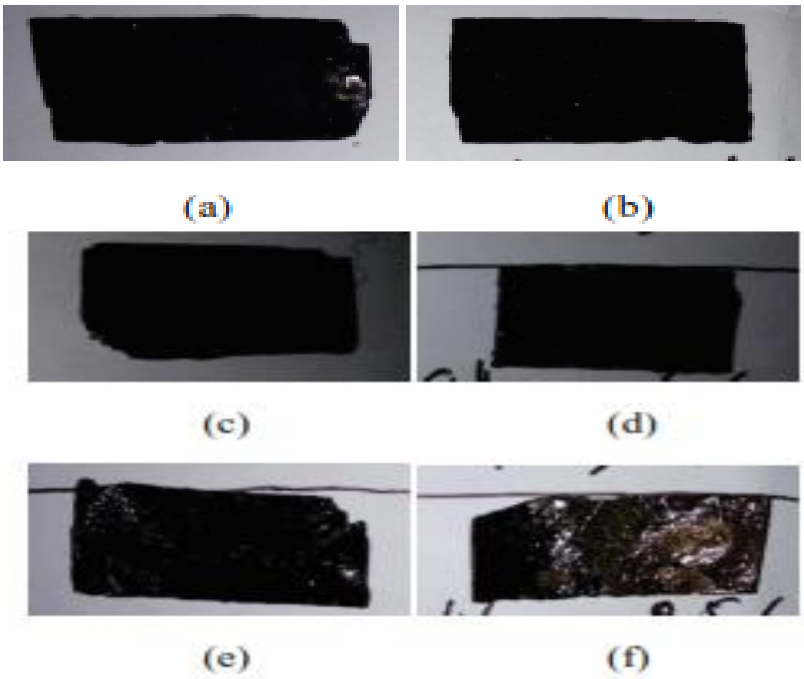


Figure 4: Samples photo of magnetic glass using cullet and magnet powder (a)20%, b)30%,(c) 40%,(d) 60%, (e)70%, and (f) 80%

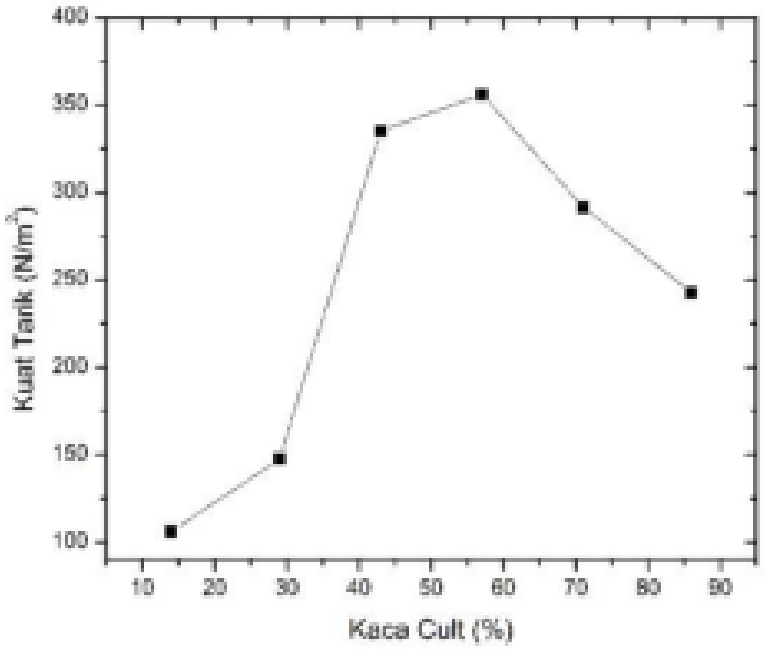


Figure 5: Tensile strength vs cullet content (wt%)

Table 2: Magnetic characterization of magnetic composite using rubber

Sample	Ba-Ferrite Portion/%	Br/kg	Hc/kOe	BH_{max}/MGOe	ρ/gcm^{-3}
A	50	0.55	1.315	0.00	1.97
B	55	0.52	1.311	0.06	1.99
C	60	0.53	1.084	0.05	2.02
D	65	0.50	1.100	0.00	2.06
E	70	0.66	1.053	0.09	2.27
F	75	0.63	1.081	0.00	2.32
G	80	0.79	1.017	0.02	2.25

Fig. 6 shows the mechanics properties of magnetic composite using rubber. As can be seen, the Young's Modulus decreases as the ferrite content is increased.

Conclusion: Some methods in the fabrication of magnetic material has been shown and some characteristic of the material has also been discussed. The use of local ferrite which originated from the explosion of volcanoes has been nicely been done. Meanwhile, the formation of magnetic composite using cullet has also been ventured and this is of particular importance for green environment.

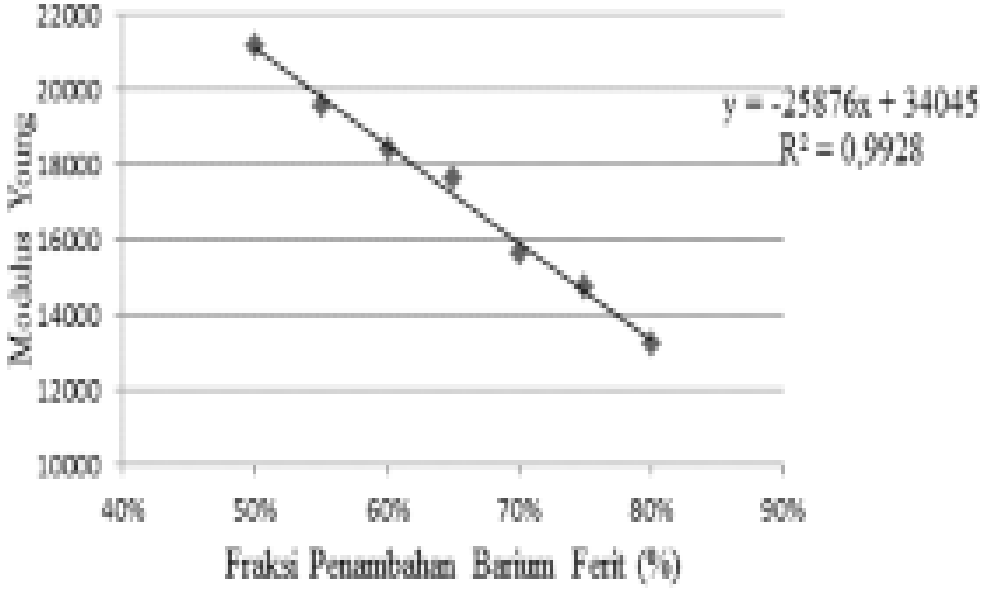


Figure 6: Young Modulus against the ferrite content (wt %)

Acknowledgement: The author would like to thanks the Physics Department of FMIPA for allowing and supporting this project to be carried out.

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