12th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

MORPHOLOGY AND HARDNESS OF Nd-Fe-B MAGNETIC MATERIALS IN POLYMER MATRIX

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ABSTRACT
The effect of different polymer binders and effect of binder percentage on morphology and hardness of synthesized Nd-Fe-B bonded composites is studied and presented. The ratio of epoxy binder content regarding to the Nd-Fe-B powder is varied as follows - 22: 78; 50:50; 75:25; 10:90,; for two different combinations of polymer binder. The goal of this preliminary investigation was to obtain good morphology characteristics and satisfactory hardness values.
Keywords: Polymeric composite magnetic material, Nd-Fe-B powder, epoxy binder, morphology, hardness

1. INTRODUCTION
Nanocomposite permanent Nd-Fe-B magnetic powders with reduced Nd content are very attractive because of their suitability for production of bonded magnets. [1]
These permanent magnets are produced by mixing of Nd-Fe-B powder with different types of polymeric matrices. [1, 2, 3] The most important advantages of polymer bonded magnets are low weight, corrosion resistance, easy machining ability, forming and handling, high production rate, good crack or break resistivity. Bonded magnets provide an almost infinite variety of combinations of mechanical, physical, chemical, thermal and magnetic properties due to various kinds of polymeric matrices. This type of magnetic materials which are advantageous in that they can be produced in any shape and have a high dimensional accuracy, etc., have conventionally been used in various fields, such as electric appliances and automobile parts. [2] The presented investigation covers some of preliminary experimental results which show correlation between synthesis conditions, fraction of applied epoxy binder and Nd-Fe-B powder and their effects on morphology and hardness of synthesized composite magnetic materials.

2. EXPERIMENTAL
In this investigation, the rapid quenched Nd-Fe-B powder with low Nd content (12 wt %) - $Nd_{4.5}Fe_{77}B_{18.5}$ obtained by centrifugal atomization method [4] was used for manufacturing of polymer composite magnets. The origin magnetic characteristics of starting Nd-Fe-B powder are given in Table 1.

Table 1. Basic magnetic characteristics of the starting $Nd_{4.5}Fe_{77}B_{18.5}$ powder

Sample	Preparation	Hc (kOe)	Br (kG)	$(BH)_{max}$ (MGOe)
$Nd_{4.5}Fe_{77}B_{18.5}$ (12 mass% Nd)	Centrifugal atomization	2.8	10.9	10.7

Commercial epoxy resin with good adhesion characteristics and curing temperature close to room temperature was used as a polymer binder. The applied combinations of polymer binder are mixing of Bisphenol A and Bisphenol F resin with a cross linking agent (hardener) polymerize to a thermosetting liquid. The investigated combinations of polymer binder and Nd-Fe-B powder are presented in Table 2.

Table 2. The investigation combination of composites Nd-Fe-B powder -polymer binder

Sample	**I-** Polymer binder / Nd-Fe-B powder wt%	Sample	**II-** Polymer binder / Nd-Fe-B powder
1	22:78	5	22:78
2	50:50	6	50:50
3	75:25	7	75:25
4	10:90	8	10:90

Combination I is a mixture of polymer binder with ratio of resin: hardener (100:26) and combination II (100:50), in wt%. The investigated Nd-Fe-B composites with different amount of polymer binder were prepared by uniaxial pressing in a magnetic field with magnetic strength of 1.2 T. Dimension of pressed plate was 36 x 13 x 3 mm.

Morphologies of the synthesized samples were observed by scanning electron microscope (SEM). Hardness was determined by Shor D according to JUS/ISO standard 868/1997.

Preliminary investigations in the present work were undertaken in order to understand the effect of different binder and effect of binders percentage on the morphology and hardness of the Nd-Fe-B polymer composites.

3. RESULTS AND DISCUSSION

SEM micrographs of used Nd-Fe-B powder are shown in Fig.1. Platelets of width between 80-140 μm and thicknesses around 25-35 μm are typical.

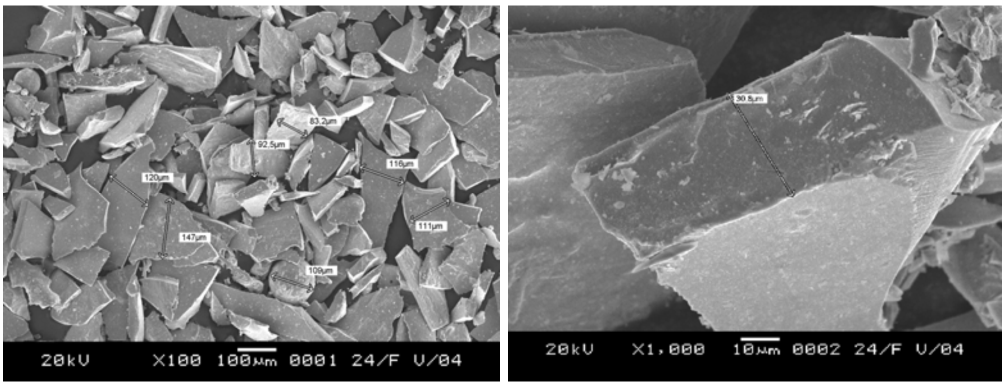

Figure 1. SEM micrographs of used rapid quenched $Nd_{4.5}Fe_{77}B_{18.5}$ powder

The proportion of Nd-Fe-B powder to polymer matrix can be varied to achieve the desired level of magnetic and mechanical performance. In this case only morphology and hardness of investigated

Nd-Fe-B polymer composites are observed. The morphology of surfaces for two investigated combinations of epoxy polymer binder: Nd-Fe-B powder, are showed with represented SEM micrographs on fig 2.

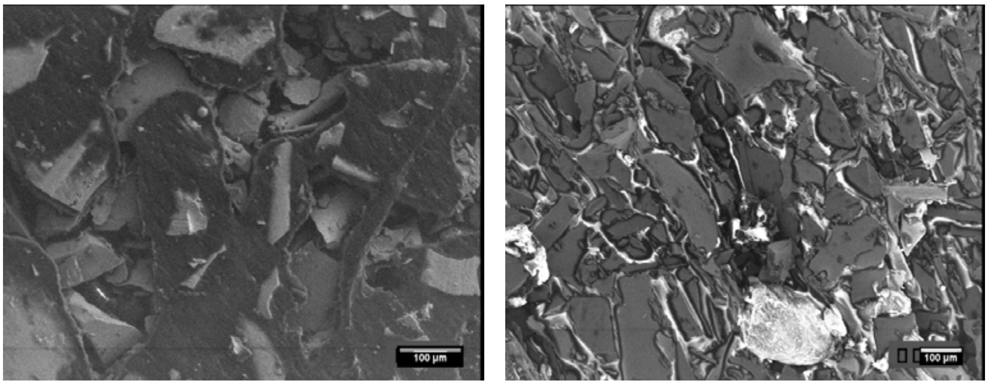

Figure 2. SEM micrographs of composite epoxy polymer binder / Nd-Fe-B powder

Good dispersion of Nd-Fe-B powder in polymer matrix is obvious in presented figures, while used Nd-Fe-B flakes have the large grain of size. For permanent bonded magnets, the particle size of magnetic powder plays an important role in determination of powder to a binder ratio, degree of particle alignment and magnetic and mechanical properties. Plate–like particles would results in more packing density under the optimal compression conditions. [5]

The mean value of hardness for all investigated samples is about 70 Shor D. Generally observed, the hardness of Nd-Fe-B polymer composites is highest in regard to used polymer binders. (50-65 Shor D in dependence from ratio of epoxy resin: hardener).The obtained values of hardness for all investigated samples are the same, probably because the compression molding is carried out by manually axial pressing.

4. CONCLUSION

The short insight in preliminary results of investigation Nd-Fe-B epoxy-polymer bonded magnets is given in presented paper. Although it was expected that the hardness of synthesized bonded magnets would increase with the increase of the fraction of magnetic Nd-Fe-B powder, the same value of hardness for all investigated samples was obtained, which can be explain firstly by the absence of required compacting pressure. These investigations are still in progress.

5. REFERENCES

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6. ACKNOWLEDGEMENT

This work has been supported by the Ministry of Science of the Republic of Serbia under Project OI 142035 B.