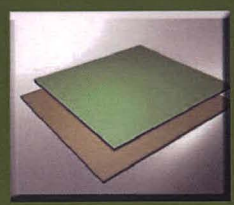
ADVANCES IN COMPOSITE MATERIALS



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Chapter 004

Investigation of Mechanically Alloyed Nd-Fe-B Powder

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Keywords: Mechanical alloying, Nd-Fe-B powders, corrosion behavior.

Abstract: Elemental powders of Nd, Fe and B were mechanically alloyed using a planetary ball mill. The change of structure and particle size was examined. XRD pattern revealed that with prolonged milling, the mixture of the powders was transformed to nearly amorphous state. Smaller particle size was observed with prolonged milling. Magnetization of the mixture of powders was studied using AGM. The saturation magnetization of the mixture was observed to increase initially and then decrease with increasing milling time. The reduction of the magnetic properties was suspected to be due to surface damage which was incurred by extensive milling. The corrosion rate was observed to be higher for larger particle size (low milling time). This indicated higher mass gain percentage of larger particle size compared to lower particle size. The magnetic properties however, did not show any significant improvement after corrosion effect.

Introduction

Nd-Fe-B magnets are regarded as the most successful magnetic materials in the electronic and consumer application. Its high energy product property enables it to be used in voice coil motor and actuator. Various applications have been extended for Nd-Fe-B magnets due to its high ratio energy product to volume. This new material was discovered concurrently by Sagawa et al and Croat et al [1,2]. Initially, the common processing routes were the conventional powder metallurgy and melt-spin process [1,3]. Recent alternative routes have been developed such as mechanical alloying and HDDR, which can give the similar magnetic properties as described with previous methods [4,5]. Although Nd-Fe-B magnets exhibit good magnetic properties, its corrosion resistance is very low comparatively [6]. Thus, surface engineering of the material is necessary in order to enhance the corrosion resistance of the material [7]. Minor additives of alloying elements also showed some improvements on the corrosion resistance of the materials [8]. On the other hand, control of particle size is also favourable for corrosion resistance improvement of the materials [9].

Experimental procedures

Elemental powders of neodymium (>99%, average particle size –40 mesh), iron (99%, average particle size –325 mesh) and boron (>99%, average particle size 2μm) were used as starting materials. The powders were weighed and mixed in a glove box filled with argon gas. The nominal composition of the powders mixture was 33 wt% Nd, 66 wt% Fe and 1 wt% B ($Nd_{15}Fe_{77}B_8$). The mixtures of the powders were pre-mixed and then transferred into a