Development of isotropic Alnico powder by Melt-dragging process

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Introduction

The isotropic Alnico magnet powders have been widely used for bonded magnets requiring high temperature stability. They have been generally made through crushing the mold cast ingot or through atomization of molten metal. The mold cast ingot generally has coarse grain structure with heavy segregation, and thus requires homogenization heat treatment at temperature around 1200°C for many hours. In addition, the Alnico ingot is too hard to crush-down, and thus requires several crushing steps. The homogenization heat-treatment and multiple steps of ingot crushing substantially increase the powder processing cost. The atomization is simpler process than the crushing of mold cast ingot. However, the water or gas atomization of powder from the molten metal results in oxidation of powder. The powder needs heat-treatment in hydrogen environment in order to reduce the oxidized surface. Consequently, it requires very high capital investments for both atomization equipment and hydrogen-reduction heat-treatment furnace. It is therefore necessary to develop a simple process of Alnico powder making with minimum capital investment.

In this study, we have developed a melt-dragging process for making Alnico powders: The molten Alnico metal is dragged by a cold copper role and solidified into thin flakes which is immediately followed by rapid quenching in cold water. Because of rapid cooling by copper role, the grain structure is uniformly fine, and thus the flake does not need a homogenization heat-treatment. Because of the rapid quenching by cold water, the flake has minimal oxidation on its surface and has micro-cracks formed in it. The flakes can be easily crushed down with a simple crushing step because of internal micro-cracks. Since it has minimal oxidation, it can be heat-treated in air without protective or reduction environment. In addition, the melt-dragging equipment can be easily built with a low cost.

Fig.1 shows a demagnetization curve of a bonded magnet made of Alnico2 powder produced by melt-dragging process. Its magnetic properties are as good as the magnetic properties of bonded magnets made of the identical composition powders produced by atomization and mold casting. As a result, good Alnico powders can be produced economically with a newly developed melt-dragging process without much capital investment.

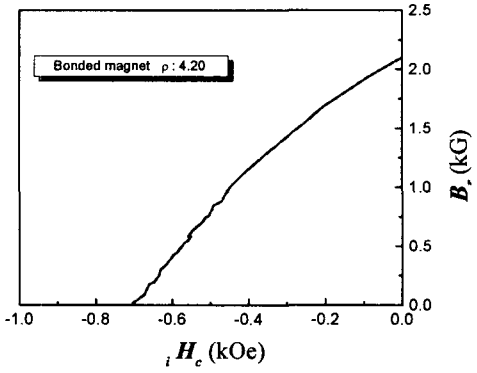

Fig. 1 Demagnetization curve for alnico bonded magnet