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MICROSTRUCTURE -CORROSION CORRELATION IN A NdFeB SINTERED MAGNET

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NdFeB sintered magnets are used for many important parts of fine electro-electronic industry. However, the main drawback of these materials is their low corrosion resistance. It is well reported in literature the promptness to corrosion of NdFeB sintered magnets [1-3]. Due to their manufacturing process (powder metallurgy sintering), they have significant porosity, and this contributes to decreasing corrosion resistance. The low corrosion properties of NdFeB sintered magnets are related to their microstructure composed of at least two phases, the Nd-rich and the magnetic φ-phase. Porosity and the electrical contact between phases of different electrochemical potentials are the main factors leading to the poor corrosion performance of these materials. In this study, the relation between microstructure and corrosion has been investigated by electrochemical polarization in an acid solution.

A commercial NdFeB magnet (Crumax) whose composition is given elsewhere [4] has been used. The surface was prepared by grinding with silicon carbide paper up to #1000. Half of the specimen surface was coated with 'nail polish', and then the specimen was polarized from the corrosion potential (E_{corr}) up to +800 mV in 0,01 M H_2SO_4 solution, at a scanning rate of 5 mV/s.

Figure 1 shows SEM and EDX analysis of the NdFeB used in this investigation. The Nd-rich phase and φ-phase are indicated. The volume fractions of Nd-rich phase and porosity were estimated as approximately 7% and 15%, respectively. The micrograph of the magnet after polarization is shown in Figure 2. The uncoated areas showed strong localized attack at the grain boundaries of φ-phase and disintegration of the material. The material starts to disaggregate by intergranular attack, leading to detachment of φ-grains. The previously coated surface remained unattacked.

Corrosion might have started due to the galvanic effect between Nd-rich phase and φ-phase in electrical contact. Since the more active phase, Nd-rich phase, is located in the grain boundaries of the φ-phase, intergranular corrosion occurs. The preferential attack of the more active Nd-rich phase is aggravated by the smaller area fraction of this anodic phase comparatively to the cathodic one, leading to large corrosion rates. The corroded region shows disaggregated dark gray grains (φ-phase), and a few white particles (Nd-rich phase). The intense intergranular attack leads to penetration of corrosion deeply into the material, as can be seen by the black holes in Figure 2. This can promote crevice corrosion. As the corrosion progresses, the disintegration of microstructure is accelerated, leading to a rapid deterioration of the magnet.

References.

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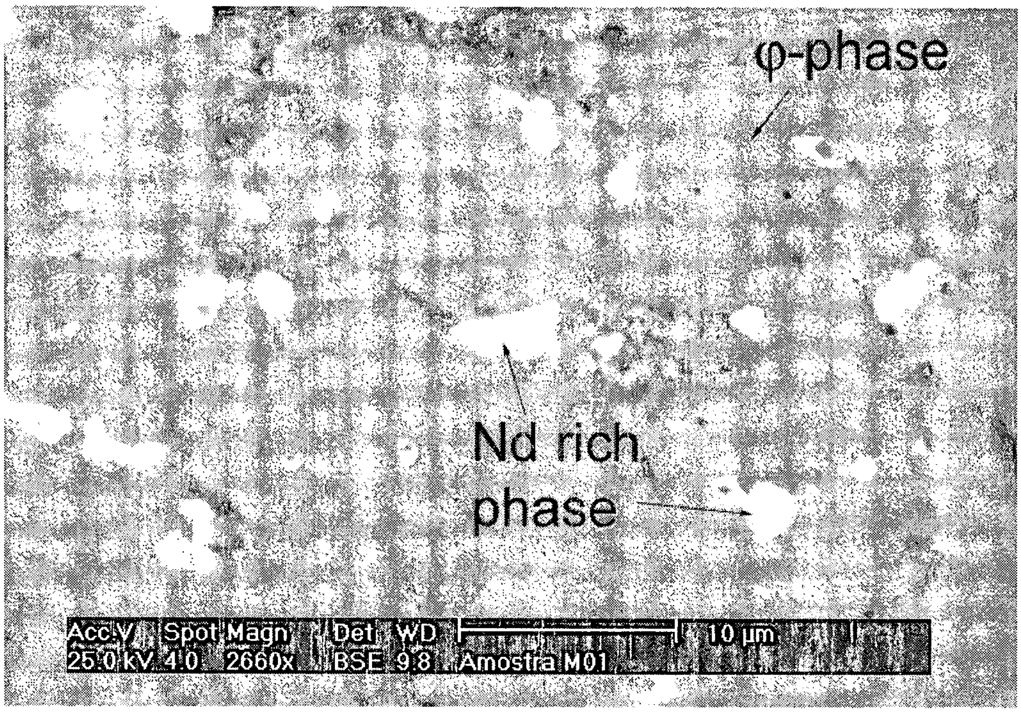

Figure 1 – NdFeB magnet surface showing main phases and porosity.

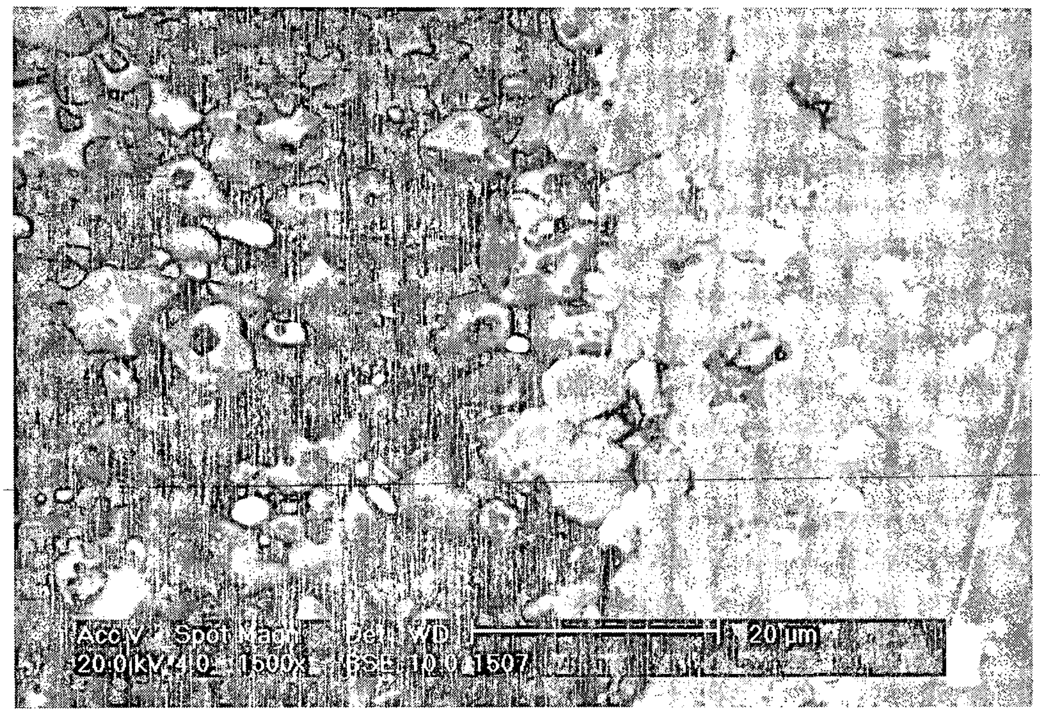

Figure 2 - NdFeB magnet after polarization in acid solution showing intense localized attack on part of the magnet. The non corroded area was protected by a 'nail polish' coating previous to polarization.