Poster | Raw materials

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[P2] Raw Materials & Recycling

Session Chair: Mr. Johann Fischbacher (University for Continuing Education Krems, Austria), Dr. Yusuke Hirayama (AIST, Japan)

[P2-30] Hydrogen processed NdFeB scraps: Evolution of properties under mechanical ball milling

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We present a study on the ball milling processing of the powders obtained after hydrogen processing of waste NdFeB permanent magnets. The aim of this research is the optimization of the Hydrogen Processing of Magnetic Scrap (HPMS) technique for recycling rare-earth permanent magnets from waste ones. HPMS decrepitates [1-4] and hydrogenates the grain boundaries and NdFeB grains leading the formation of final hydrided powders and other compounds. Post processing of these powders like particular particle size selection and further degassing process are required to get the RE hard magnetic powders that will be employed to produce new magnets [2]. In addition, the presence of the coating residues, RE hydrides, different alloys and oxides can affect the further production of the hard powders and to determine the final properties of the produced magnet. [2,3]
In this work, we have investigated the properties of the NdFeB powders produced after the HPMS process and further evolution under ball milling processing. We explore this technique to reduce the particle size alternatively to jet milling. End-of-life magnets from wind turbines were hydrogenated at room temperature. After the separation of the coating, the powders were processed by high energy ball milling using stainless steel jars and balls of different diameters under Ar atmospheres using balls of different diameters and milling times. We have performed an extended structural, morphological and magnetic characterization to investigate the effect of the milling time and the balls diameter in the final powders. In addition, structural and magnetic studies at temperatures up to 800°C and under inert atmosphere were performed to identify the presence of different phases and the structural changes due to desorption process. Initial hydrided powders are composed of polydispersed particles of hundreds of microns of size. X-Ray diffraction studies show the main presence of the hydrided 2:14:1 phase (H-2:14:1) and no α-Fe. EDX studies show that also that Fe oxides, Nd, Pr and Dy oxides are present together to other elements like Al and Cu. The specific magnetization of the

hydride powders, 130 Am^2/kg, is smaller than the bulk and its coercive field is negligible. The Curie temperature of the H-2:14:1 is around 350 °C, above of the NdFeB one. Two peaks in the susceptibility curves, at 400° C and at 620 °C, are tentatively associated to the gas desorption and the alloy decomposition to form α-Fe or Fe_2B, respectively.

The properties of the hydride powders are strongly modified by the ball milling processing and they depend on the milling parameters. The milling produces the particle size reduction but it depends on the balls that are employed and on the milling time. The milling process using smaller balls (5 mm of diameters) produces powders of micrometric sizes in few minutes and it is more efficient in the particle reduction than the use of the largest milling balls. The magnetic properties are also affected by the milling parameters, in particular coercive field increases but exhibiting a non-monotonic variation with the milling time. Structural characterizations indicate a change in the structure versus the amorphization which is not compatible with the observed magnetic properties. We will discuss these results to analyse the effects of ball milling processing to control the morphology and structure of RE powders produced by HPMS.

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