Structural and magnetic characterization of sintered Nd-Fe-B magnets machining sludge

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In the last decade, the progressive demand and production of Nd-Fe-B permanent magnets has resulted in an increase in the generation of production waste. Only in the machining process, the amount of sludge discarded can reach up to 30 wt% of the amount of sintered material (Yue *et al*., 2016). Therefore, the recycling and reuse of sintered Nd-Fe-B magnets machining sludge is necessary. In this scenario, this work aims to determine structural and magnetic characteristics of sintered Nd-Fe-B magnets machining sludge to enable the evaluation of its use in different recycling technologies. In order to do that, sintered Nd-Fe-B magnets machining sludge were characterized by X-ray diffractometry, Mössbauer spectroscopy and vibrating sample magnetometry. The XRD results showed that the Nd-Fe-B sintered magnets sludge were composed mainly of $Nd_2Fe_{14}B$ phase (95,1 %) and $Nd(OH)_3$(4,5 %). In addition, Mössbauer spectroscopy revealed that the machining process promotes disturbances in the Nd2Fe14B phase, as there were small variations in the hyperfine parameters of the 6 non-equivalent iron sites of its structure, and the degraded phases corresponds to 8,8 % of the total iron present in sludge. The sludge exhibits magnetic behavior but its coercivity (156 kA/m) and remanent magnetization (61 Am^2/kg) values are lower than those reported for the Nd-Fe-B magnet due to the presence of nonmagnetic phases because of $Nd_2Fe_{14}B$ phase degradation during machining process. By understanding the structural and magnetic characteristics of Nd-Fe-B machining sludge, it is possible to conclude that the material is viable for recycling and reuse, since the percentage of contaminants is small. One strategy is the recovery of the Nd2Fe14B phase through the calcium reduction-diffusion process to produce recycled magnets or hybrid magnets. Another strategy is to use it as a source of rare earth elements.

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