Recycling of NdFeB magnets: densification study by spark plasma sintering

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Abstract
Scientific community has been focusing on permanent magnets in the past few years for seeking alternate solutions from the so-called the rare-earth crisis. A large volume of Rare-earth Permanent magnets, after consumed, ends as Waste of Electrical and Electronic Equipment (WEEE), which can be treated as secondary resources of Rare-earth permanent magnet as there is high recycling potential for such scrap magnets. Recycling requires two steps: i) the pulverization of the magnets to obtain a powder and ii) sintering this powder to make new magnets. We have used powders produced by two different techniques: the solvo-themal process with ethanol and hydrogen decrepitation. For the solvo-thermal process optimum treatment parameters included 15 ml ethanol, 30 minutes of reaction time, and a temperature of 100°C. The resulting recycled powder exhibited coercivity of 636.6 kA/m and remanence of 0.76 T. Spark Plasma Sintering (SPS) of this recycled powder resulted in 96.2% relative density with a coercivity of 492.26 kA/m and remanence of 0.6 T. Secondly, hydrogen decrepitation (HD) was implemented to the scrap NdFeB magnets. The best recycled powders initially exhibited a coercivity of 374 kA/m and remanence of 0.63 T. After SPS study, 98% relative density could be achieved with slightly improved coercivity and remanence; 445.6 kA/m and 0.75 T, respectively.