Improving the properties of recycled rare earth permanent magnets with reduced heavy rare earth content through microstructural engineering

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Today, rare earth (RE) permanent magnets based on Nd-Fe-B exhibit the highest energy densities of all magnetic materials. Due to their excellent properties, they are of strategic importance in key technologies like e-mobility, robotics and renewable energy technologies. However mining and conditioning of the RE-containing ores do not only have considerable negative effects on the environment but are also limited to a few locations worldwide. The reliability of supply is considered highly critical [1, 2] – a situation that, with the upcoming transitions in the energy as well as in the mobility sectors, will be even intensified in the future. The dependence on only a few suppliers worldwide has already been the reason for high price volatility in the past. Industrial recycling of RE permanent magnets is one possibility to secure Europe's supply and to mitigate the criticality of these important materials. Additionally, magnets made of recycled material are ecologically favorable due to the elimination of mining and refining of rare earth elements. In this contribution, we present innovative hydrogen based technologies and concepts for functional (magnet to magnet) recycling of RE permanent magnets and demonstrate that recycled magnets are a suitable option for various applications [3]. For application in the mobility sector a high coercivity is required and the magnets often feature an increased content of very critical heavy rare earths (HRE) dysprosium or terbium. In order to optimize the required HRE content we analyzed in detail the element distribution and mechanism of coercivity increase at atomic level via atom probe microscopy for two different recycling approaches. For one approach we mixed recycled magnet powder with HRE hydrides and within the second we used the grain boundary diffusion

process (GBDP) for coercivity increase. The results enable the production of recycled magnets with properties comparable to primary magnets and optimized HRE distribution.

References:

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