Oral | Material, processing, and characterization

Tue. Jul 29, 2025 9:00 AM - 10:25 AM JST | Tue. Jul 29, 2025 12:00 AM - 1:25 AM UTC Convention Hall(300, 3F)

[O5] RE-Fe-B Magnets III

Session Chair: Prof. Dagmar Goll(Aalen University)

Invited

9:20 AM - 9:40 AM JST | 12:20 AM - 12:40 AM UTC

[O5-2] Reduction of heavy rare earths in Nd-Fe-B-based magnets by diffusion source and application area optimization

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Reduction in critical heavy rare earth (HRE) elements such as Dy and Tb in NdFeB-based magnets for coercivity enhancement at the high operating temperature in E-motors is important for sustainable green energy transition. In this work, we maximize HRE utilization by selective hardening of areas in the magnet such as corners or edges that are highly susceptible to demagnetization, as demonstrated by Finite Element magnetostatics simulation on an internal permanent magnet synchronous traction motor for electric vehicles (Fig. 1a). Commonly industrially used HRE source TbH_x as well as complex multi-component Tb-containing alloys such as $Tb_{10}Pr_{60}(Cu,Al,Ga)_{30}$ are investigated on commercial grade NdFeB-based sintered magnets. For Tb hydride not only is the HRE utilization less efficient, but also the diffusion is more sluggish resulting in shorter diffusion depth. Highly efficient Tb utilization using small HRE amount comparable to trace elements added to commercial sintered magnets (e.g. Al, Cu, Ga) and good high-temperature performance is reached. Diffusing 0.4 wt.% Tb results in coercivity of 1014 kA/m at 120 °C with only minor reduction in remanence from around 1.45 T in the initial magnet to 1.43 T after GBDP. To shed light on the HRE diffusion and local magnetic hardening, spatial coercivity mapping was done to investigate the local coercivity enhancement. The results are graphically illustrated in Fig. 1b. Corners clearly show the highest coercivity reaching nearly 1600 kA/m corresponding to 587 kA/m enhancement compared to the initial magnet. As expected for a diffusion-governed process, coercivity decrease is proportional to the distance from the diffusion source (corners).

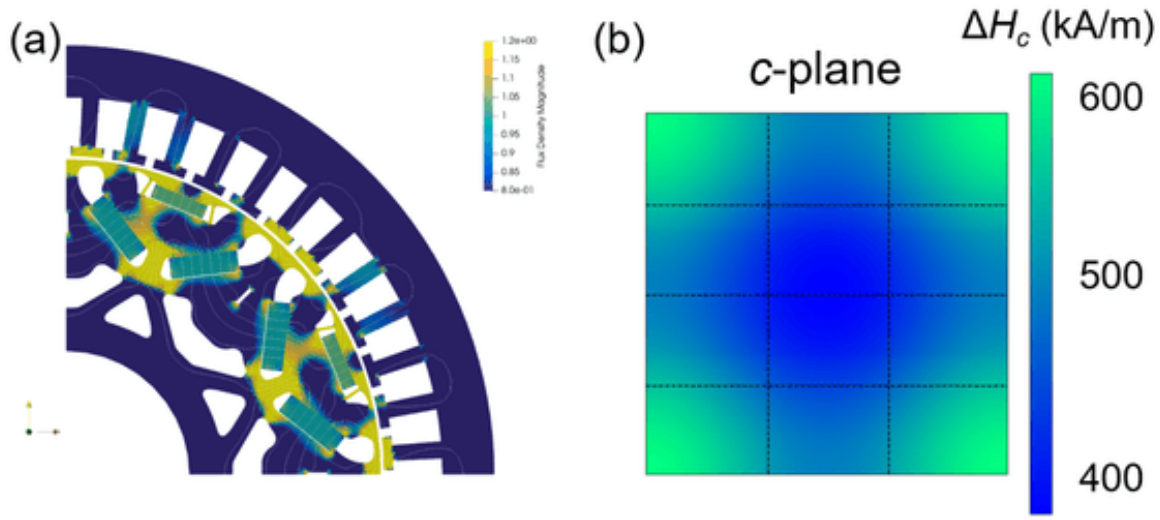

Figure 1: (a) 2D FE-Simulated flux density distribution for a typical internal permanent magnet synchronous traction motor from electric vehicles in the short-circuit operating point. (b) Coercivity mapping after HRE application on c-planes corners constructed from individual local M(H) measurements.