Jožef Stefan Institute
Ljubljana, Slovenia | K7 / Department for Nanostructured Materials

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The Hydrogen Ductilisation Process (HyDP)

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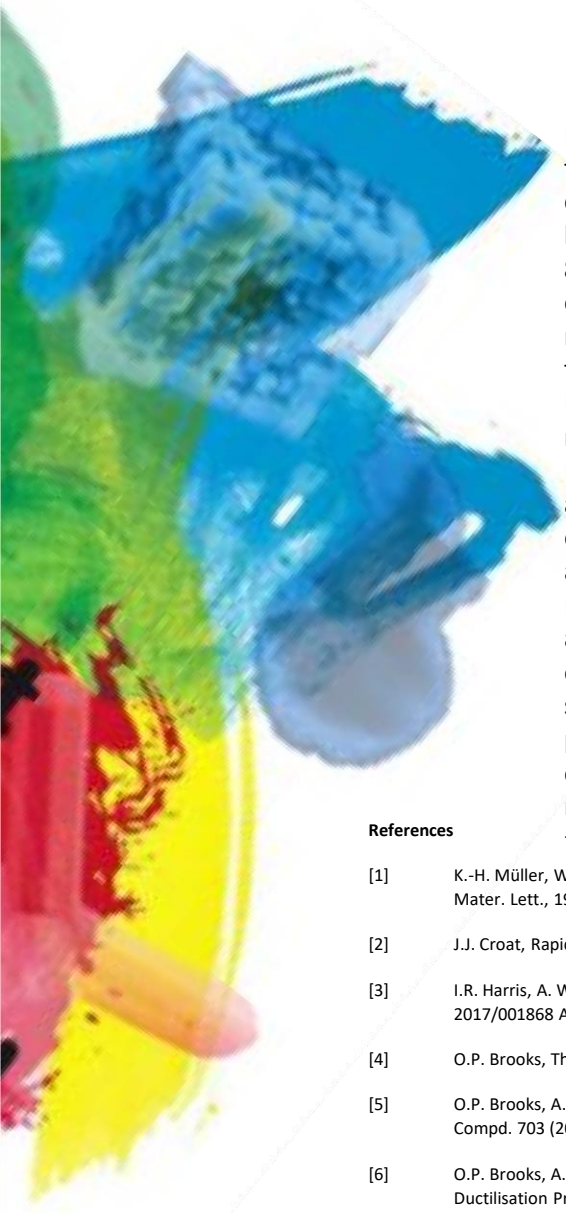

It is well known that NdFeB-type alloys are extremely brittle at room temperature. Therefore, to shape the material into fully dense magnets, it can either be reduced to a powder and sintered at high temperatures between 1,000-1,200°C [1,2] or hot pressed at temperatures between 800-900°C [1]. Recent studies [3–6] have shown that it is possible to overcome the brittle nature of NdFeB-type cast alloys by processing the material in hydrogen prior to mechanical deformation, using a process termed the 'Hydrogen Ductilisation Process (HyDP)' [3].
It was shown that the new processing technique could produce a ductile mixture of α-Fe, NdH_2 and Fe_2B utilising the high-temperature solid-Hydrogenation-Disproportionation (s-HD). This mixture can be deformed at room temperature and subsequently recombined under vacuum at elevated temperatures to form a submicron $Nd_2Fe_{14}B$ grain structure with a degree of anisotropy relative to the applied load.
Despite the successful demonstration that the HyDP can be a promising alternative for producing NdFeB-type permanent magnets with a degree of anisotropy, there are several limitations in the process, some of which still need to be resolved, such as avoiding the formation of the $Nd_{1+\varepsilon}Fe_4B_4$ phase, which has shown to fracture upon deformation and the formation of cavitation during the recombination process caused by the redistribution of the Nd-rich phase.

References

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[3] I.R. Harris, A. Walton, O.P. Brooks, Patent: Magnet Production GB1511553.8 (WO 2017/001868 AI), GB1511553.8 (WO 2017/001868 AI), 2017.

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[6] O.P. Brooks, A. Walton, W. Zhou, D. Brown, I.R. Harris, Complete ductility in NdFeB-type alloys using the Hydrogen Ductilisation Process (HyDP), Acta Mater. 155 (2018) 268–278. https://doi.org/10.1016/j.actamat.2018.04.055.

Kindly invited.