DENSIFICATION OF NdFeB MAGNETS PROCESSED BY ELECTRO-DISCHARGE SINTERING – MICROSTRUCTURE, MAGNETIC, AND MECHANICAL PROPERTIES

Lennart Leich, Ruhr Universität Bochum, Institut für Werkstoffe, Lehrstuhl Werkstofftechnik
lennart.leich@rub.de
Arne Röttger, Ruhr Universität Bochum, Institut für Werkstoffe, Lehrstuhl Werkstofftechnik
Martin Krengel, WILO SE
Werner Theisen, Ruhr Universität Bochum, Institut für Werkstoffe, Lehrstuhl Werkstofftechnik

Key Words: Nanocrystalline NdFeB magnets, Electro-Discharge Sintering, processing

In this work, the densification process of nanocrystalline NdFeB powder by electro-discharge sintering (EDS) was investigated. The EDS technique is used as a fast and energy-saving compaction process for metal powders. In contrast to the spark plasma sintering (SPS) process, EDS has not received much attention during recent years. SPS is a low voltage, direct current, pulsed current-activated, and pressure-assisted sintering process. Whereas EDS is also pressure-assisted, but uses electrical energy discharged from capacitors to densify conductive powders. During EDS a large current is discharged within 5 ms from capacitors into a pre-compacted loose powder, thus resulting in complete compaction.

In this study, we investigate the microstructure, magnetic, and mechanical properties of the compacted, hard magnetic NdFeB specimens under variation of the energy E_{EDS} and compression load p_{EDS}. For all specimens, the intrinsic coercivity $H_{c,J}$ decreases on increasing the discharge energy. However, the compaction load has apparently no influence on the coercivity $H_{c,J}$, whereas the residual induction B_r decreases only with increasing discharge energy. An increase in the compression load p_{EDS} causes an increase in the specimens' density and thus promotes residual induction B_r.

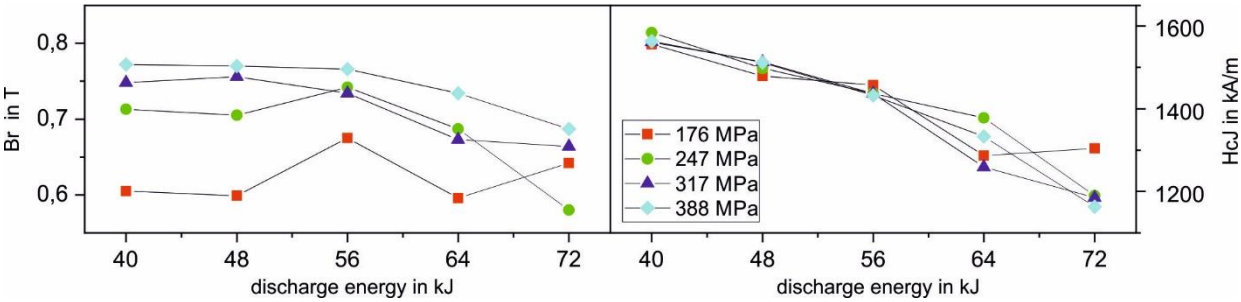

Figure 1: Energy product $(BH)_{max}$, remanence B_r, and coercivity $H_{c,J}$ with varying discharge energy E_{EDS} and compression load p_{EDS}.

The applied EDS parameters led to the formation of three different microstructures (insufficiently densified zone, fully densified zone, and remelted zone) along the cross-section of the EDS-densified specimens. Volume fractions of the three different microstructures that form during the EDS process determine the resulting mechanical and magnetic properties of the specimens.

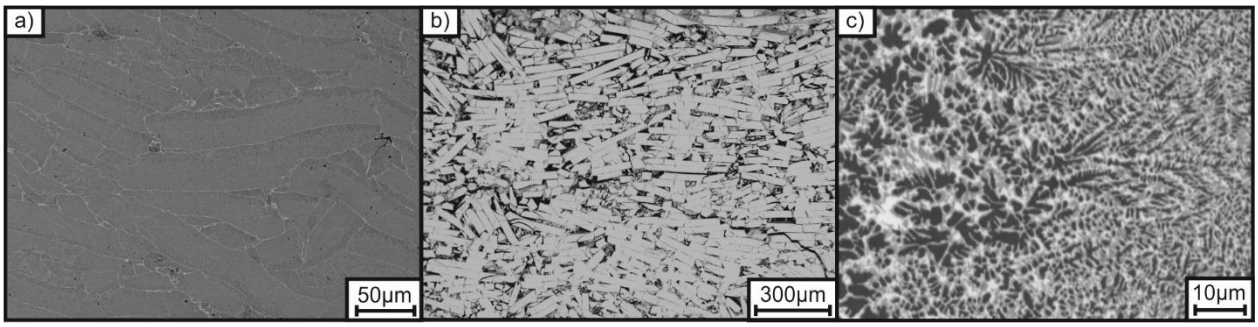

Figure 2: Three different microstructures in EDS-compacted NdFeB specimens: a) fully compacted zones, b) insufficiently compacted zones and c) remelted zones.