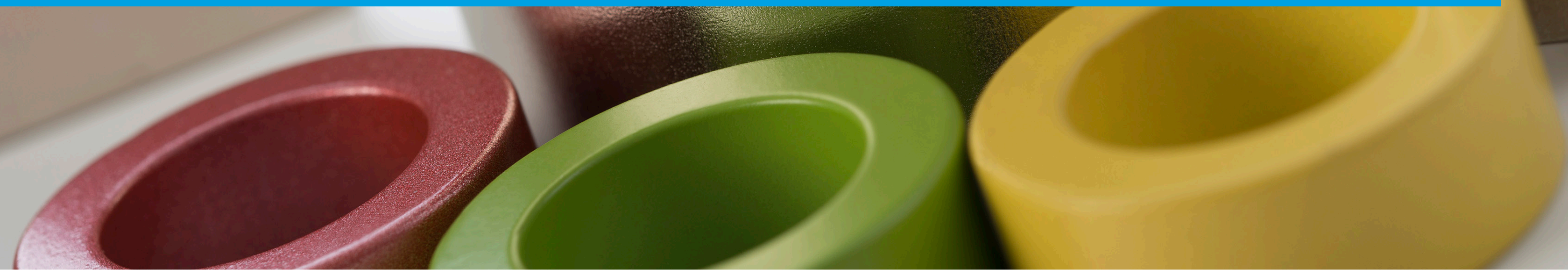
Materials Services | Materials Germany

# Neodymium-Iron-Boron magnets

Product information

thyssenkrupp



NdFeB magnets are made of an alloy of neodymium (Nd), iron (Fe), and boron (B) ($Nd_2Fe_{14}B$). The highest qualities are reached by adding materials like Co, Dy and Tb. They are the strongest commercially available types of permanent magnets.

Magnets made from NdFeB alloys enable the realisation of new technological solutions as well as the reduction of magnetic material with the same performance level of the system and not least the possibility of miniaturising the whole system.

In contrast to SmCo magnets the raw materials for NdFeB magnets are more readily available as the content of neodymium in rare earth ores is substantially higher than that of samarium. Recently admixtures of precious materials as Co, Dy and Tb are used to achieve higher qualities.

## Content



## Magnet shapes

Compression-mold pressed block, ring, segment and cylinder magnets can be produced. Small and micro magnets can be cut from larger blocks. Today it is common sense to press bigger blocks which will be subsequently cut down, grinded or eroded to the needed size.

## Delivery program

Our range comprises a wide selection of NdFeB materials with differing magnetic properties. They permit material selection tailored to individual application requirements. We look forward to advising you in detail.

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## Magnetic properties

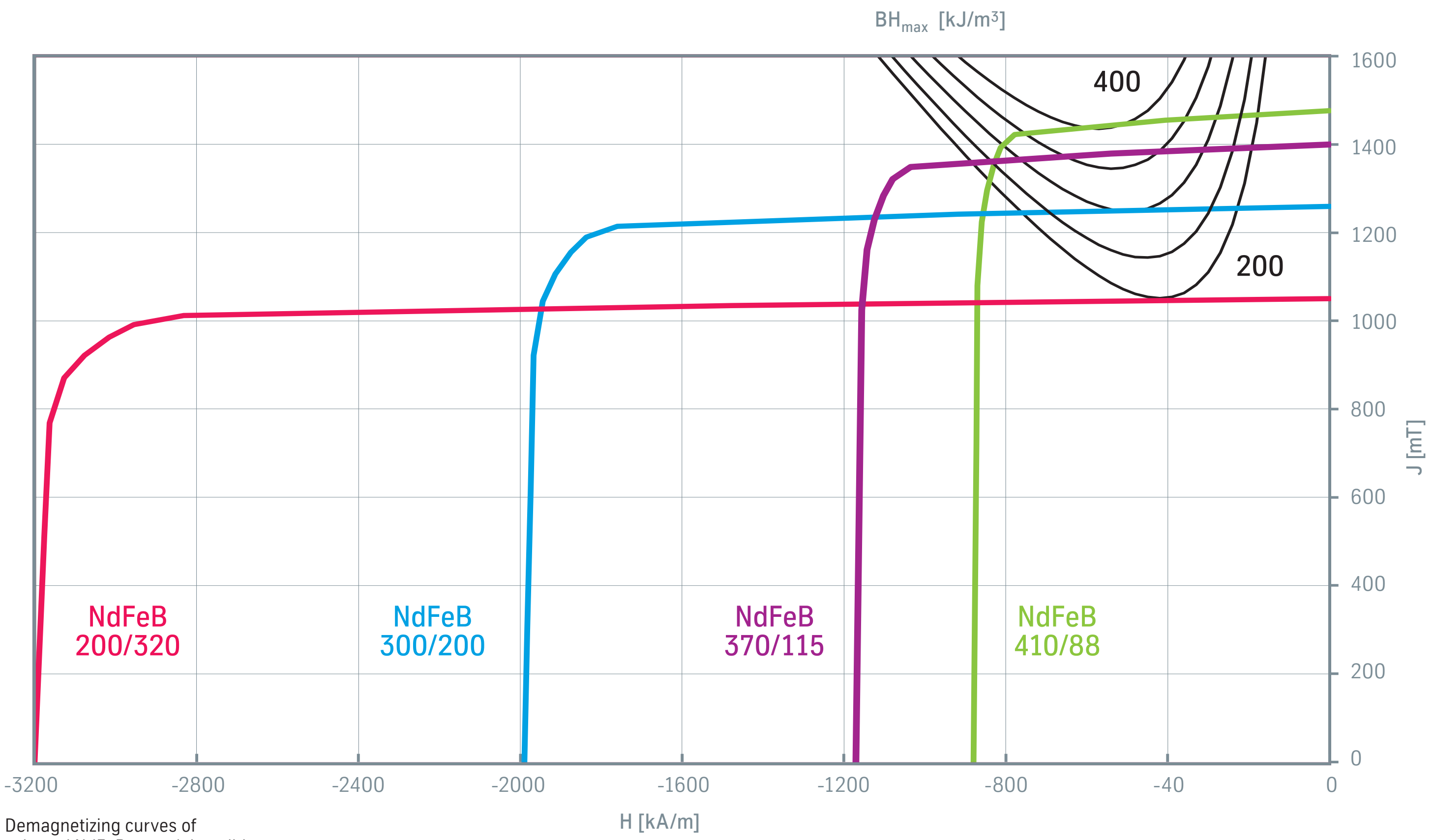
| Raw material | | Remanent magnetization | | Coercivity | | | | Energy product | | Operation temperature | Temperature coefficient | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $B_r$ | | $H_{cJ}$ | | $H_{cB}$ | | $(BH)_{max}$ | | $T_{max}$* | $TK(B_r)$ | $TK(H_{cJ})$ |
| | | mT | kG | kA/m | kOe | kA/m | kOe | kJ/m³ | MGOe | °C | %/K | %/K |
| NdFeB 410/88 | min | 1470 | 14.7 | 880 | 11 | 836 | 10.5 | 414 | 52 | 70 | -0.110 | -0.75 |
| NdFeB 370/110 | min | 1400 | 14.0 | 1100 | 14 | 1040 | 13.1 | 374 | 47 | 80 | -0.100 | -0.65 |
| NdFeB 330/140 | min | 1300 | 13.0 | 1350 | 17 | 970 | 12.2 | 330 | 41 | 120 | -0.110 | -0.55 |
| NdFeB 340/160 | min | 1330 | 13.3 | 1590 | 20 | 995 | 12.5 | 340 | 43 | 150 | -0.100 | -0.50 |
| NdFeB 300/200 | min | 1260 | 12.6 | 1990 | 25 | 940 | 11.8 | 300 | 38 | 180 | -0.100 | -0.50 |
| NdFeB 300/240 | min | 1260 | 12.6 | 2400 | 30 | 940 | 11.8 | 300 | 38 | 200 | -0.095 | -0.50 |
| NdFeB 225/280 | min | 1140 | 11.4 | 2800 | 35 | 850 | 10.7 | 225 | 31 | 225 | -0.090 | -0.45 |
| NdFeB 200/320 | min | 1050 | 10.5 | 3200 | 40 | 770 | 9.7 | 200 | 26 | 250 | -0.090 | -0.45 |

The relative permeability ($\mu_p$) is between 1.04–1.12.

* The actual maximum application temperature depends on the magnet's shear. This can only be precisely determined through a field-numeric calculation.

Selected material qualities (according EN 60404-8-1:2015). Further qualities on request.

## Demagnetizing curves




Demagnetizing curves of selected NdFeB material qualities

## Physical properties

| Raw material | Density | Young's modulus | Flexural strength | Com-pressive strength | Vickers hardness | Electrical resistivity | Heat capacity | Thermal conductivity | Coefficient of linear thermal expansion in mag. direction | Coefficient of linear thermal expansion normal to mag. direction |
|---|---|---|---|---|---|---|---|---|---|---|
| | ρ g/cm³ | E kN/mm² | $F_B$ N/mm² | $F_P$ N/mm² | $H_v$ | ρ Ω mm²/m | C J/kg K | λ W/m K | $\Delta\, dl_0$ $10^{-6}$/K | $\Delta\, dl_0$ $10^{-6}$/K |
| NdFeB | ~7.5 | 140 | 250 | 750 | 570 | 1.5 | 440 | 9 | 5 | -1 |

Curie temperature
Tc = 310-370 °C

# Chemical resistance

NdFeB magnets are not resistant to inorganic acids and alkaline solutions. Due to their high level of susceptibility to corrosion (surface rust corrosion) suitable surface protection should be applied for certain applications. This comes in the form of metallic coatings based on tin (Sn), zinc (Zn) and nickel (Ni). Varnish or plastic coatings can also be used.

Recent progress in the further development of this material has successfully diminished the corrosion problem.

# Production

Like SmCo magnets, Neodymium-Iron-Boron magnets are produced by the process of powder metallurgical sintering. The alloys can be produced by different processes: by melting and blending of certain raw materials or by reduction/diffusion of rare earth oxides and metals followed by grinding.

The nanocrystalline powder with a grain size of approximately 3–5 µm is dispensed into the blanking die of a mold. Then pressing under the influence of a magnetic field produces an anisotropic magnet. This aligns the anisotropic powder particles parallel to the direction of the magnetic field. The pressing process condenses the material and fixes the alignment. After that, in order to archive even higher quantities, an isostatic pressing process takes place. By this the density and homogeneity are increased. The magnets are then sintered at temperatures between 1030–1100 °C in an inert gas atmosphere or a vacuum. Sintering results in shrinkage of between 15–20 %. The density values measure between 7.4–7.6 g/cm³. The components are subsequently heat treated at temperatures of 600–900 °C. If specific tolerances are required the components can be ground after heat treatment.

# Temperature behavior

The strong temperature dependence of NdFeB magnets is mirrored by changing magnetic values affected by temperature. Due to the negative temperature coefficients of rare earth metals the relocation of the operating point should be considered. The values of the above mentioned table (Magnetic properties) have been measured at room temperature of 20 °C.



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