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Magnetic Bearings and High Dynamic Motors with Bulk YBCO and MgB2 Superconductors

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Abstract

Because of its unique magnetic properties melt textured material and especially single domain YBa2Cu3O7-d (YBCO) bulk HTS material has a large potential for magnetic bearing systems. Its material quality meets commercial demands in the energy technique. Substitutions of Y by Sm or Nd provide materials with increased magnetic properties, however the preparation needs a bigger effort. For hydrogen applications the structural more perfect MgB2 massive material is interesting.

The magnetic material quality is given by the ability to store magnetic energy in supercurrent loops. It is measured by the current load as product of critical current density multiplied with the smallest diameter of superconducting current loop in a single domain. Because the perovskite lattice of the YBCO material is strong anisotropic, we have to look on the current flow in the ab-planes. In MgB2 the current distribution is more istropic, however we have to look for flux jumps

The levitation force depends on the gradient of the magnetic field imposed by the levitated magnet and the total magnetic moment m of the superconductor. However, it is important to note, that between trapped field mapping results and levitation force results exists no simple relation in macroscopic disturbed material domains.

In general the macroscopic growth sector structure of melt textured blocks has to be considered by using the material for magnetic applications. Growth structure related magnetic hard and soft regions influence the penetration of magnetic flux.

We produce YBCO material blocks in different shape in a batch process and compose cryomagnetic function elements for bearings and electric machines by cutting and bonding crystallographic oriented parts of sinlge domain blocks. MgB2 blocks are prepared by a high pressure-high temperature technique in ISM Kiev. They are tested successfully in a reluctance motor at 20 K in MAI Moscow.

High power density electric reluctance motors with YBCO parts giving output power up to 200 kW are constructed and successful tested in OSWALD Electromotors Company Miltenberg/Germany and MAI Moscow.

A flywheel with 2 MW power for local energy tuning has been is under construction in the DYNASTORE project in Germany.