BULK MGB_2 AND MT-YBCO FOR SUPERCONDUCTING BEARINGS WORKING IN LIQUID HYDROGEN

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The development of hydrogen energy meet problems connected with liquid hydrogen transportation what, in particular, results in an increasing interest in the development of pumps working at liquid hydrogen temperature (20 K). High-performance submersible liquid hydrogen pumps requires superconducting bearings which can trap magnetic fields up to 1 T at 20 K. Operation of superconducting (SC) devices is independent from the superconductor type and the choice of material depends on the required operation temperature, superconducting characteristics, etc. The superconductors can operate as quasi-permanent magnets and can provide magnetic fields up to an order of magnitude higher than the best traditional permanent magnets. In the case of bulk superconductors it is not necessary direct, continuous connection to a power supply, as in the case of electromagnets. Bulk SC magnet may be safely and conveniently turned off by its heating.

MgB_2 and melt-textured YBCO (MT-YBCO) ceramics are promising candidates for this application. The present study aimed at investigation and comparison of superconducting properties and microstructure of differently prepared MgB_2 and differently oxygenated MT-YBCO. The ability of materials to trap magnetic fields was studied using hollow cylinders of the same geometry which were manufactured from hot pressed (under 30 MPa) blocks prepared from magnesium diboride with titanium, titanium oxide and titanium carbide additives as well as from melt-textured YBCO ceramics. The addition of titanium and titanium containing substances to MgB_2 was aimed not only for creating additional pinning centers in the material, but as well to avoid formation of cracks and voids in big blocks due to presence of admixture hydrogen in Mg:2B powdered mixture. Titanium is good getter of hydrogen when added to MgB_2 what has been shown by us earlier.

The results of magnetic induction measurement by Hall probe of the hot pressed MgB_2 rings with different additions show that despite the similar J_c and visual absence of cracks and same trapped field at 20 K, the materials with Ti-O addition (obtained by electroerosion dispersion method) when heated to higher temperatures demonstrated less flux jumps than that with Ti addition. And the worthiest behavior demonstrated material with TiC addition despite the higher J_c observed in the small sample cut from the same block studied by VSM. The structure of this material was the most inhomogeneous and it was very porous. The high porosity can be the obstacle of the material exploitation in submersible liquid hydrogen pump because of high surface area which will be in contact with liquid hydrogen and due to this the material can be less stable.

The high critical current densities and critical magnetic fields should ensure high trapped fields in all these materials. Indeed all materials demonstrated the required performance; however, flux jumps are a serious issue in MgB_2 even in crack free cylinders and impeded higher trapped fields. The superconducting properties of all materials investigated in this study are sufficient for magnets in submersible liquid hydrogen pumps with a required trapped field of about 500-600 mT. Their stability in liquid hydrogen is under the study. An inhomogeneous and porous MgB_2 structure was found to be less stable against flux jumps. On the other hand, deviations of the material matrices from MgB_2 stoichiometry did not impede high J_c and trapped fields.

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