HTS versus LTS: Physics, Technology, and Application Prospects

Michael Eisterer

Atominstitut, TU Wien, Stadionallee 2, 1020 Vienna, Austria

E-mail: eisterer@ati.ac.at

***Abstract*— Niobium and niobium compounds still dominate applications of superconductivity despite the discovery of many exciting new superconductors during the past decades. In particular, the cuprate and iron-based High Temperature Superconductors (HTS) evidently have superior properties in terms of transition temperature (T_c) and upper critical magnetic field (B_{c2}), thus promising largely extended operation conditions for superconducting devices. Magnesium diboride (MgB_2) with its intermediate T_c adds to the list of superconducting materials that are interesting for applications because of its inexpensive constituents and production techniques. This talk focuses on the named materials' prospects for applications in magnets and electricity generation or distribution from a viewpoint of their basic properties, and the resulting technological issues. While the former favor the "unconventional" superconductors, the latter impede their utilization as long as the performance of Nb-Ti or Nb_3Sn is sufficient. On the other hand, only HTS enable the next generation of high-field magnets and superconducting power applications, such as cables, fault current limiters, motors, and generators. While T_c and B_{c2} set the limits for the operation temperature and field, the depairing current density (J_d) limits the current, hence being the third crucial parameter for power applications. The achievable current densities depend not only on the intrinsic properties, but also to a large extent on the material's defect structure. However, for a given defect structure the maximum loss free currents do correlate with J_d, as will be demonstrated by neutron irradiation experiments on a broad spectrum of "technical" superconductors. This allows for an estimate of the ultimate limits in comparison with the actual performance, and hence provides most valuable information on strategies for material optimization. Such strategies for making the discussed superconducting materials meet the requirements of currently envisaged applications (e.g. magnets for nuclear fusion or accelerators, such as the Future Circular Collider, FCC) will be reviewed.**

***Keywords (Index Terms)* — Superconducting materials, critical current density, depairing current density, transition temperature, upper critical field, neutron irradiation, prospects for applications.**

IEEE/CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), No. 42, October 2017.
Received October 12, 2017; Selected October 17, 2017. Reference CRP77; Category 2, 5, 6.
This plenary presentation 2P1-01 was given at EUCAS 2017, September 17-21, 2017, Geneva, Switzerland.