MAR11-2010-008678

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Superconducting Materials, Magnets and Electric Power Applications

GEORGE CRABTREE, Argonne National Laboratory and University of Illinois at Chicago

The surprising discovery of superconductivity a century ago launched a chain of convention-shattering innovations and discoveries in superconducting materials and applications that continues to this day. The range of large-scale applications grows with new materials discoveries - low temperature NbTi and Nb_3Sn for liquid helium cooled superconducting magnets, intermediate temperature MgB_2 for inexpensive cryocooled applications including MRI magnets, and high temperature YBCO and BSSCO for high current applications cooled with inexpensive liquid nitrogen. Applications based on YBCO address critical emerging challenges for the electricity grid, including high capacity superconducting cables to distribute power in urban areas; transmission of renewable electricity over long distances from source to load; high capacity DC interconnections among the three US grids; fast, self-healing fault current limiters to increase reliability; low-weight, high capacity generators enabling off-shore wind turbines; and superconducting magnetic energy storage for smoothing the variability of renewable sources. In addition to these grid applications, coated conductors based on YBCO deposited on strong Hastelloy substrates enable a new generation of all superconducting high field magnets capable of producing fields above 30 T, approximately 50% higher than the existing all superconducting limit based on Nb_3Sn. The high fields, low power cost and the quiet electromagnetic and mechanical operation of such magnets could change the character of high field basic research on materials, enable a new generation of high-energy colliding beam experiments and extend the reach of high density superconducting magnetic energy storage.