Application Driven Superconducting Wires Development and Future Prospects in US

Qiang Li

Brookhaven National Laboratory, USA
Email: qiangli@bnl.go

***Abstract*— In 2007, the Advanced Research Project Agency for Energy (ARPA-E) was formed within the US Department of Energy (DOE), based on the recommendation of the "Rising Above the Gathering Storm Report." [DOI: 10.17226/11463] It made the initial funding at the end of 2009. Over seven years, ARPA-E has provided funding for more than 475 projects.[1] About half a dozen of them aimed at developing transformative superconducting technologies for energy applications. Superconducting wires offer powerful opportunities for increasing capacity, reliability, and efficiency of the electricity grid. Superconducting magnetic energy storage (SMES) systems can store electricity with near zero energy loss, and have instantaneous dynamic response. Superconducting coils can provide a lower cost alternative to rare-earth permanent magnets used in rotary machines and generators for wind turbines. Application driven superconducting wires development is at the center of the ARPA-E funded superconducting technology projects. For example: ARPA-E funded two teams in the Rare Earth Alternatives in Critical Technologies (REACT) program to develop advanced high temperature superconducting (HTS) wire for wind power applications: Brookhaven National Lab[2] (teamed with AMSC) and University of Houston[3] (teamed with SuperPower). In wind generators, the need for rare earths is quite large (a generator in a wind turbine contains approximately 100 kg of rare earth materials for every MW of rated power). Using HTS coils in wind turbines could dramatically reduce the rare earth requirement compared with traditional permanent magnet (PM) generators (from ~100 kg of Nd and Dy per MW in a PM generator to ~100 grams of rare earths per MW in an HTS generator). In addition, HTS generators offer better performance and lower weight for large turbines. Both teams worked with the second generation 2G (RE)BCO coated conductors, and they achieved quadruple increase of the critical current under operating conduction using different approaches. Recently, The DOE - Office of Energy Efficiency and Renewable Energy's (EERE) Advanced Manufacturing Office issued a new Call[4] for Next Generation Electric Machines: Enabling Technology, where superconducting wire manufacturing is one of the technical areas of interests. In this presentation, I will review the recent accomplishments on superconducting wire development broadly, discuss technical advances in details, and provide my view on the future prospect in US.**

References

1) http://arpa-e.energy.gov/?q=publications/arpa-e-first-seven-years-sampling-project-outcomes
2) http://arpa-e.energy.gov/?q=slick-sheet-project/improved-superconducting-wire-wind-generators
3) http://arpa-e.energy.gov/?q=slick-sheet-project/low-cost-superconducting-wire-wind-generators
4)http://www.energy.gov/eere/articles/energy-department-announces-25-million-develop-nextgeneration-electric-machines

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