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[Invited] Demonstration of Advanced Superconductors with Four-fold Improved Performance for High Power Wind Generators

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Superconducting generators are a viable alternative to permanent-magnet-based generators for direct-drive, high-power wind turbines especially because of their potential low operating cost, reduced weight, and near elimination of rare-earth materials. A major challenge with the commercialization of superconducting generators for wind turbines is the high cost of present day's high temperature superconductors (HTS). The University of Houston along with its industrial partners SuperPower, E2P Solutions and TECO-Westinghouse and the National Renewable Energy Laboratory were awarded a program in 2012 by the Advanced Research Projects Agency-Energy (ARPA-E) to develop transformative technologies to improve coated conductor performance by a factor of four in the operating condition of superconducting wind generators (30 K, 2.5 T). This improved conductor performance will lead to approximately four-fold less wire needed for the same generator rating resulting the significant cost and weight savings.
In the ARPA-E funded program, we were able to successfully exceed a four-fold improvement in coated conductor performance at 30 K, 2.5 T by engineering nanoscale defects in the superconductor tapes made by a metal organic chemical vapor deposition (MOCVD) process. Critical currents over 4200 A corresponding to a critical current density of 16 MA/cm2 have been achieved at 30 K, 2.5 T in the advanced superconductors made in this program. This value compares with a critical current of 750 A at 30 K, 2.5 T of HTS tapes produced by industry today. By overcoming the primary shortcoming, namely the high wire cost, the advanced coated conductor technology developed in the ARPA-E program can spur the commercial feasibility of superconducting wind generators.

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