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TU-1

Material Properties of High Temperature Superconductors for Power Application

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Superconductors are attractive for power applications, because they have no resistivity and high critical current density. This property enables one to build power machines such as cables, transformers, motors and generators of higher efficiency, smaller size and lighter weight. Superconductors transform into the normal state when the current exceeds their critical current density. This property makes the superconductor a promising material for fault current limiters. Superconducting fault current limiters limit the fault current much faster than conventional ones. Superconductors also have the property that they repel the magnetic field, and flywheels can be levitated very stably and rotated at high speeds without energy loss. One can thereby store energy in flywheels in the kinetic energy form and convert it into the electric energy when needed. Discovery of high temperature superconductors (HTS) in 1986 opened a way that can lead to economically-feasible application of superconductors. Although the power application to date that has been commercialized is based on low temperature superconductors, superconducting power machines has been built of HTS and successfully field-tested. Several machines are currently being tested in live grids. Success of HTS power application depends on developing materials of high quality and low cost, building and testing of key components, and proving their reliability. Knowledge on material properties of superconductors is important for the research and development of superconductors and superconducting power machines, because the properties determine their performance. Reviewed here are the material properties of HTS for power applications. First, current R&D status of superconducting power machines will be briefly reviewed. Then, the material properties that affect power application of superconductors will be covered. Based on this, requirements for successful applications of superconductors will be drawn.

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