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Strain control of composite superconductors to prevent degradation of superconducting magnets during a quench

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In this talk we will probe characteristics and failure mechanisms of composite superconductors during a quench, arriving at the conclusion that strain control of composite superconductors is the key to prevent degradation of superconductors within a superconducting magnet during a quench. Experimental data and analysis will be given to support the arguments that for Nb3Sn wire, Bi-2212 wire, MgB2 tape and wire, and Bi-2223 tape, degradation during a quench is driven by axial strain, and that for ReBCO coated conductors, degradation is mostly driven by the tendency of REBCO coated conductor to delaminate, caused by the thin film multilayered structure developing peeling stress when experiencing localized temperature rises. We will explore the implications of these findings on designing superconductors, cables, and magnets, and give predications of practical quench-induced degradation limits of these superconductors. The importance of this work will be illustrated using the case of recently developed Sumitomo CT-OP Bi-2223-NX high strength tapes, for which the practical axial stress limit is experimentally proved to be far less than those determined by the conventional axial stress-strain tensile measurement, and determined under various bending strain, high Lorentz forces, and high current and with presence of a quench.

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