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Sat-Mo-Po.08-09: Ultra-high thermal conductivity metal-halide insulation for cryogenic electromagnets: processing and performance

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There remains an urgent need for higher thermal conductivity electrical insulation for high steady-state thermally loaded superconducting and cryoresistive electromagnets, such as those used for fusion, undulator light sources, particle colliders, and alternating-current operated electric machines. Polymeric materials, which are currently used, demonstrate degraded thermal conductivity at cryogenic temperatures and max out at single digit W/mK. In addition, polymeric insulations have a limited pot-life, making impregnation of thick windings more difficult.

Shown in this research is ultra-high thermal conductivity polycrystalline CsI (>100 W/mK), which may be melt impregnated during a typical Nb3Sn, MgB2, or Bi-2212 heat treatment schedule. The maximum steady-state operational peak-to-peak alternating current density of sub-scale conduction-cooled electromagnetic windings impregnated with CTD-101K following standard procedures will be compared with those impregnated with polycrystalline CsI. Challenges of metal-halide melt impregnation will be presented, and the importance of finding high thermal conductivity metal-halide ceramics and processing techniques which may be integrated for REBCO coated conductors will be discussed. Other processing routes such as high solid loading gel coatings, laser additive manufacturing, and hot pressing of metal-halide powder into bulks be presented, as these processes may prove useful to provide auxiliary electrical isolation components.

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