Materials Process and Machine Application of Bulk HTS

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Abstract - We report the completion of a refrigeration system for rotating machines associated with the enhancement of the trapped magnetic flux of bulk high-temperature superconductor (HTS) field poles. A novel cryogenic system was designed and fabricated. It is composed of a low loss rotary-joint connecting a closed-cycle thermosyphon under a GM cryocooler and the rotor by using a refrigerant. Condensed neon gas was adopted as a suitable cryogen for the operation of HTS rotating machines with field poles composed of RE-Ba-Cu-O family materials, where RE is a rare-earth metal. As for the material process of the bulks HTS, thanks to the magnetic particle addition to $GdBa_2Cu_3O_{7-d}$ (Gd123) bulk superconductors, more than 20 % increase of the trapped magnetic flux density was achieved at liquid nitrogen temperature. The field pole Gd123 bulks up to 46 mm in diameter were synthesized with an addition of Fe-B alloy magnetic particles and assembled into the testing synchronous machine rotor. Successful cooling of the magnetized rotor field poles down to 35 K and the first-step low-output-power rotating operation was achieved up to 720 rpm in the test machine with eight field-pole bulks. Present results submit a substantial basis for the completion of a prototype system of the rotating machinery of applied HTS bulks.

Keywords - AC losses, flux pinning, Gd-Ba-Cu-O bulk superconductors, magnetic particles, neon, pulsed-field magnetization, thermosyphon

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