Potentials of HTS Superconducting Materials for Extensive Applications

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Abstract — Cuprate superconductors have long history of about 30 years and high critical current properties enabling various applications. In the last decade, this could be demonstrated by implementing long length tapes of Bi2223 and RE123 through several breakthroughs in controlling crystal orientation and chemical composition. Their superconducting properties, including J_c-B characteristics, could be further improved by more precise control of microstructures and local chemical compositions, in addition to introducing strong pinning sites.

The more recently demonstrated iron-based superconducting films and tapes have also exhibited largely improved critical current properties, suggesting high potentials for high field applications. In addition, new iron-based superconductors are discovered while superconducting properties of already known compounds have been also improved by optimization of synthesis conditions and doping techniques. Both cuprate and iron-based superconductors have many common features, such as high T_c, high H_{c2} (i.e., short superconducting coherence length resulting in a small pinning volume), layered crystal structures with accompanying anisotropies of physical properties and crystal shapes and superconducting behavior highly sensitive to chemical composition (i.e. carrier doping level) and local crystal structure around superconducting layers. The knowledge and techniques attained during the development of cuprate superconducting materials are considered applicable for enhancing performance and manufacturability of iron-based superconducting materials. Both superconducting material systems exhibit common features such as band structures and weak-link behaviors.

The derivable potentials of both superconducting materials systems are discussed by elucidating and comparing their various basic physical properties and respective critical current performances of tapes and wires. In particular, the importance of an increase in superconducting condensation energy by controlling local chemical compositions and local crystal structures will be indicated.

Keywords (Index Terms) — Cuprate, Bi2223, RE123, coated conductor, iron-based superconductor, chemical composition, pinning, doping.