Magnetic Shields of Various Shapes Combining Bulk Superconductors and Tapes

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Superconductors can be used to make very efficient low frequency magnetic shields [1]. One of the key advantages of type-II superconducting shields is their ability to operate at much higher fields than conventional ferromagnetic materials, the latter being limited to their saturation magnetization. For superconductors, the maximum magnetic field at which magnetic shielding becomes ineffective depends on both the critical current density J_c and the geometric parameters of the shields, mainly (i) the thickness of the walls and (ii) the size of the superconducting current loops induced by the applied field. Although their geometries differ significantly from each other, bulk superconductors [2-3] and coated conductor tapes [4-5] offer the opportunity to design remarkable magnetic shields or screens: bulk superconductors can be manufactured in the form of plates or cylinders of thick walls and moderate size, while coated conductor tapes involve thin superconducting films over significant lengths. In this contribution, the main design requirements for magnetic shields made of either bulk superconductors or coated conductor tapes will be reviewed, together with their performance levels at low frequency. Then various configurations for which bulks and tapes can be combined efficiently will be investigated. We will consider the situations for which the magnetic shields or screens made of bulk superconductors can benefit from the presence of superconducting tapes and vice-versa. These situations will be illustrated with experimental results at 77 K and finite element modelling of magnetic shields made of bulk large grain (RE)$Ba_2Cu_3O_7$ (RE = Rare Earth), bulk polycrystalline $Bi_2Sr_2Ca_2Cu_3O_{10}$ and 2nd generation (RE)$Ba_2Cu_3O_7$ coated conductor tapes. For the latter we will both consider the case of tapes of nominal width (10-12 mm) and the benefits that can be brought by using much larger (40 mm) tapes.

References

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