

Abstract of thesis entitled

**Study of Bi-2223 High Temperature Superconducting Tapes for
RF and Gradient Coils in Magnetic Resonance Imaging**

submitted by

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Since the discovery of high temperature superconductor (HTS) by Bednorz and Muller in 1986, there has been a fast development in research and industry. In the domain of MRI, HTS materials are firstly used in RF receive coil to greatly reduce the coil noise and hence improve the signal-to-noise ratio (SNR). Epitaxial thin films such as YBCO are excellent for their good alignment of grains and extremely low surface resistance, so they are well-suited for RF receive coils to significantly increase the image SNR or shorten the scan time. SNR improvements of up to tens of times have been successfully demonstrated for high field micro-imaging or low field imaging, where the sample loss dominates the total loss. However, many intrinsic restrictions and engineering issues associated with HTS thin films limit their large-scale applications and commercialization.

Bi-2223 tape is such a flexible and low-cost commercial HTS material that shows promise for use in both passive low-power electronic applications to increase SNR and active high-power electrical applications to reduce power loss. In this thesis, the use of Bi-2223 HTS tapes for RF and gradient coils for MRI is considered.

For applications in RF coils, Bi-2223 HTS tape is low cost, easy coil fabrication, convenient tuning and matching, flexibility for large coil size, and potential for use in

fabricating various types of RF coils, gives it several advantages over YBCO thin films. In this thesis, a theoretical model for quality factor of a Bi-2223 RF coil is set up to investigate its feasibility for high field applications and predict the SNR improvement. A normal-sized 5cm RF coil made of Bi-2223 tape is designed and applied to phantom imaging at high field of $1.5T$ for the first time. The results show moderate SNR improvements by a factor of 1.36 and 1.11, over a same-sized copper coil at room temperature and at liquid nitrogen of $77K$, respectively. It is predictable that HTS tape coils would show merits on SNR from $0.2T$ with coil size of 5-inch up to $1.5T$ with coil size of 2-inch. The SNR performance by Bi-2223 tape coil can be further optimized by well addressing the engineering issues and the material development of the HTS tape itself.

In the study of Bi-2223 HTS tapes for MRI gradient coils, AC power loss mechanism of the tape is analyzed theoretically first. The power loss measurement of the Bi-2223 tape is carried out to cover the normal working frequencies of gradient coils from $200Hz$ to $2KHz$, and the results show the great advantage of the tape in much lower power loss than copper, even if the critical current degradation is considered. A prototype HTS gradient coil is designed and fabricated. The gradient field distribution by the prototype is measured and agrees well with the theoretical values. The HTS coil performances are compared with a copper coil in the aspects of resistance, inductance, power loss and continuous gradient rating. The technical issues in designing and fabricating HTS gradient coils are also addressed including resistance, gradient strength, continuous gradient rating, critical current degradation, magnetic anisotropy, cryostat and mechanical performances.