

Development of Superconducting RF Probe for Low Field Orthopedic Imaging

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Introduction

A high quality receive coil, especially high temperature superconducting (HTS) receive coil [1] is of strong interest in clinical MRI because it can increase SNR of image without going with the traditional approach of increase field strength of magnet. An orthopedic HTS coil probe product is designed and developed for 0.3T MRI Scanner.

Methods

Coil Design: The coil is made of HTS film on a four-inch diameter sapphire substrate, with a coil diameter of 3.5 inch. The coil is fabricated with photolithography process. The resonant frequency is 12.858 MHz with the Q -factor of 7800 unloaded and 2000 loaded, which is much higher than the HTS tape coil previously developed [2]. The coil is in contact with a ceramic cold finger of a cryostat which is cooled by liquid nitrogen. The coil and cold finger are placed in a vacuum housing to thermally insulate it from being heat up by room temperature environment. The separation between the coil surface and the room temperature sample is about 10mm. Liquid nitrogen (LN₂) is stored in a small separated tank to continuously supply to the cryostat. The coil is actively decoupled during transmit period. For SNR gain evaluation purpose, a same sized copper coil is constructed and tested with the same phantom and same protocols as those for the HTS coil. The high quality copper coil is made of copper tubing with a tube diameter of 0.25 inch. The Q factor of the copper coil is 300. The copper coil has actively decoupling feature.

Results

Fig.1 shows the vacuum insulated LN₂ based cryostat developed for the HTS coil. The HTS RF probe is applied to human orthopedic imaging at 0.3T system.

Fig.2 are the images taken with gradient echo sequence (Resolution: 256x256; FOV: 150mm x 150mm; TR: 400ms; TE: 25ms; ST: 5mm; Nex: 4). Fig. 2 (a) was taken by the room temperature copper coil and the SNR is 36.35. Fig. 2 (b) was taken by the HTS film and the SNR is 79.97.



Fig.1. LN₂ based cryostat

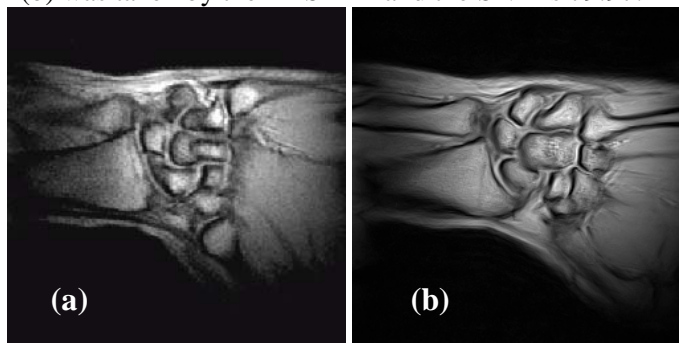


Fig.2 Image acquired by copper (a) and HTS (b) coil

Conclusions

Compared to the traditional copper coil, the Q-factor of the HTS film coil is much higher. The highest SNR gain is about 2 to 3 times. This advantage of the HTS coil has a large potential application in low-field MRI system to improve the image quality.

Ref:

[1] R.D. Black et al., "A HTS Receiver for NMR Microscopy", Science 159, 793-795 (1993)

[2] S.Y. Chong, et al., "HTS Volume Coil with Improved Imaging Volume", Proc. ISMRM (2008)