1.5-mm HTS Probe Design for 600 MHz NMR

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Introduction
NMR probes with High Temperature Superconductors (HTS) coils offer extremely high sensitivities. We previously designed a \(^1\)H optimized 1-mm triple resonance probe.\(^{[1]}\) The current project is intended to develop a 1.5-mm probe that will be optimized for \(^{13}\)C detection, with minimum or no compromise on \(^1\)H sensitivity. We are currently developing two versions of the probe, as detailed below.

Experimental
We have previously reported the use of IE3D, a commercial electromagnetic (EM) simulator from Mentor Graphics, Inc., for the evaluation of candidate coil designs. We have further developed the simulation tests to estimate the sample loss. This is achieved by using IE3D to predict the change in Q-factor upon loading the coil with a lossy sample. The sample loss can be reduced by probe design by reducing the electric field in the sample region.\(^{[2]}\)

Version 1 utilizes a more conventional nesting of 4 pairs of coils. The probe is optimized for \(^{13}\)C detection by placing the \(^{13}\)C coils closest to the sample. The coils have been fabricated, and are now being assembled into a probe body at Agilent.

Version 2 utilizes experimental double resonance designs, which can generate two resonances on a single chip. The probe will therefore employ only two pairs of coils -- one pair for \((^{1}\text{H}/^{13}\text{C})\) and another for \((^{2}\text{H}/^{15}\text{N})\). The coils have undergone several iterations of fine tuning, in order to optimize performance parameters, such as B\(_z\) homogeneity, electric field, and in the case of low frequency coils, their higher order mode spectrum. The coils will be fabricated soon and assembled into the version 2 probe early in 2012.

Additionally, design improvements have been predicted for the \(^{13}\)C coils in version 1, to make them more salt tolerant. For a 100 mM NaCl sample, an SNR improvement of approximately 10% is predicted. These coils will also be fabricated, and depending on bench tests, they may be switched into the version 1.

Results
An Agilent 600 MHz spectrometer, along with a cryogenic station is installed and operational at the University of Florida. The probes will be installed and available for use through the AMRIS user program.

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References