Resonator with Improved Temperature Stability and Capability of Fast Frequency Tuning for Proton Electron Double Resonance Imaging and Spectroscopy

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Introduction

PEDRI application of *in vivo* imaging of free radicals has recently attracted more attentions as a promising technique (1) (2). In order to saturate electron spins, a long EPR pulse (3 x proton T1) and relative high power is normally needed. The EPR irradiation (normally at frequency 100 MHz – 1.2 GHz) can heat the resonator together with sample causing the resonator frequency shift and coupling change. Alderman-Grant (AG) resonator (3) was popular used in PEDRI application as the EPR excitation resonator. Maximization of temperature stability of this type resonator can be achieved by using thermo stable materials such as fused quartz and by utilizing some particular designs described in this abstract (such as construct the resonator as a single piece). Previously, only magnetic coupling circuit was introduced in AG resonator design. It means that a coupling loop was positioned between the resonator and the shield. Any mutual physical travel or distortion of these elements caused alternation of the resonator frequency and the resonator coupling. Electrical coupling between feeding cable and resonator was designed and built in our case.

Materials and the construction of the resonator

Fig. 1 shows NMR/EPR double resonator without shield. Components of the resonator and the matching circuit were rigidly placed on the surface of the quartz tube (not shown). Two capacitors were used for tuning and coupling correspondely. The tunning capacitor was connected to the end of balun allowed to perform tuning without affecting coupling in a narrow band of frequency. Cylindrical electrodes were grounded to the resonator external screen by means of ring shape sliding contact which served as the edge shield. Two feeding lines were designed as symmetric transmission lines with characteristic impedance of 250 ohms and were connected to the two gaps of one side of the resonator. Wide adjustment of the capacitance could be changed by moving the cylindrical electrode through the gap in axial direction. Uniformity of the cylindrical gap between plates was secured by fused quartz tube which simultaneously serves as the body of the resonator. NMR resonator consisted of 25 turns 18 AWG soild silver copper wire around a 25 mm diameter quartz tube. Fig.2 is the equivalent electrical diagram of the same resonator.

Results

Easy and fast tuning of EPR frequence around 567 MHz (fine range: ± 5 MHz, wide range: ± 50 MHz) was achived. Coupling was good and could be easily changed under different *in vitro* and *in vivo* experiments with sample valume up to 18 cc. The unloaded Q for the EPR resonator was 120 (loaded Q: 80) and the Q for NMR coil (856 KHz) was 90. The improved PEDRI resonator showed no frequence shift up to 20 W for 5 minutes EPR irridiation, and it could handle the EPR power up to 60 W for 3 min EPR irridiation (frequence shift 0.3 percent at 60 W). Reliable and good PEDRI images/spectroscopy were got by using this resonator at 20.1 mT.

Conclusions

AG typed resonator can be improved by redesign, modifications and using temperature stable materials for PEDRI application.

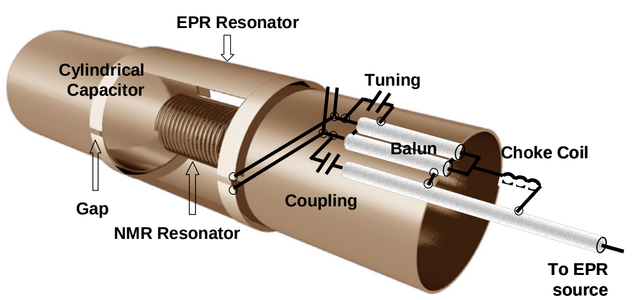

Fig. 1 Mechanical diagram of the improved PEDRI resonator

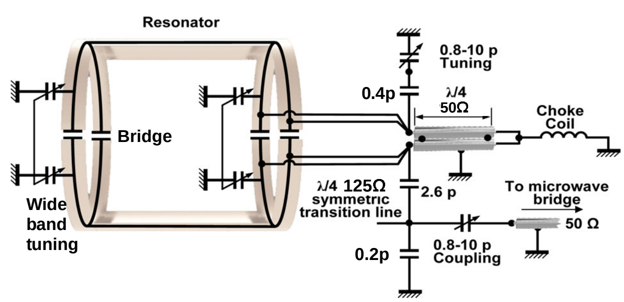

Fig. 2 Electrical diagram of the improved PEDRI resonator

Reference

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