Non-Coaxial-Based Balanced Antenna for Microwave Ablation

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Coax-based interstitial antennas, widely used for microwave ablation (MWA), are often equipped with baluns to choke the currents excited on the outer surfaces of the outer conductors and thereby achieve localized specific absorption rate (SAR) patterns. However, the implementation of a balun often increases the overall diameter of the antenna and, hence, its invasiveness for medical ablation applications. Moreover, baluns designed for MWA antennas generally exhibit narrowband characteristics. Therefore, their optimum operating frequency band may shift during ablation as the tissue undergoes significant changes, resulting in degradation of the SAR pattern. To overcome these limitations, we propose to use a non-coaxial-based balanced antenna fed by a balanced transmission line to achieve a localized SAR pattern without the use of a balun.

The balanced antenna proposed in this paper is a dipole fed with a balanced two-wire transmission line. A floating shield is used to enclose the fields of the feeding transmission line and prevent them from penetrating into surrounding tissue. To demonstrate the concept, we designed a planar version of this antenna using a three-layer printed circuit board (PCB). Two identical striplines connected to the two arms of the dipole are printed on the opposing surfaces of the middle dielectric substrate. The two arms of the dipole are tilted away from each other and are implemented on the middle substrate at one end of the transmission line. At the other end of the transmission line, an integrated impedance transformer that is also printed on the middle substrate connects the input of the balanced transmission line to a 50-Ω coax interface. The top ground plane of the top substrate and the bottom ground plane of the bottom substrate are connected to each other using copper tape to create a floating shield for the transmission line.

The proposed planar antenna structure was designed to operate in *ex vivo* bovine liver tissue at 10 GHz and simulated in CST Microwave Studio. The three-layer PCB structure was made of low-loss dielectric substrates from Rogers (RT/duroid 5880) and has a cross sectional width of 3.4 mm and a height of 1.2 mm. The dipole arm length is 3.9 mm and the angle between the two arms is 24^{o}. The designed impedance transformer provides a good impedance match between the planar antenna and a 50-Ω source ($|S_{11}| < -30$ dB at 10 GHz). Moreover, due to its balanced nature, the planar antenna produces localized SAR patterns over the wide frequency range (1 to 12 GHz) that we examined in the simulations. Additional simulations and experimental results for ablations conducted in *ex vivo* bovine livers using the proposed balanced antenna will be presented and discussed at the Symposium.