SLOT-LINE ARRAY APPLICATOR FOR SUPERFICIAL HYPERTHERMIA TREATMENT

Togni P., Vrba J.
Department of Electromagnetic Field, Faculty of Electrical Engineering, Czech Technical University in Prague

Introduction

This paper describes a slot-line array applicator for hyperthermia treatment of superficial tumours in cases where it is important to have limited penetration inside the biological tissue. For this reason this applicator has been designed in order to obtain a homogenous heating until a depth of 1 cm from the surface. For its optimization a 3D electromagnetic field simulator was used and impedance matching was evaluated by aid of a vector analyzer.

Methods

This applicator is obtained repeating the structure of a single squared slot-line applicator on a matrix with dimensions 2 x 2. The applicator is designed on a planar structure composed by a dielectric board which thickness is 1.5 mm and relative permittivity $\varepsilon_r = 4.3$. This board is covered with a 0.03 mm metal layer on one side. The slot-lines are then obtained removing chemically the metal on this layer. This applicator is therefore composed by four main parts: the active parts, the ground plane, the slot-lines and the substrate. The active parts are the squared metal patches located inside the slot-lines. The dimensions of active part are such to allow the structure to resonate at the chosen working frequency of 2450 MHz. The rest of metal layer forms the ground plane of the structure. The slot-lines are squared loops with a width to allow the applicator to be impedance matched at the working frequency. The distance between the slot-lines has been chosen in order to have the best SAR distribution inside the biological tissue. The substrate is composed by a squared piece of the dielectric board described above with same dimensions as the ground plane.
All applicator dimensions have been optimized with the help of a 3D electromagnetic field simulator. The feeding is given by means of four coaxial cables connecting the internal conductors to the active part and external conductor on the ground plane. The position of these connections haven been chosen in order to obtain a symmetrical structure, a good impedance matching at the working frequency and first of all the best SAR distribution as possible inside the phantom. The phantom used to evaluate this applicator is and homogeneous agar phantom with relative permittivity similar to muscular tissue. The applicator has been also designed to work with a water bolus, with a thickness of about 10 mm, located between the applicator and the phantom.

Conclusion

The results of SAR distribution simulations and temperature measurements made on agar phantom have shown how it is possible to obtain a treatment with a depth within 1 cm depth. For this reason this kind of applicator is particularly suitable for superficial hyperthermia treatments.

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