Student Project Proposal

Project title: : Broadband tailor-made tissue phantoms for biomedical appplications

Project type: Bachelor Semester Project (8 credits) or Master Semester Project (10 credits)

Faculty and Laboratory: STI, Microwaves and Antennas Group (MAG)

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Project description:

Wearable and implantable devices for medical purposes have experienced a huge interest surge in the last decade. Analysing the performance of implantable devices is important for several reasons and such analysis should consider realistic scenarios with body-like phantoms. This project aims at phantoms that mimic the electrical properties of human tissues (permittivity and losses), for example, muscle, kidney, blood, liver, and so on.

Although several biological phantoms were designed earlier [1] [2], but they present various limitations. Some phantoms mimic the electrical properties of human tissues at single frequencies or within narrow bandwidths. Other broadband phantoms are made with toxic compounds such as acetonitrile [3]. We look to overcoming these problems in this project and the objective becomes to **design broadband biological phantoms (400 MHz – 6GHz) based on ionic** (N-Lauroylsarcosine sodium salt and Sodium deoxycholate) **and non-ionic detergents** (Triton X-100). Electrical properties will be characterized using an open-coaxial probe. The obtained permittivity measurements will be post-processed and compared to theoretical models for respective biological tissue.

We look forward to working with you.

Type of work:

- Theory: 20%
- Measurements and post-processing: 60%
- Documentation and reporting: 20%.

Student tasks:

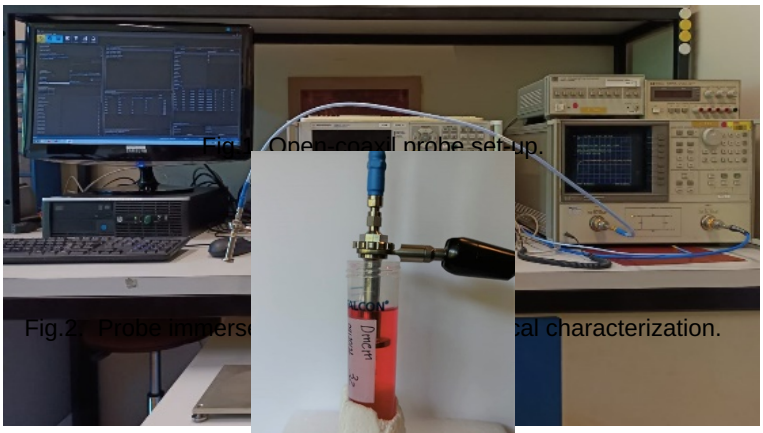

Fig.1 Open coaxial probe set-up.

Fig.2 Probe immersed in liquid for dielectrical characterization.

- Mixing different solutions in different proportions for obtaining the dielectric properties of human tissues.
- Measuring the mixtures with an open-coaxial probe.
- Measurement post-processing and comparisson with theoretical models of tissues.

References:

[1] K. Guido, C. Matos, J. Ramsey and A. Kiourti, "Tissue-Emulating Phantoms for In Vitro Experimentation at Radio Frequencies: Exploring characteristics, fabrication, and testing methods," in *IEEE Antennas and Propagation Magazine*, vol. 63, no. 6, pp. 29-39, Dec. 2021, doi: 10.1109/MAP.2020.3003208.

[2] C. Garcia-Pardo *et al*., "Ultrawideband Technology for Medical In-Body Sensor Networks: An Overview of the Human Body as a Propagation Medium, Phantoms, and Approaches for Propagation Analysis," in *IEEE Antennas and Propagation Magazine*, vol. 60, no. 3, pp. 19-33, June 2018, doi: 10.1109/MAP.2018.2818458.

[3] S. Castelló-Palacios, C. Garcia-Pardo, A. Fornes-Leal, N. Cardona and A. Vallés-Lluch, "Tailor-Made Tissue Phantoms Based on Acetonitrile Solutions for Microwave Applications up to 18 GHz," in *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 11, pp. 3987-3994, Nov. 2016, doi: 10.1109/TMTT.2016.2608890.