A setup for cells EM exposure during Coherent Anti-Stokes Raman (CARS) imaging

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Extended Abstract

Before designing new non-thermal therapeutic applications of the RF EMF, it is important to understand the interactions between RF EMF and the cells down to the molecular level. To this end, the design of a coplanar wave guide (CPW) to expose in vitro biological samples to wide band signals (including high amplitude ones) is presented. The system was designed under the framework of the OPTIC BioEM project (Marie Sklodowska Curie Action - H2020) which aims at understanding first interaction steps of EM field with biological membranes using a new experimental configuration. This configuration consists into the coupling of a non-linear imaging system based on a CARS wide-field microscope [1] with a wide-band EM exposure system for cells. The CARS analysis allows the detection of specific vibrational modes of molecules (e. g. lipids, interfacial water) that underpin modifications during an electric/electromagnetic exposure.

To work under the microscope, we designed planar EM structures based on a coplanar waveguide (CPW). The designed device was simulated (HFSS vs. 1.5) in frequency and time domains. The device has a ground plane with a central opening coated by a transparent conductive film (indium tin oxide) to maintain the EM continuity of the field streamlines and to contemporary allow cell visibility maximally reducing the EM radiation near the microscope stage. Cell solutions within the electrode gap of 500 µm were simulated using water dielectric permittivity and a conductivity of 1.5 S/m. Results in terms of reflection/transmission coefficients of the structure evidence a very good match (less than -10 dB and more than -1 dB respectively) up to 3.5 GHz, as well as high field levels within the biological solutions. E field has a homogeneity better than 70% within the exposure volume (30 µL). Fig. 1 presents the time trend of the E field induced within the biological solution by a wide band 10 ns pulse with rise/fall times of 1 ns, 1 V amplitude in a single central point of the device channel. The signal is not distorted (input voltage reported on the left y-axis) confirming the suitability of the designed CPW.

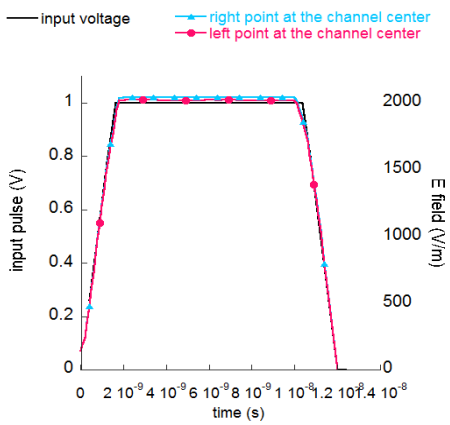

Figure 1. E field vs. time in biological solution

This abstract briefly provides the numerical design of a CPW conceived for electric/EM exposures of cells and real time optical imaging acquisition. Fabricated device characterization is ongoing for future bio-experiments into the OPTIC BioEM framework. Authors acknowledge funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No. 661041. This study was also conducted in the scope of LEA EBAM (European Laboratory of Pulsed Electric Fields Applications in Biology and Medicine).

References

1. A. Silve et al., "A wide field arrangement for single-shot CARS imaging of living cells," *J Raman Spectroscopy*, 43, 2012, pp. 644-650, doi:10.1002/jrs.4051.