Changes in RF Signal as a Response of Biological Substance Exposed in the Near Field Region

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Abstract

The biological systems can absorb electromagnetic energy during radio frequency (RF) exposition. It is often applied in medicine for therapeutic and diagnostic purposes. Additionally the modifying capability of the biological target activity through electromagnetic energy independently of its energy content is relatively recent acquisitions. Biological effects of the RF field exposition are complex and depend on numerous factors. To obtain better insight into association between frequency of the electromagnetic field and biological effects we studied the waves penetrating the biological organic water solutions and brain metabolite in powder. We have investigated changes in the amplitude of the response signal from biological substances exposed on the RF electromagnetic very near field. The changes of the RF (investigated frequency range was 1,76÷250 MHz) signal amplitude after passing through water, Hb, BSA, m-l, NAA water solution and m-I powder in our specially constructed setup were observed. The signal amplitude leaving the organic solution samples was depended on setup geometry, kind of substances and of course of its physical state.

Keywords: RF electromagnetic fields, near field region, biological substances

Introduction

Electromagnetic fields are commonly used in the case of home appliances like home electric power network, microwaves oven, computers and telecommunications. Everybody who lives on Earth is constantly bombarded by electromagnetic fields, on other hand, electromagnetic energy is also used in medicine for diagnostic and therapy but purposes are based mainly on the simple observation [1,2] so understanding the interaction of electromagnetic field with matter seems to be very interesting and important as well. The research has been developing in two parallel but interacting and complementary streams: theoretical and experimental. The experimental study was concerned with the measurements of the RF field in the very near region [3]. Biological effects of electromagnetic fields are the complex function of numerous parameters [1-5]. The dependence on waveform, frequency and medium parameter like dielectric constant or conductivity is well known. Today, several diseases, in different fields of medicine, are treated with non-ionising electromagnetic energy, even though the mechanism of action is not fully explained. To obtain a better insight into association between RF frequency electromagnetic field and biological effects we study RF waves penetrating biological organic materials. We attempt to find any changes in signal amplitude to response of biological substances exposed on RF electromagnetic near fields.

Materials and methods

We have investigated the following listed below materials, Bovine Serum Albumin (BSA) -major protein constituent of the circulatory system to have
physiological functions. N-Acetyl L-Aspartic Acid (NAA) – one of the endogenous substances is located in the central nervous system especially in neurons. Myo-Inositol (M-I) – metabolite of brain essential for various bio functions related to the intracellular signal transduction.

We attempt to investigate the changes in amplitude, frequency of the signal, as a response of biological substances exposed on RF electromagnetic within the very near field (inductive region) [6]. For these purposes we construct rather simple experimental setup. It consists of three main components, source of the RF field, sample part and the most important, professional spectrum analyser. The formal scheme of whole setup is presented in Fig. 1. The very low energy generator with coils which have Q=300-500 represents the RF source. Closely to the coil is placed investigated sample and the probe of the spectrum analyzer. All measurement were done with the probe always situated in the near inductive region. The sample stands as additional generator load of mixed $X_{L_{\text{add}}}$, $X_{C_{\text{add}}}$ character with components which depend on material properties $\varepsilon(k_{\omega})$, $\sigma(k_{\omega})$. Additional load causes changes in the resonance frequency of the tuned circuit $L_v$, $C_v$ and the rather high impedance of $V$ additionally amplifies the effect. The signal frequency shift $\Delta f$ and changes in the signal amplitude $\Delta A$ were measured. The volume of the sample was always the same therefore we could directly compare the effects. The measured frequency shifts and changes in the signal amplitudes for different frequencies 27.13, 80, 100 MHz and different biological samples are presented in Fig. 2. The users of those equipments are very often in the very near inductance field region. Simply speaking they are very close to the transmitting antennas. From Fig. 2, we can see that the changes in resonance frequency were of order several kHz down for 27.13 MHz and up to several hundreds kHz also down for 100 MHz. The changes in signal amplitude are of the order up to 40%. The frequency $\Delta f$ and the signal amplitude changes $\Delta A$ depend mainly on $\varepsilon(k_{\omega})$, $\sigma(k_{\omega})$ of the investigated sample respectively. We can introduce the additive quantity $\gamma$ equal to sum of the percentage changes in both $\Delta f/f$, $\Delta A/A$ which will quantitatively characterize the sensitivity of the investigate samples on the RF field.

Results and discussion

Changes in electromagnetic RF spectrum after passing through biological substances in our experimental setup presented on Fig. 1. were observed (Fig. 2). The frequency shifts of the signal peak decreased and its amplitude increased after passing through organic solution and water at frequency 100 MHz were 190 kHz ± 10 kHz and up to 40% respectively. Differences between frequency shifts for water and other investigated organic solutions were smooth, noticeable and were up to 40 kHz ± 10 kHz. We can observe also from Fig. 2. that the width of the signal for all investigated samples was only slightly changed.

![Fig. 1. Electrical scheme of the experimental setup](image-url)
Fig. 2. Changes in the electromagnetic signal after passing through the different biological materials for frequencies (a) 27.13 MHz, (b) 80 MHz, (c) 100 MHz, respectively.
Conclusions

Various biological substances and their solutions show up individual characteristic spectra.

References