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ASPECTS REGARDING ELECTROMAGNETIC FIELD PROTECTION

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Abstract: *Electromagnetic field effects on life are important because people live in the fields of increasing intensities. In the military field, the problems are even greater, because of the possibility of attacks with electromagnetic weapons and information theft by electromagnetic fields emitted from telecommunications equipment. The paper presents a method of simulation of Neuron and effects of disturbing voltages and also a method for the simulation of composite materials that can be used in electromagnetic shielding.*

Keywords: *Electromagnetic Compatibility, simulation, composite materials*

1. INTRODUCTION

Official statistics show that in Romania there are now 232 phones per one thousand inhabitants. Mobile and fixed service stations mounted on blocks concern among the population. Increasingly more people are looking for answers to questions about the effects of electromagnetic radiation on physical and mental health of the individual.

In the military field, the problems are even greater, because of the possibility of attacks with electromagnetic weapons and information theft by electromagnetic fields emitted from telecommunications equipment.

An official report of the World Health Organization (World Health Organization, the WHO), [1] shows that there are a huge number of mobile and fixed stations serving mobile telephony. Mobile phones emit powers between 0, 2W and 3W and fixed stations up to 100W in the range of 800-1800 MHz frequencies. Electromagnetic energy is absorbed in the human body and produce heat, but the self-system of regulating body keeps a constant temperature. In general, there was an increase in the number of cases of cancer in the world over the past decade in the world, where the number of mobile and fixed stations has skyrocketed, what is already a serious statistical evidence that electromagnetic radiation causes cancer. There were, however, put the biological effects (other than warming) in cell cultures (increases) or invertebrates (increasing fertility) so that the studies can continue and it is recommended that samples of the population growth that are tests.

WHO carried out the research on the effects of electromagnetic waves and mentioned in the report [2] that there was no connection between the exposure through the use of mobile phones and cancer. Studies go further in this direction, but in others such as changes in brain activity, reaction times, etc. However, investigations are not finalized and it is premature to draw a conclusion, so that WHO recommends caution with mobile phones, especially for children, shortening the calls, the use of system calls ' hands free ' etc. For fixed stations, measures must be taken to limit the access of antenna in the vicinity of where the energy radiated is great.

The report published in the Netherlands and taken over by WHO [4] confirms the results of the WHO. WHO carried out the research on the effects of electromagnetic waves and mentioned in the report [2] that there was any connection between the exposure through the use of mobile phones and cancer. Studying further in this direction, but in others, such as changes in brain activity, reaction times, etc. However investigations are not finalized and it is premature to draw a conclusion, so that WHO recommends caution with mobile phones, especially by children, shortening, use system calls ' hands free ' etc. For fixed stations, measures must be taken to limit the access of antenna in the vicinity of where the energy radiated is great.

On the WHO website are punctual research results published on the effects of electromagnetic radiation emitted by mobile phones and the organization proposes new directions of research. In [3] are the results of a study on 550 thousand people in Denmark who carried out the incidence of cancer and did not register an incidence increased to mobile phone users. Generally, there was no increase in the number of cases of cancer in the world over the past decade, where the number of mobile and fixed stations has skyrocketed, what is already serious statistical evidence that electromagnetic radiation doesn't cause cancer.

However, biological effects (other than warming) were highlight in cell cultures (increases) or to invertebrates (increasing fertility) so that the studies can continue and it is recommended that samples of the population should grow for tests. The report published in the Netherlands and taken over by WHO [4] confirms the results of the WHO.

2. THE NEURON

Using the cell phones close to the brain makes a great deal of research to be directed over the electromagnetic radiation influences on the brain.

The neuron is the basic unit of the nervous system, situated mostly in the brain. A conceptual drawing of the neuron is given in Figure 1.

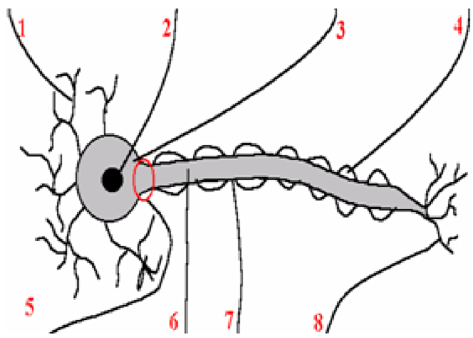

Fig. 1. Neuron structure

The main body of the neuron - soma connects externally through the dendrites branched structure 1, forming a tree. The nucleus of the neuron 2 is located in the soma. Inside, the neuron contains the intracellular fluid and the extra cellular fluid is located external. The membrane of the neuron is 3.

When the neuron is excited with a greater level than the potential action, a signal along the axon 6 is send. The axon starts with a swelling 5 and ends with a filament 8 that connects with the dendrites of another neuron with a connection called a synapse. Signal reception is cumulative, each momentum impulse potential is added to previous pulse potential. The signals are received and additive processed in the soma.

The electrical signal is generated by the difference potentials of each side of the membrane due to the Ionic concentration of chemical elements (potassium, sodium and chlorine). Potential difference is expressed by the relation:

$$V_t = \frac{k \quad T}{q} \quad \frac{N_{in}}{N_{ext}}, \qquad (1)$$

where N_{in} are N_{ext} are the ion concentrations inside and outside, k is the Boltzmann constant, T the absolute temperature and q is the ion constant loading.

Axon terminal can be regarded as an electrical transmission line. Axon terminal electrical resistance of is great, but axon terminal is wrapped in a myelin sheath that improves performance of the transmission. The myelin sheath is suspended, 7, forming the nodes of Ranvier which behave as signal amplifiers.

To be able to simulate electrically a neuron has been defined a standard neuron. This definition will be useful for simulating an axon terminal through a transmission line. In table 1 are given parameters for a neuron with the myelin sheath of 8 µm diameter at 300^0K.

Parameter	Value
Characteristic impedance	8500Ω/m
Parallel capacity	4.4E-10 F/m
Series capacity	3.22E-2 H/m
Reference potential	65mV

Table 1

3. NEURON SPICE SIMULATION

A simple SPICE model was used to study the axon terminal behavior when there is an electromagnetic disturbance or not. A Matlab model is presented in [5]. Model with electronic components is given in Figure 3.

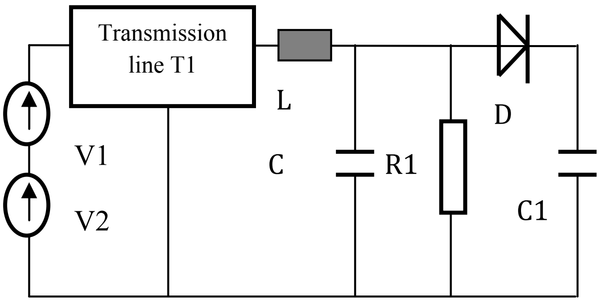

Fig. 2. Spice model with the transmission electrical axon components

Voltage source V1 is simulating a repetitive form of stimulus as a rectangular signal, having the amplitude of the order of the cell potential, dozens of mV, 10ms period and a 20% fill factor. The voltage source V2 simulates a disturbance - a 1 GHz frequency rectangular signal.

In the simulation, the T1 transmission line axon characteristic impedance was taken from the Table 1 and the series inductance and parallel capacity values corresponds to the 1mm axon length. The load resistance R1 simulates the axon terminal. For a correct interpretation of the results, was simulated the receiver located in the next neuron that receives then cumulative by a circuit with diode and capacitor C1.

The model is valid for one segment of the axon with myelin sheath set between 2 nodes of Ranvier. The results of the simulation of an electromagnetically non-disturbed axon are given in Figure 3. neperturbat sunt date în figura 3:

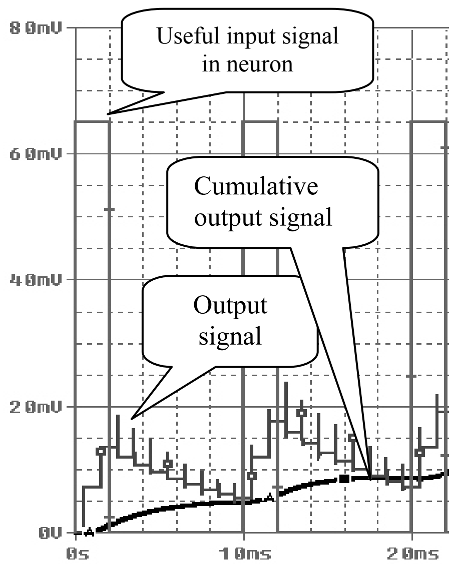

Fig. 3. Simulation results for an electromagnetically non disturbed axon terminal

It can seen in the Figure 3 the decrease in amplitude due to the axon terminal resistivity and the need for the nodes of Ranvier.

The Graph for simulating a disturbed axon terminals by a 1GHz frequency rectangular signal having the amplitude equal to the useful signal is given in Figure 4. It can be seen on the graph the 1 GHz pulses superimposed to the input signal and a serious deterioration in the form of the output signal of the axon. The cumulative signal is identical in shape and is close to the unperturbed values.

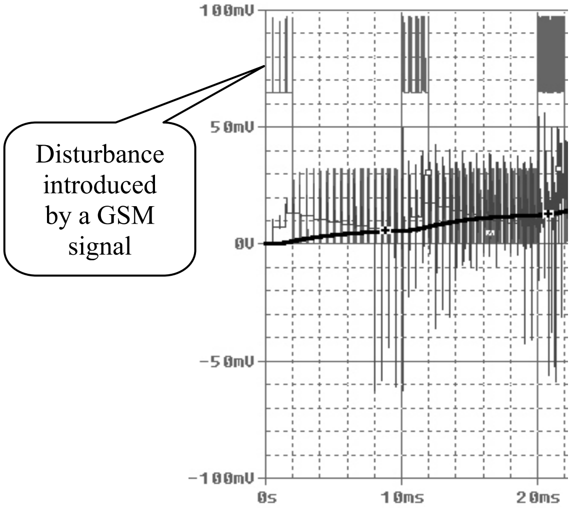

Fig. 4. Simulation results for the behavior of an axon terminal disturbed with an 1GHz rectangular signal

4. SPICE SIMULATION FOR SHIELDING EFFECTIVENESS EVALUATION APPLIED TO COMPOSITE MATERIALS

Late twentieth century is considered by many experts as age materials. These materials with properties superior to traditional materials programmable entered the top technology fields such as microelectronics, aerospace technology, nuclear technology, medical implants construction technique, but also in the automotive industry, shipbuilding, chemicals, furniture, construction materials industry, sports.

Composite conductive structures can be used as electromagnetic shields, repeated reflections on structure planes providing a greater attenuation.

The proposed approach consists in a Spice model using transmission line model to simulate the attenuation introduced by a material characterized by the macroscopic parameters ε, μ, σ.

The method has been validated for copper [6], the results obtained being compared with theoretical results published by White [7].

Simulation conditions require that the electromagnetic radiation source be placed at a certain distance from the shield. This simple method enable to obtain a quick shielding effectiveness evaluation for new materials only by knowing their macroscopic properties ε, μ, σ.

The capability of a shield can be expressed using Shielding Effectiveness, that can be computed by the relation (1) [8, 9].

Simulation of electromagnetic shield through a transmission line is suggestive represented in Figure 5.

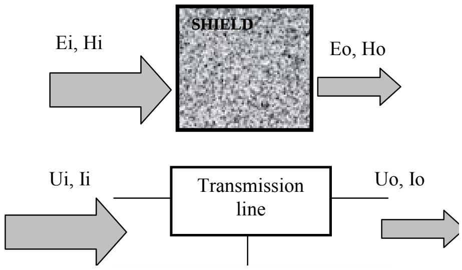

Fig. 5. Loss less Transmission line model showing material properties

$$SE_{dB} = 20\lg\frac{U_i}{U_0} \qquad (2)$$

Layered composite materials have the main advantage the economic one and qualitative reasons, because their use is by saving important quantities of expensive materials or deficient, improving at the same time, the qualities of products and increasing the duration of their operation in conditions of high performance.

Composite material structure, reveals itself in the fabrication, electrical characteristics of layers containing components, i.e. electric conductivity σ, the electric permittivity ε and the magnetic permeability μ is represented in Figure 6.

For simulation have been used the following model, Figure 7, where T1 is the line transmission model for Si material, T2 is the line transmission model for SiO2 and T3 is the line transmission model for the last conductive layer in the analyzed composite material.

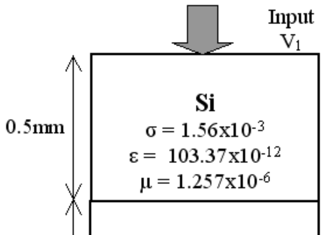

Fig. 6. About the composite material structure

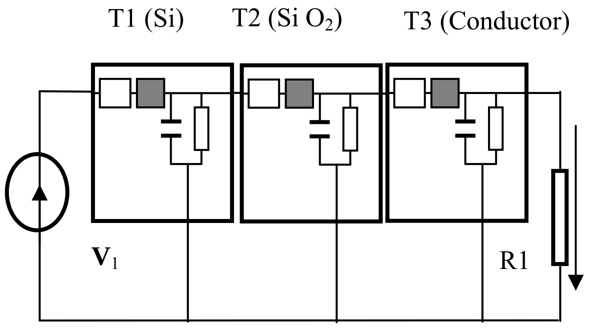

Fig. 7. Layered composite material transmission line model

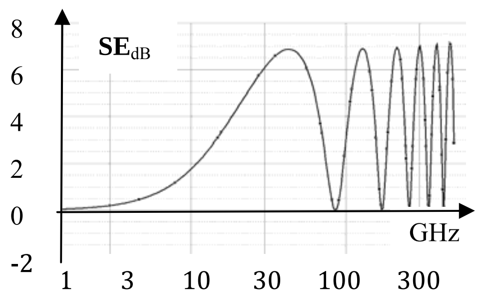

Fig. 8. The material attenuation in the frequency range of 1GHz - 500GHz

After the simulation made in the frequency range of 1GHz - 500GHz, Figure 8, it can be seen that till 3GHz the electromagnetic waves attenuation is low, for all frequencies.

The results obtained by simulations have compared with experimental determinations at 10GHz. The composite material capability to attenuate the electromagnetic waves, expressed by the shielding effectiveness, is around 2dB and was computed by relation (2) after simulations.

5. SHIELDING EFFECTIVENESS EVALUATION WITH SIMULINK SIMULATION

Based on the transmission line mode Simulink simulations have been made for the composite material, Figure 9.

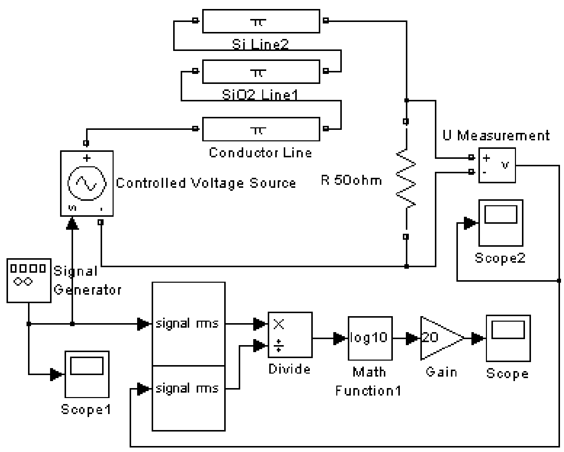

Fig. 9. Simulink simulation model for advanced composite material

The shielding effectiveness (simulated at 10GHz) is shown in Figure 10, calculated with relation (2). Comparing the simulation results obtained with different programs it can be seen that the attenuation introduced by the composite material at a frequency of 10GHz are in the range of (1.5dB-3dB).

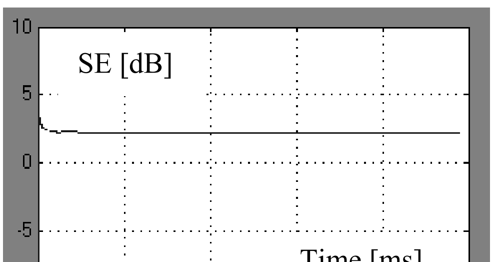

Fig. 10. Simulink simulation results

6. EXPERIMENTAL RESULTS

For the composite material attenuation measuring in the field of radiofrequencies, was used the substitution method, known to be of high precision. Measuring scheme is given in Figure 11.

For experimental determinations was used a wave guide system with an Gunn oscillator at a frequency of 10 GHz, as stated above. The result obtained through the mediation of several determinations is around SE_{dB} = 3dB. Comparing the value obtained with the simulations at the same frequency SE_{dB}= (1.5dB-3dB), it reveals a good precision, which means that the simulations made for the composite material are correctly made.

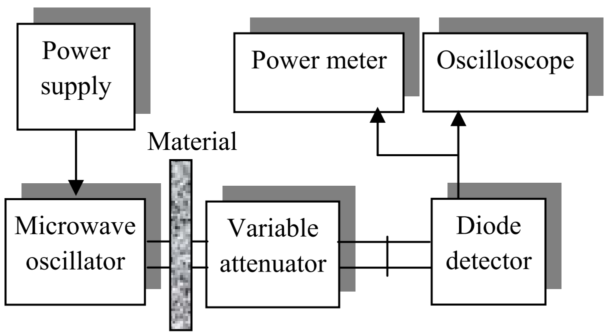

Fig. 11. Block diagram for experimental determinations

7. CONCLUSIONS

The proposed transmission model via axon terminal confirms that a disturbing signal with amplitude of 10% of the useful signal does not have visible effects on the transfer of data. The Neuron's receptor cumulative voltage from the simulation is 12,44E-3V if there is no electromagnetic disturbance and 12,81E-3V if there is one, which means a difference of 3%, so the neuron transmission reduced the disturbance. However, if the disturbance is comparable to the useful signal useful shielding measures must be taken.

The future can bring big surprises on the border areas where composite materials will be used. In addition, the simple method of simulation presented in this paper offers to the manufacturer the possibility to pre-choose the dimensions and the combination of materials in order to get superior performance of the composite material.

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