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Effect of Metallic Materials on SAR

Asma Lak

Department of Electrical Engineering, Genaveh branch
Islamic Azad University, Genaveh, Iran
lak.asmae@gmail.com

Abstract. Many parameters influence the SAR measurement such as frequency, distance from source and ect. In this paper the effect of metallic material is evaluated. The human hand once alone and once with a metallic watch include iron and gold and titanium is simulated. The simulations are done at 900MHz frequency and with HFSS software.

Keywords: human hand;electromagnetic fields; Specific Absorption Rate

Introduction

When we talked about bioeffects of EM fields on human body, this is noticeable that the human bodies have some internal fields. When the external fields are greater than those fields, the biological effects have been occurred. Biological effects from EM fields divide into thermal and nonthermal. Nonthermal effects such as pearl, cancer, DNA breakage and ect. When we talk about biological effect, it has to introduce the tissue dielectric properties. Every tissue in living being has conductivity and permittivity. For example liver, muscle, skin, bone marrow and ect. Some researchers obtained good values for human dielectric tissue properties [1], [2].

EM field absorption

Many countries recommend standard values for human protection from EM exposure source. These standards are written by SAR unit. But what is the meaning of SAR?

To study the probable biological effects on human body, it have been examined the rate at which energy is deposited in a given volume of tissue. This means Specific Absorption Rate and its unit is watt per kilogram of tissue. There is no single world-wide standard limit for SAR. For example in Table1, the standard of SAR limitation is shown. The handset of cell phone is situated near the human body, so the head and hand are exposure to field source from antenna. The body is not electrically homogeneous. Bone, brain, muscle and other tissues have different dielectric constant, dielectric loss factor and complex shapes. In international commercial systems for SAR measurement, they use from phantom models. Phantom is a model of human body and it shows the human properties its liquid. SAR is measure by these models and the values are explored for human. Extensive investigation of possible health effects of RF field absorbed from cell phones has been carried out in many countries. [3], [4], [5].

Table1. SAR limits for general public specified by various countries.

	Australia	Europe	USA
Standard	ASA	ICNIRP	ANSI
Whole body	0.08W/kg	0.08W/kg	0.08W/kg
Special peak	2 W/kg	2 W/kg	1.6W/kg
Average over	10 gr	10 gr	1 gr
Average for	6 min	6min	30 min

SAR measurment In Human Hand Model

When a person using from cell phone,head and hand is exposure to electromagnetic field from cell phone antenna. The effect of fields on human head and whole body reported by many researchers such as [5], [6] ,[7],[8]. In this part the effect of field on human hand model is simulated. The simulations are done at 900MHz and by using HFSS software. The thickness of hand is about 30mm. the size of model is in Table 2. The length of hand is 30 cm. The antenna model is a dipole antenna with characteristics in Table3. And the other properties of model is in table 4 and 5.

Table 2.The thickness of human hand model

Skin	2mm
Muscle	10mm
Bone	18mm

Table3. the geometry of antenna

Frequency (MHz)	L (mm)	d (mm)
900	149.0	3.60

Table4. Dielectric properties of hand tissues.

	835MHz	
Tissue	ε_r	σ
Bone	17.40	0.25
Skin	35.40	0.63
muscle	58.5	1.21

Table5. Other properties of model

Power of source	1Watt
SAR line	60mm

The figures 1 to 4 shows the simulation of effect of dipole antenna on human hand model and show the electric field strength and SAR distribution on it.
Hand model is exposure to a dipole antenna as an exposure source. Fig.1 shows the electric field strength on human hand.

In this part hand model is exposure to a dipole antenna as an exposure source and hand has a metallic watch (gold and titanium watch with 2mm thickness and 5mm height) Fig 2, Fig3.

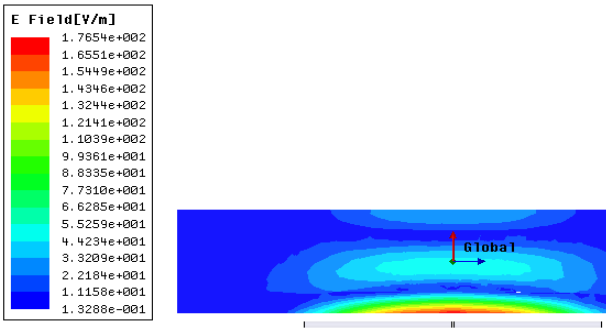

Fig1. Electric field strength at 900MHz without watch

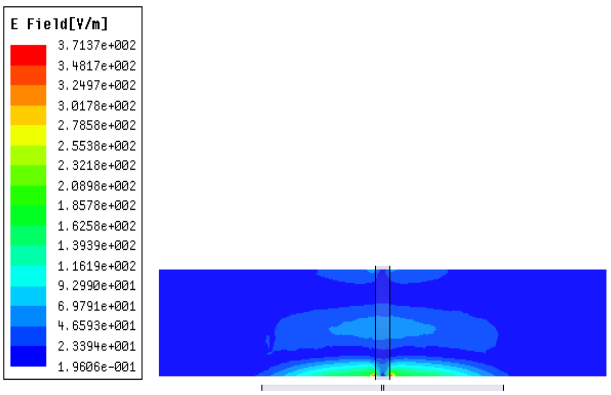

Fig2. Electric field strength at 900MHz with a golden watch

In this part the SAR distribution is shown. Because of metallic watch in Fig.3, 4 the SAR is increased rather than Fig 3.

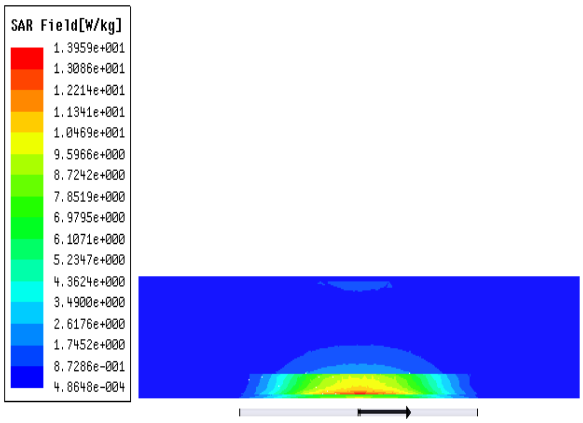

Fig3. SAR at 900MHz without watch

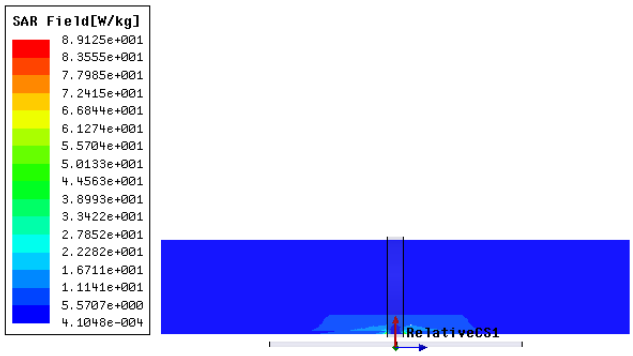

Fig4. SAR at 900MHz with a golden watch

As the figures are shown the E field and SAR are increasing when the metallic watch is adding to hand model. The SAR has directly relationship by electric field strength. So when the electric field strength is increasing, the SAR is increasing too. The exposure environment affect on SAR.This paper show that the metallic material increases the SAR.

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