Analysis of SAR for Metal-Frame Spectacles

Priyanka Shivaji Arer
Dept. of E&CE
GMIT, Davangere
Davangere, India
priyankaarer8448@gmail.com

Sahana M
Dept. of E&CE
GMIT, Davangere
Davangere, India
msahana95911@gmail.com

Ramya S Patil
Dept. of E&CE
GMIT, Davangere
Davangere, India
ramyaspatil520@gmail.com

Rajendra Soloni
Assistant Professor
Dept. of E&CE, GMIT Davangere
Davangere, India
rajendrass@gmit.ac.in

Roja Chappardahallli
Dept. of E&CE
GMIT, Davangere
Davangere, India
rojachap95780@gmail.com

Rajappa H S
Assistant Professor
Dept. of E&CE, GMIT Davangere
Davangere, India
rajappahs@gmit.ac.in

Abstract— **The effect of Specific Absorption Rate (SAR) inside the head due to the different metal-frame spectacles is investigated. CST Microwave Studio 2014 tool is used for the investigation. A simple microstrip antenna is designed and implemented for 4G applications. The SAR of this antenna is evaluated inside the head with different metal-frame spectacles. A head model is developed in the tool using a sphere and brain tissue. Metal frame spectacle model is developed using circular cylinder on the head model. SAR is first evaluated for head model without considering the metal frame spectacle. Then it is evaluated for copper, aluminum, silver and gold metal frame spectacles. From the study it is clear that use of metal frame spectacles increases the SAR to a greater level.**

Keywords: Specific Absorption Rate, CST MWS 2014, Metal frame spectacles.

Introduction

Over the decades, the usage of mobile communication devices increased very rapidly. This usage leads to users being exposed to the Radio Frequency (RF) electromagnetic radiation emitted by mobile communication equipment, such as cellular phones [1]. Concern about possible health effects due to exposures to electromagnetic fields (EMs) has increased among the public and professionals since these communication devices have proliferated around the globe. This concern has caused an increase in the research emphasis on analyzing the rate at which electromagnetic radiation is being absorbed by the human body. In addition to concerns about potential harmful effects of such exposure, change in brain function related to RF electromagnetic fields also is of concern. There is sufficient experimental evidence that mobile phone exposure does alter brain activity in human brain [2]. Epidemiological studies showed a higher brain cancer risk in people who had used mobile phones for more than ten years [3].

SAR is defined as the Radio Frequency (RF) radiation absorbed by the head and body phantom during the usage of wireless devices. It is measured in terms of watt per kg (W/Kg). The standard value set by the FCC (Federal communication Council) is 1.6 W/Kg for 1 gm of tissue and 2.0 W/Kg for 10 gm of tissue. The electromagnetic radiation affects the human and especially it affects the children 50 % more than the adult [4]. Effect of SAR on human eyes for the frequency range 1.5GHz to 3GHz is presented in [5].

The purpose of this study is to investigate whether specific absorption rate (SAR) increases in human head when metal frame spectacle is used.

II. ANTENNA GEOMETRY

The inset fed microstrip patch antenna is designed for 4G application using CST microwave studio 2014 and it is shown in Figure1. FR-4 (lossy) is used as the substrate material with dielectric constant of 4.3. Patch has the dimension of 40mmX31mm.

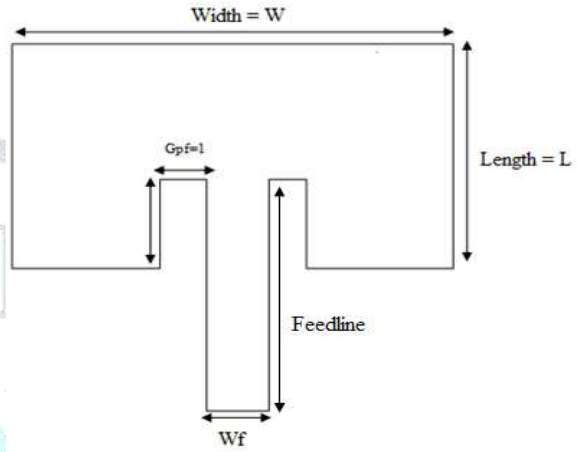

Fig1. Geometry of the patch with Inset feed

To design the antenna following formulae [6] were used:

To find the width of the patch

$$W = \frac{c}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad \text{---------- (1)}$$

Where $c=3x10^8$ m/s, f_r=Resonating frequency and ε_r= dielectric constant.

To find the length of the patch

$$L = L_{eff} - 2\Delta L \quad \text{---------- (2)}$$

Where

$$\Delta L = 0.412h\left[\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}\right] \quad \text{----- (3)}$$

$$\varepsilon_{reff} = \left(\frac{\varepsilon_r+1}{2}\right)+\left(\frac{\varepsilon_r-1}{2}\right)\left[1+12\left(\frac{h}{W}\right)\right]^{-0.5} \quad \text{------ (4)}$$

$$L_{eff} = \frac{c}{2 f_r}\sqrt{\frac{2}{\varepsilon_{reff}}} \quad \text{---------- (5)}$$

The following table 1 gives the dimensions of different parameters.

Table1: Design parameters for fr=2.3 GHz

Parameters	mm
Width(W)	40.062
Length(L)	31.092
F_i	9.4756
W_f	3.137
G_{pf}	1

Ground Length(Lg)	2*L
Ground Width (Wg)	2*W
Height of the conductor(h_t)	0.035
Substrate thickness(h_s)	1.6
ΔL	$7.433* 10^{-4}$
Ereff	4.006

The head model is developed in the tool by using sphere of radius 75 mm since the average width of a human head is about 15 cm. Sphere is loaded with brain tissue which is available in CST MWS tool. The antenna is kept at a distance of 20mm from the head model and SAR is evaluated. The head model with the antenna is shown in figure 2.

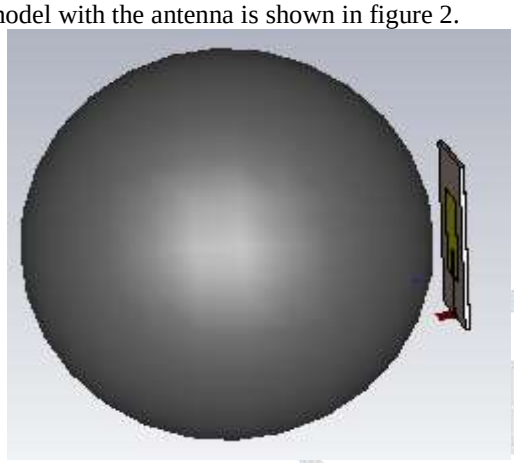

Fig2: Antenna with head model

III. RESULTS AND DISCUSSIONS

The return loss for reference antenna is shown in figure 3. It has VSWR of 1.08 and bandwidth of 0.07GHz.

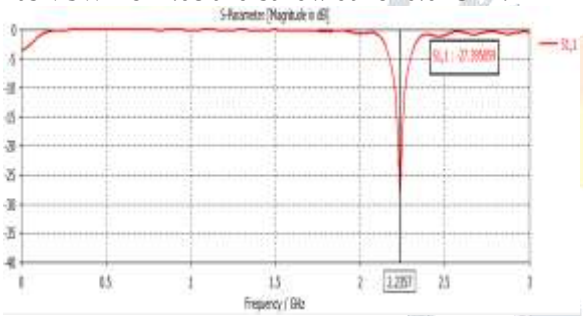

Fig3: Return loss of reference antenna

Evaluation of SAR

1. Head model without metal frame spectacle

The head model with antenna is shown in figure2. The SAR is evaluated for this head model with considering 10gm of tissue. Figure 3 shows the effect of SAR for head model without the metal frame spectacle. The measured SAR value is 1.396 W/Kg for 10gm of tissue.

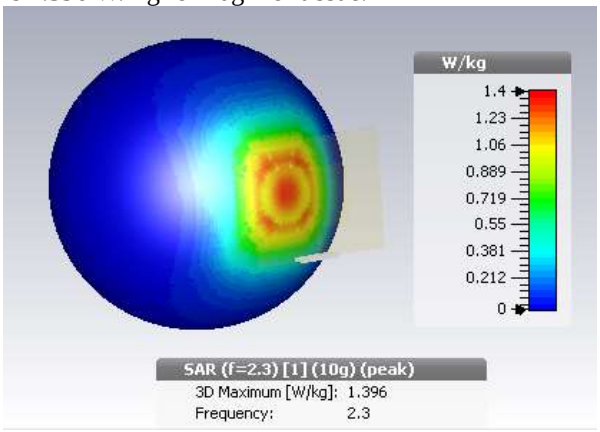

Figure 3: SAR measurement for head model without the metal frame spectacle

1. Head model with Aluminium metal frame spectacle

To implement metal frame spectacle on the head model a cylindrical ring of aluminium is developed. A 4mm width is considered for this ring i.e. metal spectacle width is assumed as 4mm. Figure 5 shows head model with aluminium metal frame spectacle arrangement and figure 6 shows its SAR.

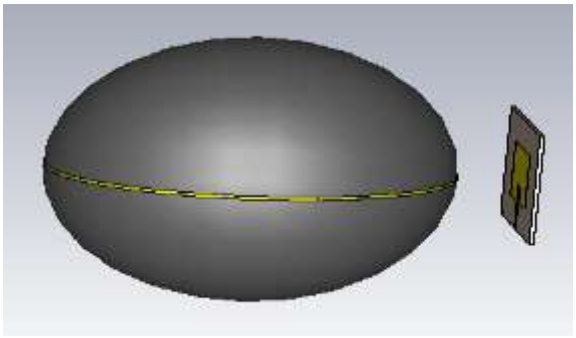

Figure 5: Head model with metal (Aluminum) frame spectacle

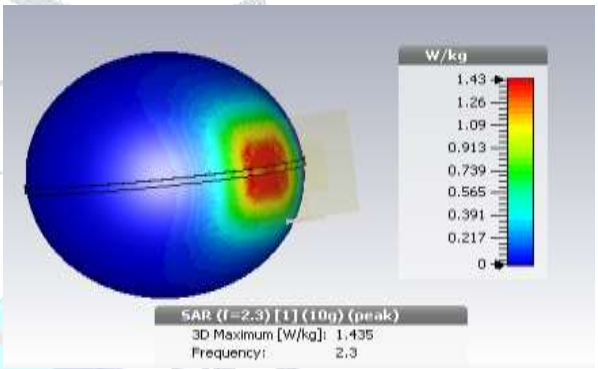

Fig6: SAR measurement for head model with aluminium metal frame spectacle.

2. Head model with Copper metal frame spectacle

The same procedure is followed for copper metal frame spectacle to evaluate the SAR and is shown in figure 7. The SAR for 10gm of tissue is 1.435 W/Kg.

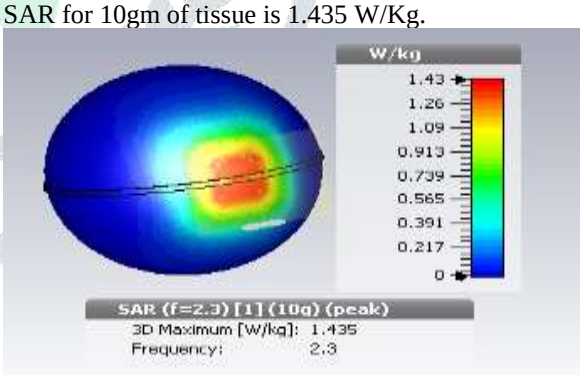

Fig7: SAR measurement for head model with copper metal frame spectacle.

3. Head model with Silver metal frame spectacle

The SAR is evaluated for silver metal frame spectacle and it is about 1.43 W/Kg for 10gm of tissue. The evaluation is shown in figure 8.

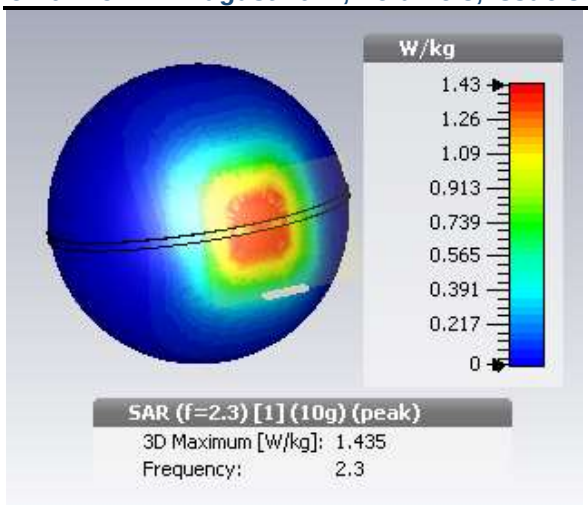

Fig8: SAR measurement for head model with silver metal frame spectacle.

4. Head model with Gold metal frame spectacle

The SAR is also evaluated for gold metal frame spectacle and it is shown in figure 9.

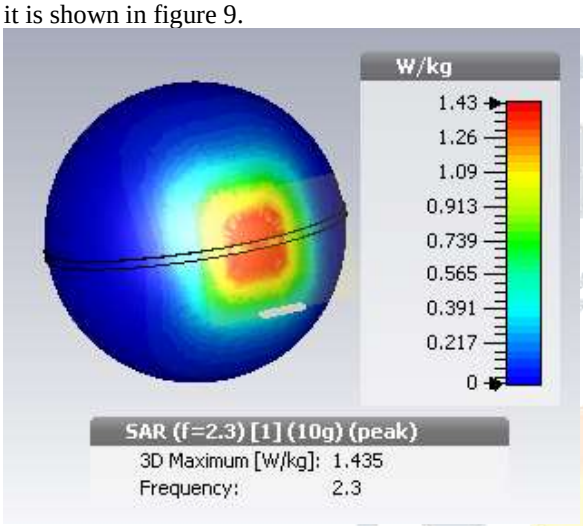

Fig9: SAR measurement for head model with gold metal frame spectacle.

From the above discussion, it is clear that there is nearly 3% increase in the SAR whenever a person uses the metal frame.

Model	SAR (For 10gm of tissue) in W/Kg
Head model without metal frame spectacle	**1.396**
Head model with aluminum metal frame spectacle	**1.43489**
Head model with copper metal frame spectacle	**1.43471**
Head model with silver metal frame spectacle	**1.43466**
Head model with gold metal frame spectacle	**1.43457**

CONCLUSION

SAR is evaluated for head model without and with metal frame spectacle and the results have shown that using the metal frame spectacles increases the absorption of radio frequency signals and hence increases the SAR. SAR is evaluated for copper, aluminum, silver and gold metal frame spectacles. The results have shown that 3% increase in SAR when metal frame spectacle is used.

REFERENCES

[1] M. H. Mat, M. F. B. A. Malek, W. G. Whittow, S. H. Ronald, M. S. Zulkefli, N. Saudin, and L. Mohamed *Progress In Electromagnetics Research*, PIER 137, 453-473, 2013.

[2] R. Luria, I. Eliyahu, R. Hareuveny, M. Margaliot, and N. Meiran, "Cognitive eflects of radiation emitted by cellular phones: the influence of exposure side and time," Bioelectromagnetics, vol. 30, pp.19S-204, 2009

[3] Hardell, M. Carlberg, F. Soderqvist, and K.H. Mild, "Meta-analysis of long-term mobile phone use and the association with brain tumours,. Int J Oncol, vol. 32, pp. 1097-1103, 2005.

[4] Shivalingappa M Baligar, Rajendra Soloni and Dr. Chandrappa D N, "Analysis of Specific Absorption Rate (SAR) of Microstrip Patch Antenna for Wireless Applications" IJARCCE, Vol. 5, Issue 5, May 2016.

[5] W. G. Whittow and R. M. Edwards, "A study of changes to specific absorption rates in the human eye close to perfectly conducting spectacles within the radio frequency range 1.5 to 3.0 GHz," in *IEEE Transactions on Antennas and Propagation*, vol. 52, no. 12, pp. 3207-3212, Dec. 2004.

[6] C.A. Balanis, Antenna Theory Analysis and Design, Third Edition, New Jersey: J. Wiley & Sons, 2005