Research Article

Preparation of Papers for Balkan Journal of Electrical and Computer Engineering

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*Abstract*—These instructions give you guidelines for preparing papers for IEEE Transactions and Journals*.* Use this document as a template if you are using Microsoft *Word* 6.0 or later. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at IEEE. Paper titles should be written in uppercase and lowercase letters, not all uppercase. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., "Nd–Fe–B"). Do not write “(Invited)” in the title. Full names of authors are preferred in the author field, but are not required. Put a space between authors’ initials. Define all symbols used in the abstract. Do not cite references in the abstract. Do not delete the blank line immediately above the abstract; it sets the footnote at the bottom of this column.

*Index Terms*—Enter key words or phrases in alphabetical order, separated by commas.

# INTRODUCTION

T

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Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). This applies to papers in data storage**.** For example, write “15 Gb/cm2 (100 Gb/in2).” An exception is when English units are used as identifiers in trade, such as “3½-in disk drive.” Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation [1].

The SI unit for magnetic field strength *H* is A/m. However, if you wish to use units of T, either refer to magnetic flux density *B* or magnetic field strength symbolized as µ0*H*. Use the center dot to separate compound units, e.g., “A·m2.”

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The word “data” is plural, not singular. The subscript for the permeability of vacuum µ0 is zero, not a lowercase letter “o.” The term for residual magnetization is “remanence”; the adjective is “remanent”; do not write “remnance” or “remnant.” Use the word “micrometer” instead of “micron.” A graph within a graph is an “inset,” not an “insert.” The word “alternatively” is preferred to the word “alternately” (unless you really mean something that alternates). Use the word “whereas” instead of “while” (unless you are referring to simultaneous events). Do not use the word “essentially” to mean “approximately” or “effectively.” Do not use the word “issue” as a euphemism for “problem.” When compositions are not specified, separate chemical symbols by en-dashes; for example, “NiMn” indicates the intermetallic compound Ni0.5Mn0.5 whereas “Ni–Mn” indicates an alloy of some composition NixMn1-x.

Be aware of the different meanings of the homophones “affect” (usually a verb) and “effect” (usually a noun), “complement” and “compliment,” “discreet” and “discrete,” “principal” (e.g., “principal investigator”) and “principle” (e.g., “principle of measurement”). Do not confuse “imply” and “infer.”

Prefixes such as “non,” “sub,” “micro,” “multi,” and “ultra” are not independent words; they should be joined to the words they modify, usually without a hyphen [2-4]. There is no period after the “et” in the Latin abbreviation “*et al.*” (it is also italicized). The abbreviation “i.e.,” means “that is,” and the abbreviation “e.g.,” means “for example” (these abbreviations are not italicized).

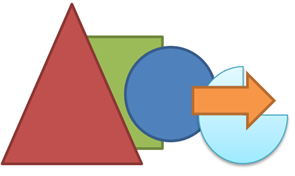


Fig.1. Proposal structure of Salesbary Screen

# Guidelines for Graphics Preparation and Submission

## Types of Graphics

The following list outlines the different types of graphics published in BAJECE journals.

### *Author photos*

### Head and shoulders shots of authors which appear at the end of our papers.

### *Tables* Data charts which are typically black and white, but sometimes include color.

## Multipart figures

Figures compiled of more than one sub-figure presented side-by-side, or stacked. If a multipart figure is made up of multiple figure types (one part is lineart, and another is grayscale or color) the figure should meet the stricter guidelines.

## Sizing of Graphics

Most charts, graphs, and tables are one column wide (3.5 inches / 88 millimeters / 21 picas) or page wide (7.16 inches / 181 millimeters / 43 picas). The maximum depth a graphic can be is 8.5 inches (216 millimeters / 54 picas). When choosing the depth of a graphic, please allow space for a caption. Figures can be sized between column and page widths if the author chooses, however it is recommended that figures are not sized less than column width unless when necessary.

There is currently one publication with column measurements that don’t coincide with those listed above. Proceedings of the IEEE has a column measurement of 3.25 inches (82.5 millimeters / 19.5 picas).

The final printed size of author photographs is exactly   
1 inch wide by 1.25 inches tall (25 millimeters x 38 millimeters / 6 picas x 7.5 picas). Author photos printed in editorials measure 1.59 inches wide by 2 inches tall (40 millimeters x 50 millimeters / 9.5 picas x 12 picas).

TABLE I

REAL AND IMAGINARY COMPONENT OF PERMITTIVITY OF NANOSTRUCTURED COMPOSITE MATERIALS AND GRAPHITE UNDER THE 6 -18 GHz FREQUENCY BAND [9],[10]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type of fillers | Frequency, GHz | | | | | | | | | | | | | |
| 6 | | 8 | | 10 | | 12 | | 14 | | 16 | | 18 | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 % MWCNTs | 18.1 | 14.5 | 17.8 | 14.1 | 17.4 | 13.8 | 17.2 | 13.6 | 17 | 13.4 | 16.8 | 13.3 | 16.6 | 13.1 |
| 3 % CNFs | 14.7 | 5.2 | 13.6 | 5.3 | 12.9 | 5.4 | 12.3 | 5.5 | 11.8 | 5.55 | 11.4 | 5.6 | 11 | 5.7 |
| graphite | 13.5 | 8.1 | 12.2 | 7.8 | 11.1 | 7.0 | 10.7 | 6.6 | 10.1 | 6.4 | 9.8 | 6.2 | 9.5 | 6.0 |

# Mathematical Background

## Vector Art

While IEEE does accept vector artwork, it is our   
policy is to rasterize all figures for publication. This is done   
in order to preserve the figures’ integrity across multiple computer platforms.

## Color Space

The term color space refers to the entire sum of colors that can be represented within the said medium. For our purposes, the three main color spaces are Grayscale, RGB (red/green/blue) and CMYK (cyan/magenta/yellow/black). RGB is generally used with on-screen graphics, whereas CMYK is used for printing purposes [5,7,9].

All color figures should be generated in RGB or CMYK color space. Grayscale images should be submitted in Grayscale color space. Line art may be provided in grayscale OR bitmap colorspace. Note that “bitmap colorspace” and “bitmap file format” are not the same thing. When bitmap color space is selected, .TIF/.TIFF is the recommended file format.

## Figures

Figures (line artwork or photographs) should be named starting with the first 5 letters of the author’s last name. The next characters in the filename should be the number that represents the sequential location of this image in your article. For example, in author “Anderson’s” paper, the first three figures would be named ander1.tif, ander2.tif, and ander3.ps.

Tables should contain only the body of the table (not the caption) and should be named similarly to figures, except that ‘.t’ is inserted in-between the author’s name and the table number. For example, author Anderson’s first three tables would be named ander.t1.tif, ander.t2.ps, ander.t3.eps.

Author photographs should be named using the first five characters of the pictured author’s last name. For example, four author photographs for a paper may be named: oppen.ps, moshc.tif, chen.eps, and duran.pdf.

If two authors or more have the same last name, their first initial(s) can be substituted for the fifth, fourth, third... letters of their surname until the degree where there is differentiation. For example, two authors Michael and Monica Oppenheimer’s photos would be named oppmi.tif, and oppmo.eps.

## Referencing a Figure or Table Within Your Paper

When referencing your figures and tables within your paper, use the abbreviation “Fig.” even at the beginning of a sentence. Do not abbreviate “Table.” Tables should be numbered with Roman Numerals.

|  |  |
| --- | --- |
|  | (1) |

Taking in account graphite diamagnetic properties it is assumed that its permeability is equal to 1. Therefore the Eq. (1) can be presented as:

|  |  |
| --- | --- |
|  | (2) |

The complex permittivity is calculated:

|  |  |
| --- | --- |
|  | (3) |

Here: – is the relative permittivity of the medium directly contacted with air;

– is the real part of complex permittivity;

– is the imaginary part of complex permittivity;

– is dielectric constant.

As a graphite layer thickness the depth h1 should be calculated according to the skin depth for non-metals at high frequencies formula [12]:

|  |  |
| --- | --- |
|  | (4) |

Where: – is light speed in [vacuum](http://en.wikipedia.org/wiki/Vacuum), [m/s];

– is frequency, [];

– is skin depth as function of frequency, [m].

*2.1.2 Spacer layers thickness*

In respect that proposal structure should absorb all 6-18GHz frequencies range EMW, it is needed to evaluate the skin depth for the MWCNTs and CNFs composites under defined frequency range, and as the spacer layer height the maximum penetration depth must be considered as:

|  |  |
| --- | --- |
|  | (5) |

The relative permeability of the composites is also equal to 1, therefore, for the spacer layer, thickness evaluation the equation (4) can be used. For the resonance which is the key to successful absorption it is necessary that the number of wave length quarter must be equal to odd number in the spacer layer. The number of wave length quarter is calculated as:

|  |  |
| --- | --- |
|  | (6) |

Here: – is the quarter number of wave length;

– is the certain frequency wave length index.

Wave length in the composites medium is calculated as:

|  |  |
| --- | --- |
| . | (7) |

Complex permittivity is calculated by following equation:

|  |  |
| --- | --- |
| . | (8) |

Where: and – are the real and imaginary parts of relative permittivity accordingly.

*2.1.3 Back layer thickness*

EMW cannot penetrate from the metal surface with thickness which is larger than the skin depth. For this reason the thickness of back layer is calculated as:

|  |  |
| --- | --- |
| , | (9) |

Here: – is the electric conductivity, [S/m].

*2.2 Absorbance factor calculation*

Taking in account that for polymer conductive material, the permeability is equal to 1, the equations of absorbency factors are:

|  |  |
| --- | --- |
|  | (10) |

Where: – is wave number, [m-1];

– is the thickness of dielectric layer (polymer conductive material), [m];

– is the resistivity of outer layer, [Ωm].

Wave number is calculated as:

|  |  |
| --- | --- |
| . | (11) |

The resistivity of dielectrics namely of outer layer can be represented by conductivity which is the frequency function:

|  |  |
| --- | --- |
|  | (12) |

Here: – is the electric conductivity [S/m].

Therefore formula (10) can be rewriten as:

|  |  |
| --- | --- |
|  | (13) |

*II.3. Power calculation*

This chapter presents the specific power index as well as total power calculation results for the proposal structures.

*II.3.1 Specific power factor calculation*

Specific power released in the form of heat per unit volume in material is determined by the following relationship:

|  |  |
| --- | --- |
| , | (14) |

Where: – is specific power, [W/m3];

– is electric field strength inside of medium; [V/m],

–is the loss tangent.

Loss tangent is defined as the ratio:

|  |  |
| --- | --- |
| . | (15) |

Intrinsic electric field in interested layer could be obtained by using the following formula:

|  |  |
| --- | --- |
| , | (16) |

Here: – is external electrical field strength, [V/m];

– is relative permittivity of graphite;

– is relative permittivity of the spacer layer’s material.

*2.3.2 The structure total power calculation*

Total power can be calculated as:

|  |  |
| --- | --- |
|  | (17) |

Where: - structure’s height, length and width respectively, [m].

# Calculations results

Here the layers thicknesses and power calculation results are presented.

*III.1 Layers’ thicknesses*

The layers thicknesses had been given as shown in Table 2. Calculation results are presented in the Tables 2 and 3:

TABLE II

GRAPHITE LAYER PROPERTIES CALCULATION RESULTS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **,[GHz]** |  | **,** | **, [Ω]** | **, [S/m]** |
| **6** | 15.66 | 0.024 | 286 | 2.70 |
| **8** | 14.48 | 0.018 | 297 | 3.47 |
| **10** | 13.21 | 0.017 | 311 | 3.99 |
| **12** | 12.57 | 0.078 | 319 | 4.41 |
| **14** | 12.04 | 09812 | 326 | 4.88 |
| **16** | 11.60 | 0.230 | 332 | 5.52 |
| **18** | 11.32 | **0.009** | 336 | 6.01 |

As it is shown in Table 2, the impedance of 336 under the frequency of 18 GHz is very close to the air impedance. Therefore the outer layer thickness should be defined as equal to 9 mm. However it is necessary to evaluate the absorbency factor for this layer under the applied frequency range of 6-18GHz. Calculation had been done using Equations (9) - (12). These results are presented in the Table 3.

TABLE III

ABSORPTANCE AND TRANSMİTTANCE FACTORS FOR OUTER LAYER

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *h*1=d(*f*),[m] | , [GHz] | | | | | | | Average value of  absorptance | Average value of  transmittance |
| 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| 0.024 | 0.54 | 0.29 | 0.50 | 0.52 | 0.63 | 0.76 | 0.82 | 0.58 | 0.42 |
| 0.018 | 0.38 | 0.87 | 0.92 | 0.31 | 0.46 | 0.97 | 0.82 | 0.68 | 0.32 |
| 0.016 | 0.96 | 0.73 | 0.28 | 0.97 | 0.60 | 0.52 | 0.98 | 0.72 | 0.28 |
| 0.013 | 0.10 | 0.89 | 0.46 | 0.84 | 0.67 | 0.78 | 0.78 | 0.65 | 0.35 |
| **0.012** | 0.20 | 0.96 | 0.18 | 0.95 | 0.26 | 0.93 | 0.42 | **0.56** | **0.44** |
| 0.010 | 0.93 | 0.03 | 0.96 | 0.46 | 0.74 | 0.92 | 0.07 | 0.59 | 0.41 |
| 0.009 | 0.94 | 0.48 | 0.55 | 0.97 | 0.16 | 0.81 | 0.92 | 0.69 | 0.31 |

The results of Table 3 indicate that the most suitable outer layer thickness is 12 mm, because for this chosen value the average absorbency factor under the applied frequency range is the lowest, namely 0.56; and as a result the transmission factor through the graphite layer is highest, namely 0.44. It means that only 44% incident EMW with different length would be penetrating to resistive sheet. For the effectively energy collection by proposal structures it is necessary to evaluate the graphite layer height such that the transmission factor would be approaching to 1. Therefore, Table 4 presents calculations of the most appropriate outer layer height. As it is seen, average value of the highest transmittance occurred if the graphite layer height is equal 0.039mm.

TABLE IV

OUTER LAYER THICKNESS EVAULATION RESULTS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Estimated height h1, [*mm*] | | 5.000 | 2.500 | 1.250 | 0.625 | 0.313 | 0.156 | 0.078 | 0.039 |
| ,[GHz] | , | Transmittance factors | | | | | | | |
| 6 | 12.63 | 0.3318 | 0.9654 | 0.9864 | 0.7319 | 0.9198 | 0.9789 | 0.9947 | 0.9987 |
| 8 | 9.85 | 0.9895 | 0.9900 | 0.9778 | 0.6136 | 0.8733 | 0.9657 | 0.9912 | 0.9978 |
| 10 | 8.25 | 0.3081 | 0.9829 | 0.9686 | 0.5149 | 0.8271 | 0.9517 | 0.9875 | 0.9969 |
| 12 | 7.05 | 0.0210 | 0.8503 | 0.9574 | 0.4614 | 0.7750 | 0.9347 | 0.9830 | 0.9957 |
| 14 | 6.18 | 0.0486 | 0.6130 | 0.9451 | 0.3417 | 0.7222 | 0.9163 | 0.9779 | 0.9844 |
| 16 | 5.51 | 0.4182 | 0.2270 | 0.9317 | 0.2745 | 0.6698 | 0.8965 | 0.9724 | 0.9930 |
| 18 | 4.95 | 0.9800 | 0.0051 | 0.9167 | 0.2162 | 0.6165 | 0.8746 | 0.9660 | 0.9913 |
| Average value of transmittance | | 0.4425 | 0.6591 | 0.9548 | 0.4449 | 0.7720 | 0.9312 | 0.9818 | **0.9954** |

For the evaluation of absorbency of middle structures layers, the wave lengths and thickness had been calculated. For the properties of composites, calculation results for 3% MWCNTs and 3% CNFs fillers are shown in Tables 5 and 6.

TABLE V

COMPOSITES FILLERS ELECTRICAL PROPERTIES

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 3 % MWCNTs | | | | 3 % CNFs | | | |
| *f*,[GHz] |  | d(*f*), [*m*] | Z, [Ω] | , [S/m] |  | d(*f*), [*m*] | Z, [Ω] | , [S/m] |
| 6 | 23.19 | 0.017 | 78.28 | 4.84 | 15.60 | 0.038 | 95.45 | 1.74 |
| 8 | 22.71 | 0.013 | 79.11 | 6.28 | 14.57 | 0.027 | 98.77 | 2.37 |
| 10 | 22.21 | 0.010 | 80.00 | 7.68 | 14.00 | 0.021 | 100.76 | 3.03 |
| 12 | 21.93 | 0.009 | 80.51 | 9.08 | 13.48 | 0.017 | 102.68 | 3.68 |
| 14 | 21.65 | 0.007 | 81.03 | 10.44 | 13.06 | 0.014 | 104.33 | 4.35 |
| 16 | 21.43 | 0.007 | 81.44 | 11.84 | 12.70 | 0.012 | 105.78 | 4.98 |
| 18 | 21.15 | 0.006 | 81.98 | 13.12 | 12.39 | 0.010 | 107.11 | 5.71 |

TABLE VI

WAVE LENGTH AND SPACER LAYER THICKNESS CALCULATION RESULTS

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *f*,[GHz] | 3% MWCNTs | | | | 3% CNFs | | | |
| d(*f*), [c*m*] | λ, [cm] | λ/4, [cm] |  | d(*f*), [c*m*] | λ, [cm] | λ/4, [cm] |  |
| 6 | **1.700** | 1.037 | 0.26 | 7 | **3.800** | 1.266 | 0.316 | 12 |
| 8 | 1.300 | 0.786 | 0.20 | 9 | 2.700 | 0.982 | 0.245 | 16 |
| 10 | 1.000 | 0.637 | 0.16 | 11 | 2.100 | 0.802 | 0.201 | **19** |
| 12 | 0.900 | 0.534 | 0.13 | 13 | 1.700 | 0.681 | 0.170 | 22 |
| 14 | 0.700 | 0.461 | 0.12 | 15 | 1.400 | 0.594 | 0.148 | 26 |
| 16 | 0.700 | 0.405 | 0.10 | 17 | 1.200 | 0.527 | 0.132 | **29** |
| 18 | 0.600 | 0.362 | 0.09 | 19 | 1.000 | 0.473 | 0.118 | 32 |

Presented results show that odd number of quarte wave length very well matches with the depth that is defined as 1.7cm for the 3% MWCNTs filler. However for the 3% CNFs filler it is not so well. It means that the most possible absorbency factors can be achieved only at frequencies of 8 and 16 GHz. With the reason of optimizing this situation, the absorbency factor was calculated under the frequency range of 6-18GHz for all possible thicknesses which are represented in Table 6. The calculation results are presented in Table 7.

TABLE VII

ABSORBENCY FACTOR FOR 3% CNFs FILLER LAYER

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *h*2=d(*f*),  [m] | *f*,[GHz] | | | | | | | Avrg |
| 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| 0.038 | 0.01 | 0.76 | 0.97 | 0.61 | 0.46 | 0.98 | 0.24 | 0.58 |
| 0.027 | 0.99 | 0.24 | 0.03 | 0.39 | 0.54 | 0.02 | 0.76 | 0.42 |
| 0.021 | 0.01 | 0.76 | 0.97 | 0.61 | 0.46 | 0.98 | 0.24 | 0.57 |
| 0.017 | 0.88 | 0.97 | 0.77 | 0.00 | 0.78 | 0.96 | 0.64 | 0.71 |
| 0.014 | 0.7 | 0.45 | 0.97 | 0.36 | 0.80 | 0.9 | 0.15 | 0.62 |
| 0.012 | 0.27 | 0.98 | 0 | 0.99 | 0.10 | 0.97 | 0.2 | 0.50 |
| 0.001 | 0.5 | 0.66 | 0.77 | 0.85 | 0.91 | 0.95 | 0.97 | **0.80** |

Finally, the thicknesses of 1.7cm and 1.0 cm were chosen for 3% MWCNTs and 3% CNFs fillers of spacer layer. The absorbency factor for them is shown in Fig.2.

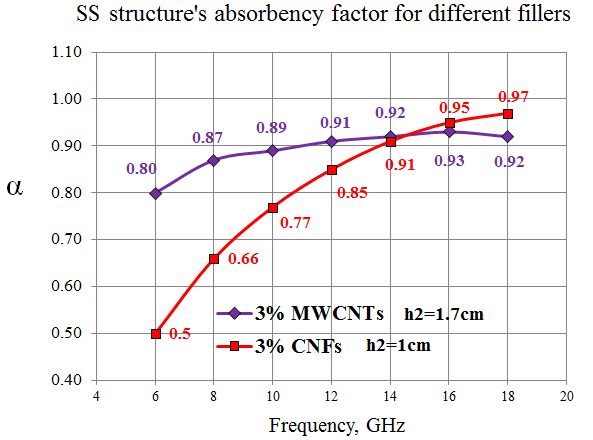


Fig.2. Back layer skin depth evaluation under 6-18GHz frequency range

In order to evaluate the thickness of back layer there are used three metals namely aliuminium, cooper and silver. For the best shelding ability it is recommended to use of 3d(*f*), 5d(*f*) and 11d(*f*) for the minimum, medium and exelent shielding respectively [11]. For these three metals the depth skin were calculated under the frequency range of 6-18GHz assuming the magnetic permeabilities which have the values of  μr = 1 [11]. Calculation results are shown in Fig. 2. Most lower skin depth is appeared for the cooper. The average value of cooper skin depth under applied frequency range is 0.22nm. Therefore, as it was discussed above, finally the back layer material is choosen cooper and the thikness equal to 2.42 nm.

*III.2. Power evaluation*

The specific power factor was calculated using Equations 14-16. The external electric field strength with extremely high frequency must not exceed the value of 5V/m in Lithuania [12]. Therefore, for the calculation of specific power factor the outside electric field value of 5V/m was considered. Graphical representation of power factors is shown in Fig. 3.

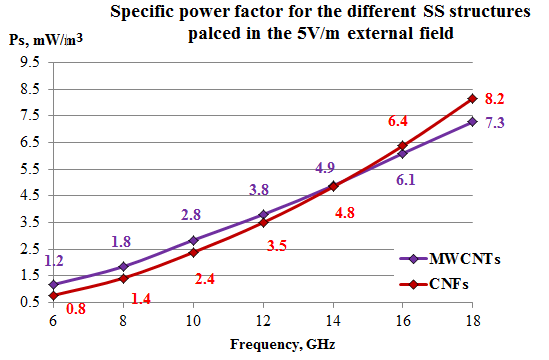


Fig.3. Specific power calculation results

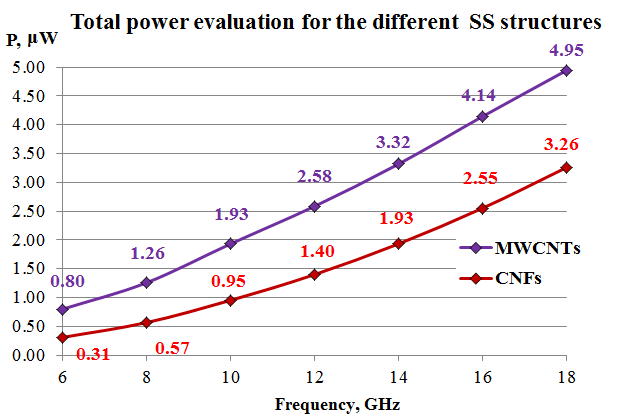


Fig.4. Total power calculation results for the SS structures: 

Equation (17) defines the total power dependency on the geometrical parameters of spacer layer. It is clear that increasing the structures width and length the total collected power increases. Nevertheless, the precise calculations were done assuming the equality of the length and width. The total collected power in certain volume of the composite material is presented by Fig. 4.

# Discussions

The layers of proposal structures were used because of the data [9,10]. Also the graphite as outer layer has very good ability to collect the heating because of its high thermal coefficient that is very relevant in term of further study on the energy converter by these structures. The layers thicknesses were obtained to achieve the resonance in the spacer layers which directly influences to the heating properties of composites. Therefore the thicknesses of the proposal structures as well as the spacer layers thicknesses are calculated so that they can operate with all frequencies within the microwave frequency range of 6-18GHz. Average absorbency factor for the 3% MWCNTs with optimal thickness 1.7cm is 0.89. For the SS with 3% CNFs and thickness size of 1cm the average absorbency factor is equal to 0.8.The total calculated harvesting power values are very small, average total power for SS with 3% MWCNTs and with 3% CNFs not exceeds the value of 2.71µW and 1.57µ W respectively. The main reason is the low value of electric field applied for the calculation. Although the legislation limits of the high frequency electromagnetic field up to 5V/m, there are a lot of investigations which find out much more electric field strength values then 5V/m. As an example, police’s radar system used in speed tacking can radiate from 17V/m to 142V/m for high frequency electromagnetic waves [13]. Therefore, the electric field value of 5V/m could not be assumed as a constant or limit value.

# Conclusion

## A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Acknowledgment

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