American Journal of Electromagnetics and Applications
2026, Vol. 14, No. 1, pp. 17–23
https://doi.org/10.11648/j.ajea.20261401.12

SciencePG
Science Publishing Group

Research Article

On the Radar Absorbing Material Reflectivity and Electromagnetic Interference Shielding Effectiveness

Tarek Abdulrahman Sallam[1, 2], **Abdel Rahman Mohammad Sallam**[3, *]

[1]School of Computer Science and Technology, Shandong Xiehe University, Jinan, China

[2]Faculty of Engineering at Shoubra, Benha University, Cairo, Egypt

[3]Microwave Lab., National Institute of Standards (NIS), Giza, Egypt

Abstract

The goal of this work is to examine radar absorbing material (RAM); which -in the simplest case- is composed of a single metal-packed coating layer, reflectivity (R) through a frequency (f) range from 0.5 GHz to 40 GHz; this range covers applications of long-range radar, missile detection, surface target tracking, and airborne precision ground radars. Variation of nonmagnetic, homogeneous, and non-dispersive RAM R is reformed to facilitate calculations. Effect of dielectric parameters; permittivity and permeability (ϵ and μ) on R for one layer-metal-packed RAM with two different thicknesses (they influence the electromagnetic wave absorption due to attenuation and matching models) are given. Electromagnetic interference shielding effectiveness (EMISE) which characterises the behaviour of a material depends on material conductivity (σ), relative permittivity (ϵ_r) and relative permeability (μ_r). reflection loss (R), absorption loss (A), and internal loss (M) for one and two layers located between two semi-infinite free space media are derived. Attenuation (α) variations with f, ϵ, μ, and layer thickness for single and double layers are examined. Results indicate that most waves are reflected from inside interfaces of RAM also high conductivity, high permeability, and increasing thickness are necessary to configure good absorbent. Calculations and graphs are carried on using MATLAB R2013a.

Keywords

Radar Absorbing Material, Electromagnetic Shield, Attenuation, Loss

1. Introduction

A great challenge is to force targets to be invisible to enemy radars, this can be achieved by reducing radar cross section (RCS), four techniques can reduce RCS are shaping, RAM, passive cancellation, and active cancellation [1].

The simplest RAM structure composed of a single metal-packed coating layer (Figure 1), to enhance minimum reflectivity, the effects of all loss mechanisms can be lumped by refractive index or permittivity (ϵ) and permeability (μ) of the material, all of them can be complex [2]. RAM converts radar wave energy into heat causing loss and/or scattering it back to free space [3]. To achieve considerable attenuation of radar waves, ϵ and μ must be large which is tempered with the fact that large values of ϵ and μ would result in a large

*Correspondence: Abdel Rahman Mohammad Sallam (abdelrahman.mohammad@nis.sci.eg)

Received: 21 September 2026; **Accepted:** 4 October 2026; **Published:** 11 November 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

reflection coefficient [4]. RAM thickness influences the electromagnetic wave absorption due to attenuation and matching models [5].

The present work selects the operating frequency band to cover applications of long-range radar, missile detection, surface target tracking, and airborne precision ground radars, these applications demand a spectrum of 0.5 GHz to 40 GHz, more details are given [6-10].

Starting by initializing varying $|\epsilon|$ with electric loss angle $\delta_e = \pi/9$ and constant RAM thickness, assuming common dielectric materials used for absorbers, such as foams, plastics and elastomers, these materials have no magnetic properties, giving them $\mu = 1 + j0$ [11].

2. RAM Reflectivity

In case of incident fields have a negative time dependence $e^{-j\omega t}$ the relative dielectric properties of RAM are

$$\varepsilon_r = \varepsilon_r' + j\varepsilon_r'' = |\varepsilon_r| e^{j\delta_e} \quad (1)$$

$$\mu_r = \mu_r' + j\mu_r'' = |\mu_r| e^{j\delta_m} \quad (2)$$

RAM's relative intrinsic impedance and refractive index are

$$Z_r = Z_r' + jZ_r'' = (\mu_r/\varepsilon_r)^{1/2} \quad (3)$$

$$N_r = N_r' + jN_r'' = (\mu_r\ \varepsilon_r)^{1/2} \quad (4)$$

Prime and double prime superscripts represent real (energy storage) and imaginary (energy loss) parts of RAM dielectric properties which are complex scalars, $\tan\delta_e$ and $\tan\delta_m$ are the dielectric loss tangents, they are a measure of the power loss in the medium. RAM wave number $k = k_o N_r$, where $k_o = \omega\sqrt{\mu_o\varepsilon_o} = 2\pi/\lambda_o$ is free space wave number and $\lambda_o = f/c$ is free space wavelength, f is the incident wave frequency and $c = (\mu_o\varepsilon_o)^{-1/2}$ is the energy speed in free space, μ_o $(\approx 0.4\ microhenry/m)$ and $\varepsilon_o (\approx 8.854\ picofarad/m)$ are free space permeability and permittivity, ω is the radian frequency.

The reflection coefficient of RAM backed by a perfect electric conductor (PEC) (Figure 1) is given by the stratified media approach [12, 13] or transmission line theory [14, 15] as:

$$R = \frac{Z_r tanh(-jkd) - 1}{Z_r tanh(-jkd) + 1} \quad (5)$$

d is the RAM thickness, Z_r is the RAM impedance normalized by free space intrinsic impedance $Z_o = (\mu_o/\varepsilon_o)^{1/2} = 120\pi\ \Omega$. $tanh$ argument of (5) is assumed as $-jkd = -jk_oN_rd = k_odN_r'' - jk_odN_r' = x + jy$.

Expressing $tanh(x+jy) = \frac{tanh(x)+jtan(y)}{1+j\ tanh(x)tan(y)}$ with (1-4) are substituted into (5) with some of trigonometric and hyperbolic identities utilization, the voltage reflection coefficient amplitude is given as:

$$|R| = \left(\frac{X_1{}^2 + X_2{}^2}{X_3{}^2 + X_4{}^2}\right)^{1/2} \quad (6)$$

Phase angle of R is important in some narrowband RAM applications where resonant energy cancellation is used [16].

here,

$$X_1 = \frac{Aa}{C} - b - Z_r'',\ X_2 = \frac{Ba}{C} + Z_r',$$

$$X_3 = \frac{Aa}{C} + b + Z_r' sinh(2x),\ X_4 = \frac{Ba}{C} + Z_r'' sinh(2x)$$

$$a = sinh^2(x) + sin^2(y),\ b = sinh^2(x) + cos^2(y),$$

$$A = \mu_r'\varepsilon_r' + \mu_r''\varepsilon_r'',\ B = \mu_r''\varepsilon_r' - \mu_r'\varepsilon_r'',$$

$$C = \varepsilon_r'^2 + \varepsilon_r''^2,\ Z_r' = Lcos(\theta),\ Z_r'' = Lsin(\theta),$$

$$L = \left(\frac{A^2+B^2}{C^2}\right)^{1/4},\ \theta = \frac{1}{2}tan^{-1}\left(\frac{B}{A}\right)$$

Eqn. (6) rather than (5) paved the way for the algorithm to configure minima with less round error, less iterations, and no discontinuities, it expresses magnitude of RAM reflectivity which is given in decibels as [17].

$$[R_{dB}] = 20log_{10}(|R|) \quad (7)$$

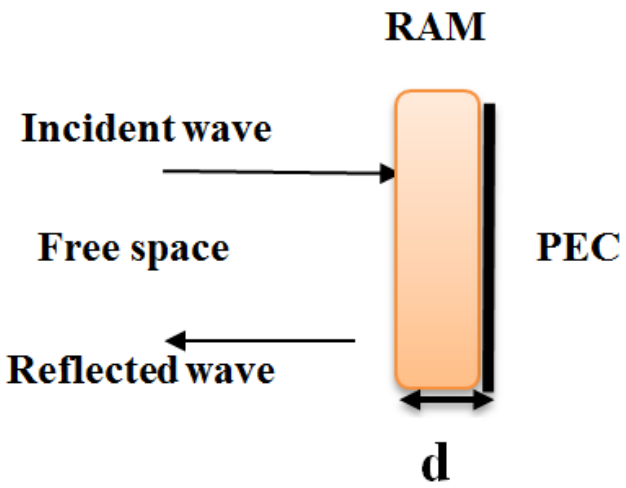


Figure 1. *One-layer RAM backed by a PEC {impedance of layer i $(Z_i), i = 1-3$, 1-air, 2-RAM, 3-PEC/or air (section III)}.*

3. EMISE

EMISE is based on its ability of attenuating incident radia-

tion by reflection, absorption, and internal reflection mechanisms (classical shielding theory) [18, 19]. The EMISE behaviour of a material depends on its conductivity (σ), ε_r and μ_r [20]. It is defined as the ratio of transmitted energy (E_t) and incident energy (E_i) [21], the total (SE_t) is given [21-23]. $SE_t(dB) = SE_A + SE_R + SE_M$. Consider a dielectric sheet of thickness d is located between two semi-infinite free space media (Figure 1 with removed PEC). The transmission coefficient is given [24].

$$T = \frac{1}{(1+Z_{12})(1+Z_{23})} \frac{4e^{j(k_2-k_3)d}}{1+r_{12}r_{23}e^{2jk_2d}} \tag{8}$$

here, $r_{12} = \frac{Z_2-Z_1}{Z_2+Z_1}$, $r_{23} = \frac{Z_3-Z_2}{Z_3+Z_2}$, substituting in (6.a) gives

$$T = \frac{4Z_2Z_3}{(Z_2+Z_1)(Z_3+Z_2)} e^{j(k_2-k_3)} \frac{1}{1+r_1r_2e^{2jk_2d}} \tag{9}$$

$r_1 = \frac{Z_2-Z_1}{Z_2+Z_1}$, $r_2 = \frac{Z_3-Z_2}{Z_3+Z_2}$, and $Z_i = \frac{\omega\mu_i}{k_i}$, where Z_i is the impedance of layer i, the permeability and propagation constant of layer i are μ_i and k_i respectively. $k_i = \omega\sqrt{\mu_i\left(\varepsilon_i - j\frac{\sigma_i}{\omega}\right)}$,

$$SE = -20log_{10}|T| = R + A + M \tag{10}$$

Eqns. (9) and (10) lead to

$$R = 20\ log_{10}\left|\frac{(Z_2+Z_1)(Z_3+Z_2)}{4Z_2Z_3}\right| \tag{11}$$

$$A = 20log_{10}\left|e^{j(k_3-k_2)d}\right| \tag{12}$$

$$M = 20log_{10}\left|1 + r_1r_2e^{2jk_2d}\right| \tag{13}$$

The propagation constant γ is given as [25, 26]

$$\gamma^2 = j\omega\mu(\sigma + j\omega\epsilon) \tag{14}$$

The attenuation constant $\propto (Np/m)$ is given as

$$\propto = \omega\sqrt{\frac{\omega\epsilon}{2}\left[\sqrt{1+\left[\frac{\sigma}{\omega\epsilon}\right]^2}\right] - 1} \tag{15}$$

Skin depth (δ) is given [27].

$$\delta = \frac{1}{\sqrt{\pi f\mu\sigma}} = \frac{1}{\alpha} \tag{16}$$

The total conductivity σ_t of RAM is given as

$$\sigma_t = \sigma_{AC} + \sigma_{DC}\ \ S\ \ m^{-1} \tag{17}$$

σ_{AC} is the AC electrical conductivity $\sigma_{ac} = \omega\epsilon_r''\epsilon_o$, σ_{DC} is the DC electrical conductivity $\sigma_{dc} = \frac{\epsilon_r''(\omega\epsilon_o-1)}{\omega\epsilon_r'}$, when $SE_t > 9\ dB$, SE_M can be neglected [28-30]. Good EMI absorption is achieved by impedance matching [31]. High absorbing shield is attractive because it decreases EM pollution [32-39].

4. Results

A survey is performed among a plethora of published references, among them references [22, 37, 38, 40-48] are selected to configure RAM of good contrasted ϵ_r and μ_r combinations.

Relatively high ϵ_r values are fed to algorithm, as this is essential for enhancing absorption [49], so the algorithm varies $|\varepsilon_r|$ from 1 to 20 with $\delta_e = \pi/9\ \ radians$, with $(\mu_r = 1 + j0)$. Figures 2 and 3 gives ε_r' and ε_r'' versus $\mathbf{R_{dB}}$ $(d = 2\ mm\ )$. minimum R occurs at 10 GHz, (Figures 2 and 3). Figure 4 and 5 shows complex ϵ_r versus $\mathbf{R_{dB}}$ $(\boldsymbol{d = 0.5\ mm})$. Minimum **R** is shifted to 40 GHz, the reason is that $d = 0.5\ mm$, which accepts only δ at 40 GHz (Figures 4 and 5).

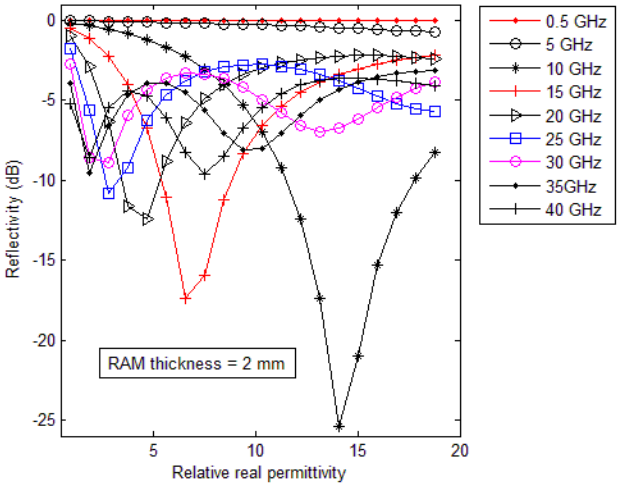


Figure 2. *ϵ'_r versus R_{dB}.*

Figure 6 depicts $\alpha\ (dB/m)$, it shows that α increases with high magnetic loss ([43]), high electric loss ([42]), but with less sensitivity for moderate values of both electric and magnetic loss RAM ([44]). Figure 7 displays EMISE components SE_{total}, SE_A, SE_R, SE_M, it is clear that M and R are insignificant if SE_{total} exceeds 9 dB, the major contribution is due to A. Figure 8 shows SE for stepped $\epsilon_r^{shied} = \mu_r^{shied} = 10m + j10m, step\ \ m = 1\ \ to\ \ 5$.

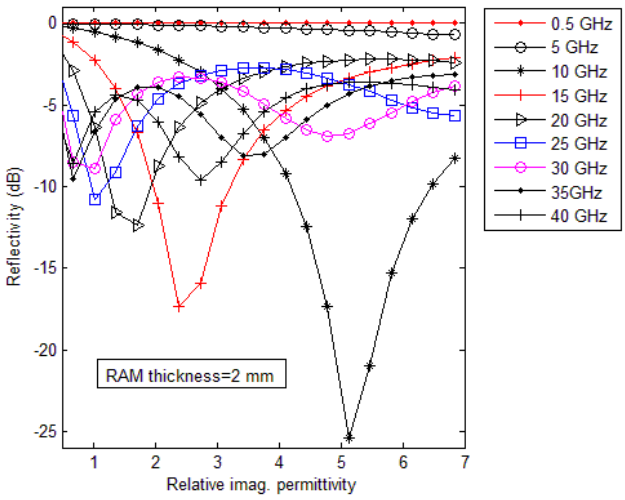


Figure 3. ϵ''_r *versus* R_{dB}

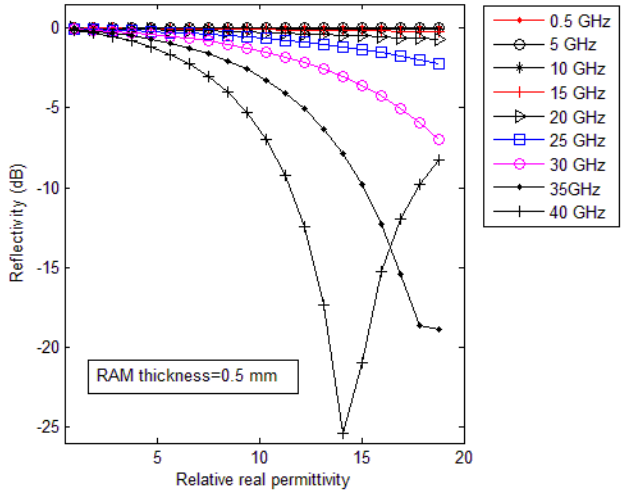


Figure 4. ϵ'_r *versus* R_{dB}

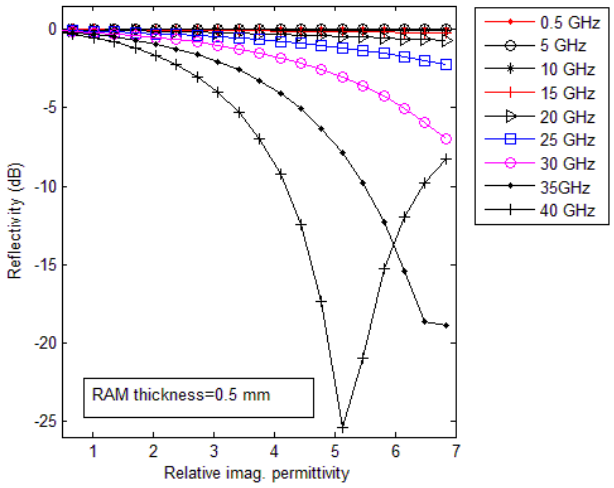


Figure 5. ϵ''_r *versus* R_{dB}

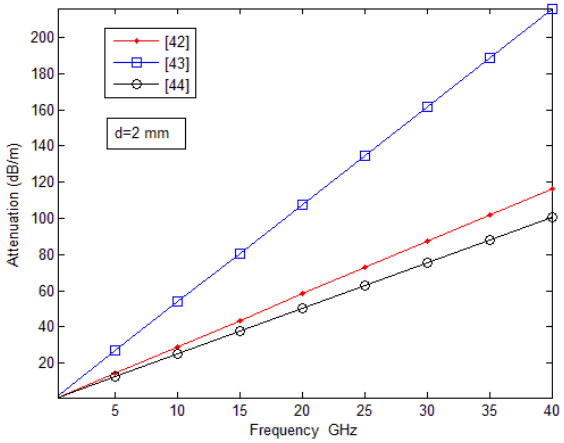


Figure 6. $\alpha \quad dB/m$ *(dielectric properties of [42, 43], and [44]).*

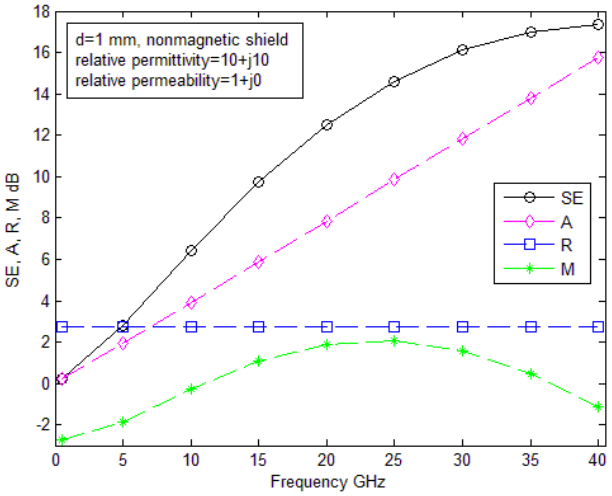


Figure 7. *EMI SE components.*

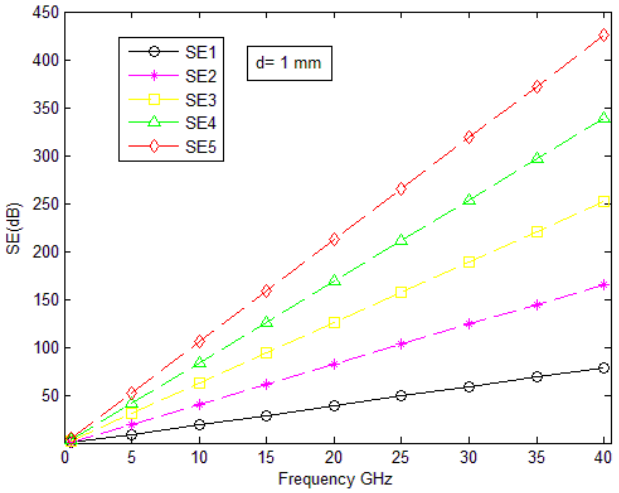


Figure 8. $SE1 \ to \ SE5 \approx A1 \ to \ A5 \ coresponds \ to \ \epsilon_r^{shied} = \mu_r^{shied} = 10m + j10m, step \ m = 1 \ to \ 5.$

5. Conclusion

RAM reflectivity and EMISE are investigated. Study of one and two dielectric layers indicates that when material has high permeability and low electrical conductivity most waves are reflected from inside interfaces, SE_R for lower frequencies is greater than higher frequencies and it decreases with frequency increase. SE_A increases with frequency increase, that is why high conductivity, high permeability, and increasing thickness $d/\delta > 1$ are necessary to configure good absorbent. The absorption loss is proportional to the thickness of the shield and increases with increasing frequency, unlike reflection where the loss decreases with increasing frequency.

Abbreviations

RAM	Radar Absorbing Material
R	Reflectivity
f	Frequency
EMISE	Electromagnetic Interference Shielding Effectiveness
R	Reflection Loss
A	Absorption Loss
M	Internal Loss
α	Attenuation
RCS	Radar Cross Section
PEC	Perfect Electric Conductor
δ_e	Electric Loss Angle

Author Contributions

Tarek Abdulrahman Sallam: Data curation
Abdel Rahman Mohammad Sallam: Conceptualization

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] E. F. Knott, J. E. Shaeffer, and M. T. Tuley, Radar Cross Section, 2nd edition, Chapter 7, Scitech, 2004.

[2] David C. Jenn, Radar and Laser Cross Section Engineering, AIAA, 1995.

[3] R. C. Parida, D. Singh and N. K Agarwal, Implementation of multilayer ferrite radar absorbing coating with genetic algorithm for radar cross-section reduction at X-band 2007 *Indian Journal of Radio & Space Physics* 36 145-152.

[4] Paul Saville, Review of Radar Absorbing Materials, Defence Research and Development Canada, Defence R&D Canada - Atlantic DEFENCE Technical Memorandum, DRDC Atlantic TM 2005-003, Report 3, January, 2005.

[5] Bluma Guenther Soares, Guilherme M. O. Barra, and Tamara Indrusiak, Conducting Polymeric Composites Based on Intrinsically Conducting Polymers as Electromagnetic Interference Shielding/Microwave Absorbing Materials—A Review. J. Compos. Sci. 2021, 5, 173. https://doi.org/10.3390/jcs5070173

[6] IEEE Standard Dictionary of Electrical and Electronics Terms, 3rd ed., ANSI/IEEE standard 100-1984.

[7] Joseph P. Camacho, Federal Radar Spectrum Requirements, NTIA Special Publication 00-40, U. S. DEPARTMENT OF COMMERCE, May 2000.

[8] John R. Hoehn, Jill C. Gallagher, and Kelley M. Sayler, Overview of Department of Defense Use of the Electromagnetic Spectrum, Congressional Research Service, https://crsreports.congress.gov R46564, August 10, 2021.

[9] NATO, Radar Spectrum Engineering and Management, STO TECHNICAL REPORT, TR-SET-182, Final Report of Task Group SET-182, April 2016.

[10] John A. Stine and David L. Portigal, An Introduction to Spectrum Management, MTR 04W0000048, MITRE TECHNICAL REPORT, Spectrum 101, MITRE, March 2004.

[11] Laird Technologies, Microwave Absorbing Materials, ABSORB-CAT-2006, www.lairdtech.com

[12] J. R. Wait, Electromagnetic wavea in stratified media, 2nd Ed. Oxford. Pergamon, Chapter 2, 1970.

[13] Perhi J and Cohen L S, Design of broad-band radar absorbing materials for large angles of incidence, *IEEE Transactions on Electromagnetic Compatibility* 35 223-230, 1993.

[14] D. M. Pozar, *Microwave Engineering*. Hoboken, NJ, USA: Wiley, 2012.

[15] Z. Zhang, Z. Wang, L. Wang, Design principle of single- or double-layer wave-absorbers containing left-handed materials, Vol. 30; Iss. 9, Materials & Design, 2009.

[16] Jussi Säily and Antti V. Räisänen, STUDIES ON SPECULAR AND NON-SPECULAR REFLECTIVITIES OF RADAR ABSORBING MATERIALS (RAM) AT SUBMILLIMETRE WAVELENGTHS, Helsinki University of Technology Radio Laboratory Publications, Teknillisen korkeakoulun Radiolaboratorion julkaisuja, Espoo, February, 2003 REPORT S 258.

[17] K. Gaylor, RADAR ABSORBING MATERIALS - MECHANMS AND MATERIALS, MRL Technical Report, MRL-TR-89-1, AR No. 005-686, DSTO Materials Research Laborstory, Commonwealth of Australia 1989.

[18] S. A. Schelkunoff, Electromagnetic Waves, Van Nostrand, New York, 1945.

[19] A. D. S. Gomes, New Polymers for Special Applications, 2012.

[20] Huo J, Wang L and Yu H. Polymeric nanocomposites for electromagnetic wave absorption. J Mater Sci 2009; 44: 3917-3927.

[21] Shan, L.; Chen, X.; Tian, X.; Chen, J.; Zhou, Z.; Jiang, M.; Xu, X.; Hui, D. Fabrication of polypyrrole/nano-exfoliated graphite composites by in situ intercalation polymerization and their microwave absorption properties. Compos. Part B Eng., 73, 181-187, 2015.

[22] H. Wang, D. Zhu, W. Zhou, and F. Luo, Temperature dependence of the electromagnetic and microwave absorption properties of polyimide/Ti3SiC2 composites in the X band, RSC Advances 2015, Issue 105, Page 85983 to 86848.

[23] Chung, D. D. L. Materials for electromagnetic interference shielding. Volume 255, 15 November 2020, 123587, Elsevier.

[24] J. A. STRATTON, ELECTROMAGNETIC THEORY, JOHN WILEY, Hoboken, New Jersey, 2007.

[25] Parker Hannifin, Conductive Elastomer Engineering Handbook Products and Customer Solutions, Parker Chomerics. https://www.parker.com › Literature › Chomerics.

[26] M. Sadiku, Elements of Electromagnetics, Ch. 10, 5th Edition, OXFORD UNIVERSITY PRESS, 2011.

[27] Jiang D., Murugadoss V., Wang, Y., Lin J., Ding, T., Wang Z., Shao Q. Wang C., Liu H., Lu N. et al, Electromagnetic Interference Shielding Polymers and Nanocomposites—A Review. Polym. Rev. 2019, 59, 280-337.

[28] A. P. Singh, A. Kumar, A. Chandra, and S. K. Dhawan1, Conduction mechanism in Polyaniline-flyash composite material for shielding against electromagnetic radiation in X-band & Ku band, AIP ADVANCES 1, 022147 2011.

[29] Munir, A. Microwave Radar Absorbing Properties of Multi-walled Carbon Nanotubes Polymer Composites: A Review. Adv. Polym. Technol. 2017, 36, 362-370.

[30] H. W. Ott, Noise Reduction Techniques in Electronic systems, Wiley, New York, 1987.

[31] Maosheng Caoa, c,*, 1, Ruru Qinb, Chengjun Qiuc, Jing Zhua, Matching design and mismatching analysis towards radar absorbing coatings based on conducting plate, Materials and Design 24 (2003) 391-396, ELSEVIER.

[32] A. Zamanian and C. Hardiman, Electromagnetic Radiation and Human Health: A Review of Sources and Effects, High Frequency Design, EMR & HUMAN HEALTH, July 2005 *High Frequency Electronics,* Summit Technical Media.

[33] J. F. B. Bolte and M. J. M. Pruppers, Electromagnetic fields in the working environment, Ministry of Social Affairs and Employment (SZW) report, RIVM no. 610015001, June 2006.

[34] I. Eliyahu, R. Luria, R. Hareuveny, M. Margaliot, N. Meiran, 2 and G. Shani, Effects of Radiofrequency Radiation Emitted By CellularTelephones on the Cognitive Functions of Humans, Bioelectromagnetics 27: 119-126 (2006).

[35] World Health Organization, ESTABLISHING A DIALOGUE ON RISKS FROM ELECTROMAGNETIC FIELDS RADIATION AND ENVIRONMENTAL HEALTH, DEPARTMENT OF PROTECTION OF THE HUMAN ENVIRONMENT, W. H. O. GENEVA, SWITZERLAND, 2002, ISBN 92 4 154571 2.

[36] J. C. Lin, Human Exposure to RF, Microwave, and Millimeter-Wave Electromagnetic Radiation, IEEE Microwave Magazine, June 2016.

[37] W. Wiatr, R. Frender, and M. Żebrowski, CHARACTERIZATION OF MICROWAVE ABSORBING MATERIALS USING A WIDEBAND T/R MEASUREMENT TECHNIQUE, MIKON 2008 - 17th International Conference on Microwaves, Radar and Wireless Communications.

[38] L. Sun, H. Cheng, Y. Zhou, and Jun Wang, Design of a Lightweight Magnetic Radar Absorber Embedded with Resistive FSS, IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 11, 2012.

[39] D. J. Panagopoulos and L. H. Margaritis, The effect of exposure duration on the biological activity of mobile telephony radiation, Volume 699, Issues 1-2, 17 June 2010, Pages 17-22, Elsevier.

[40] Yuzcelik, Cihangir Kemal, Radar absorbing material design, Monterey, California. Naval Postgraduate School, Downloaded from NPS Archive: Calhoun, http://www.nps.edu/library

[41] R. G. Geyer, Dielectric Characterization and Reference Materials, NIST Technical Note 1338.

[42]] P. Zhou, L. Huang, J. Xie, D. Liang, H. Lu, and L. Deng, A Study on the Effective Permittivity of Carbon/PI Honeycomb Composites for Radar Absorbing Design, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 60, NO. 8, AUGUST 2012.

[43] D. Vladimirov. E. Khandogina, L. Gazian, V. Larin, AMORPHOUS MICROWIRE - UNIQUE MATERIAL FOR MODERN MICROWAVE ABSORBERS, International Conference on Antenna Theory and Techniques, 9-12 September, 2003, Sevastopol, Ukraine pp. 682-683.

[44] K. Chao, Y. Liu, and R. Yang, Application of The Microgenetic Algorithm to The Optimization of Multilayered ZnO Whisker Radar Absorbing Coating, 7th International Symposium on Antennas, Propagation & EM Theory, Guilin, China, 26-29 Oct. 2006.

[45] N. Vohra and M. El-Shenawee, *K*- and *W*-Band Free-Space Characterizations of Highly Conductive Radar Absorbing Materials, IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 70, 2021.

[46] A. Toktas, D. Ustun, and M. Tekbas, Multi-Objective Design of Multi-Layer Radar Absorber Using Surrogate-Based Optimization, IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 67, NO. 8, AUGUST 2019.

[47] Y. Zhao, J. Liu, Z. Song, and X. Xi, Novel Closed-Form Expressions for Effective Electromagnetic Parameters of Honeycomb Radar-Absorbing Structure, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 64, NO. 5, MAY 2016.

[48] Q. Yu, Y. Zeng, and G. Ma, A radar-infrared compatible broadband absorbing surface, Design and analysis, Chin. Phys. B Vol. 30, No. 7 (2021) 078402.

[49] R. Kaur and G. D. Aul, Review on Microwave Absorbing Material using Different Carbon Composites, International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 3 Issue 5, May 2014.