



## Electromagnetic Shielding Performance of Aluminium Foil for Stealth Applications

\*<sup>1</sup>Joseph, J. I., <sup>2</sup>Ahmed, R. B., <sup>3</sup>Omiogbemi, I. M-B., <sup>1</sup>Omidiji, I. I., & <sup>4</sup>Abdullahi, A. N.

<sup>1</sup>Department of Aerospace Engineering, Air Force Institute of Technology, Kaduna, Nigeria.

<sup>2</sup>Department of Aircraft Engineering, Air Force Institute of Technology, Kaduna, Nigeria.

<sup>3</sup>Department of Mechanical Engineering, Nile University of Nigeria, Abuja, Nigeria.

<sup>4</sup>Department of Civil and Environmental Engineering, Air Force Institute of Technology, Kaduna, Nigeria.

\*Corresponding author email: [jirex2018@outlook.com](mailto:jirex2018@outlook.com)

### Abstract

To evade radar detection, modern warfare requires the development of effective stealth technologies. This experiment aims to evaluate the potential of aluminium foil as a covert radar-absorbing material (RAM) by analysing the electromagnetic properties and reflection loss of aluminium foil using High-Frequency Structure Simulator (HFSS), and also carrying out physical experimentation (Faraday's cage set-up) of the foil to evaluate its electromagnetic (EM) wave shielding characteristics, with a focus on its applicability as a candidate RAM. The research explores the use of aluminium foil in stealth design, highlighting its radar-absorbing properties. The results demonstrate that aluminium foil-based RAMs can be engineered to reduce radar cross-section, enhancing stealth capabilities. This domestically developed technology offers a versatile and cost-effective solution for stealth applications, fostering significant growth and operational efficiency.

**Keywords:** Aluminium Foil, Radar Detection, Radar-Absorbing Material, Stealth Technologies, High-Frequency Structure Simulator

### Introduction

The rapid advancement in technology has brought about strategical improvement in warfare and surveillance. For effective reconnaissance, there has been a deep dive into stealth technology. Radar absorption, which is a result of stealth technology, plays a crucial role in reducing the detectability of a vehicle (Bae & Kim, 2015). The measure of how an aircraft can be detected by a radar system is known as the RCS. The RCS, known as the radar cross section of an aircraft, is the measure of the detectability of aircraft to electromagnetic waves (radar waves) (Ball & Younan, 2017). This study focuses on the material from which the Aerial vehicle is made, being aluminium foil, as a potential Radar Absorbing Material (RAM) for stealth applications. During World War I, the Germans were the first to attempt to reduce their visibility with the use of translucent Cellon (Cellulose acetate), a transparent covering material. In 1916, the British followed suit and were able to modify the SS Class Airship for reconnaissance over German lines. Later on in 1945, the diffused lighting camouflage concept was introduced for the newer model aircraft (*Stealth Technology - Wikipedia*, n.d.).

Aluminium foil is a good conductor and a non-magnetic material, having the ability to shield significant electromagnetic waves. It is a less expensive, lightweight and widely available material, which makes it useful in low-cost applications (Aynalem, 2020). The high reflectivity of aluminium means its interaction with EM waves is not the same as that of true radar absorbing materials, which should supply energy as heat through magnetic loss (Memorandum, 2005). Instead of providing aluminium foil as the complete RAM solution, this paper analyses its electromagnetic shielding and attenuation performance through simulation using HFSS. This characterises reflection loss and EM blocking behaviour, which is evaluated through the physical Faraday cage experiment. This study aims to explore the use of aluminium foil as an easily accessible and lightweight prospective material in the application of stealth on UAVs

Cite this paper as:

505 Joseph, J.I., Ahmed, R.B., Omiogbemi, I. M-B., Omidiji, I.I., & Abdullahi, A.N. (2026). Electromagnetic shielding performance of aluminium foil for stealth applications. In Proceedings of the 1<sup>st</sup> International Conference and Exhibition on Research, Innovation and Development (ICERID), Ignatius Ajuru University of Education, Port Harcourt, Nigeria (Vol. 1, pp. 505-514).

### Stealth Technology and Radar Cross-Section

Stealth technology is a critical advancement in military and aerospace industries, primarily aimed at making objects, such as aircraft and ships, less visible to radar, infrared, sonar, and other detection systems. The main goal of stealth is to reduce the RCS, which is achieved by manipulating the electromagnetic properties of materials used in the construction of vehicles (Balaji Ananth et al., 2021). Long before the Second World War (WW II), there was a drive to go invisible and be more effective in combating the enemy and for reconnaissance, since an object's location and distance can be measured by radar by calculating the time taken for the return burst EM wave (Gurbuz, 2020).

Radar Absorbing Materials (RAMs) were employed in military applications to reduce the amount of energy reflected from the target to the radar antenna through an absorption process. This technique creates magnetic or dielectric losses by placing magnetic and dielectric materials on the target's surface. The frequency at which these losses occur affects RAM absorption performance (Bae & Kim, 2015; Padhy et al., 2013). To counter radar detection, stealth technology employs advanced materials and design techniques. Radar Absorbing Materials (RAMs) are one of the primary methods used to minimise the reflection of radar waves. These materials absorb the incident electromagnetic energy rather than reflecting it to the radar receiver, significantly reducing the object's RCS and making it less detectable (S. Kim *et al.*, 2023). Additionally, stealth designs incorporate shaping techniques that deflect radar waves away from the receiver, further reducing the radar signature (Liu *et al.*, 2023; Peixoto et al., 2005). By combining RAMs with strategic shaping, modern stealth technologies have drastically improved the survivability of military assets by limiting their visibility to radar detection systems (Kim *et al.*, 2023).

### Radar Absorbing Material (RAM)

Radar Absorbing Materials (RAM) are specifically engineered to minimize the reflection of electromagnetic waves, effectively reducing an object's radar cross-section (RCS) and making it less detectable by radar systems. These materials play a critical role in stealth technology by absorbing incident radar waves, preventing their reflection back to the radar receiver (Aytaç *et al.*, 2020; Balaji *et al.*, 2021). The effectiveness of RAM hinges on two key electromagnetic properties: permittivity and permeability (Yang *et al.*, 2022). Together, these properties dictate how RAMs interact with incoming radar signals and determine their effectiveness in different frequency ranges. Over the years, significant research has focused on developing RAMs using a variety of materials, including ferrites, carbon-based composites, and metal alloys, each with unique electromagnetic properties tailored to absorb radar waves at various frequencies (Hwang & Nam, 2024; Wang *et al.*, 2011; Smitha *et al.*, 2016; Micheli *et al.*, 2014; Yu, 2019). Modern RAMs are often composites that combine different materials to enhance absorption across a broader range of frequencies (Peev *et al.*, 2022). For instance, ferrite-based materials are commonly used for low-frequency applications, while carbon nanocomposites are effective at higher frequencies due to their lightweight and high conductivity (Atay, 2016; Ruiz-Perez et al., 2022). Advanced materials such as metamaterials and nanostructures are also being explored to further improve RAM performance by manipulating electromagnetic waves at the subwavelength scale (Chen *et al.*, 2024).

### Aluminium Foil as a Shielding Material

Aluminium foil, a widely used material in various industries, is gaining attention as a potential Radar Absorbing Material (RAM) due to its unique conductive and reflective properties. Composed primarily of aluminium alloy, aluminium foil typically contains between 92% and 99% aluminium, with small quantities of iron and silicon added to enhance its mechanical properties. The most common composition is 98.5% aluminium, which offers an ideal balance of strength, durability, and conductivity (Divya *et al.*, 2022; Chakrapani & Suryakumari, 2021). Aluminium foil is versatile for various applications, including electromagnetic interference (EMI) shielding, thermal insulation, and now, potentially, stealth technology. Aluminium foil is already widely used in EMI shielding in the electronics industry, where its conductive properties block unwanted electromagnetic interference. This established use in other high-frequency applications indicates its potential in radar absorption. As a result, aluminium foil is being considered not only for its primary properties but also for its ability to be integrated into existing technologies and manufacturing processes. The potential to optimise aluminium foil for use in stealth applications could provide an economical and efficient solution for enhancing the radar-evading properties of military assets (García-Martínez *et al.*, 2023).

### Research Gap on Radar Absorbing Material

Several studies have explored the development and optimisation of RAMs for stealth applications. The focus has been on materials that exhibit high permittivity and permeability, ensuring efficient absorption of radar waves. Research has indicated that composite materials, such as carbon-based nanocomposites, magnetic materials, and metal alloys, play an essential role in improving RAM performance across varying frequencies. Aluminium-based composites, in particular, have shown promise due to their lightweight, cost-effective production, and adaptable electromagnetic properties. Previous studies of HFSS-based RAM evaluations have depended on one simulation tool, neglecting complementary physical validation, and have overall required reduced material thicknesses (around 1 mm) to obtain maximum performance. Furthermore, no identified early study combines cost-effective HFSS simulation and physically realisable EMI-shielding

validation experiment for aluminium foil, mainly in an area related to stealth applications. This study addresses that gap by pairing ANSYS HFSS simulation of aluminium's reflection loss and field behaviour with a Faraday cage-based physical shielding experiment. Hence, making available both simulated and practical evidence of aluminium foil's EM-attenuating behaviour.

## Methodology

This study used two methods for the validation of aluminium foil's electromagnetic shielding performance. The two processes include the use of electronic simulations with ANSYS HFSS (High Frequency Simulation Software) for the characterisation of field behaviour and loss in reflection, while the physical experimental process was used to achieve behavioural validation of the blocking of electromagnetic fields in real-world conditions based on Faraday cage principles.

## Simulation ANSYS (HFSS)

The simulation was carried out using ANSYS HFSS on a simple target to find out the electromagnetic and attenuation properties of the model geometry.

The solution type was first set to 'modal', and then a sample target design box of 1mm on the X, Y and Z axes was created using the draw tool, as shown in [Figure 1](#). The target material was assigned as aluminium, which could somewhat represent aluminium foil (98.5% aluminium alloy).

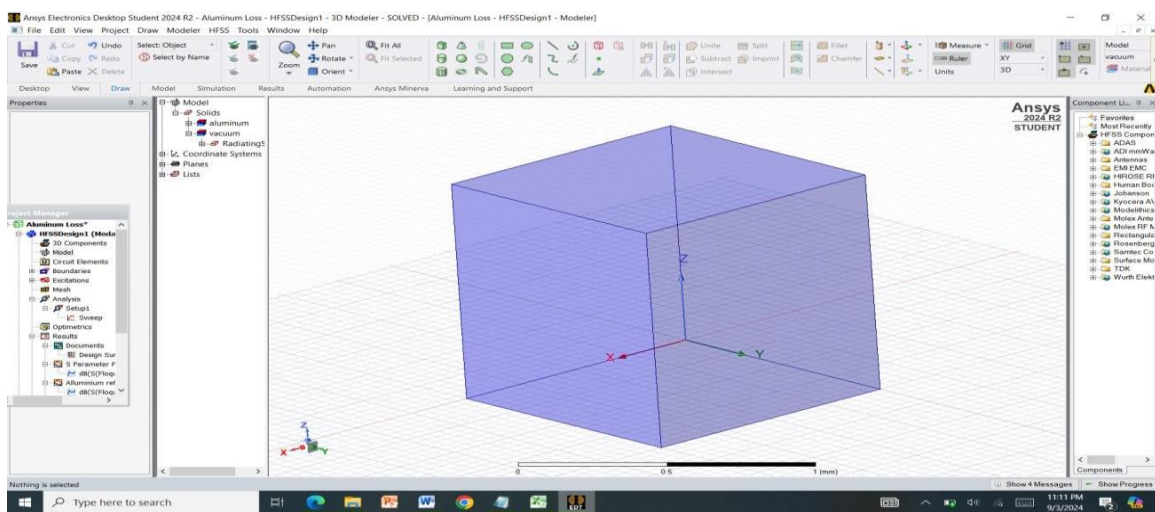
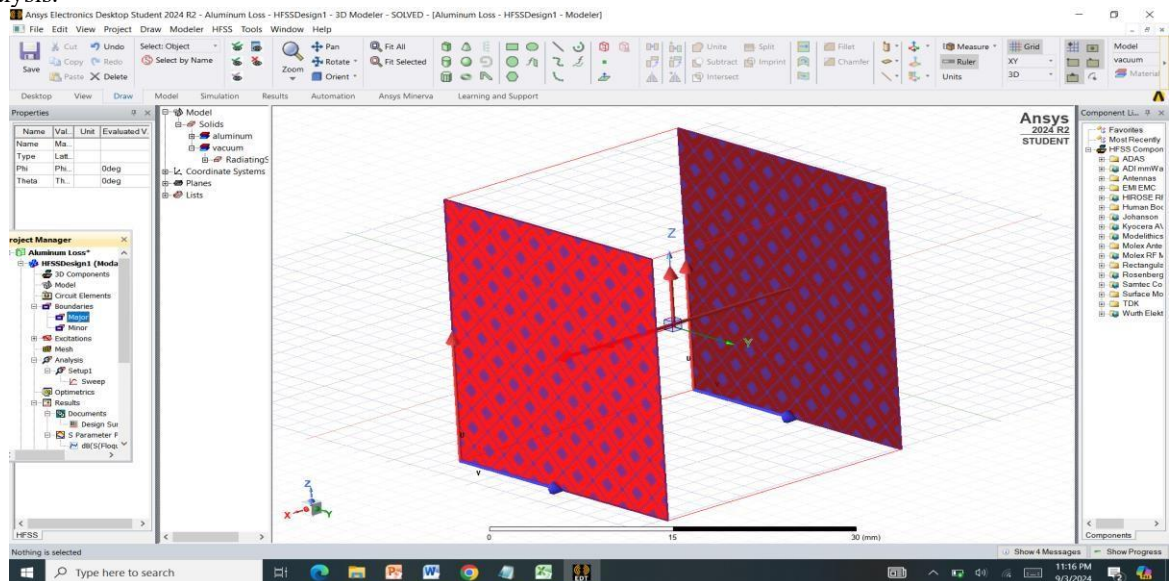


Figure 1: Basic Sample Design

## Boundary Conditions

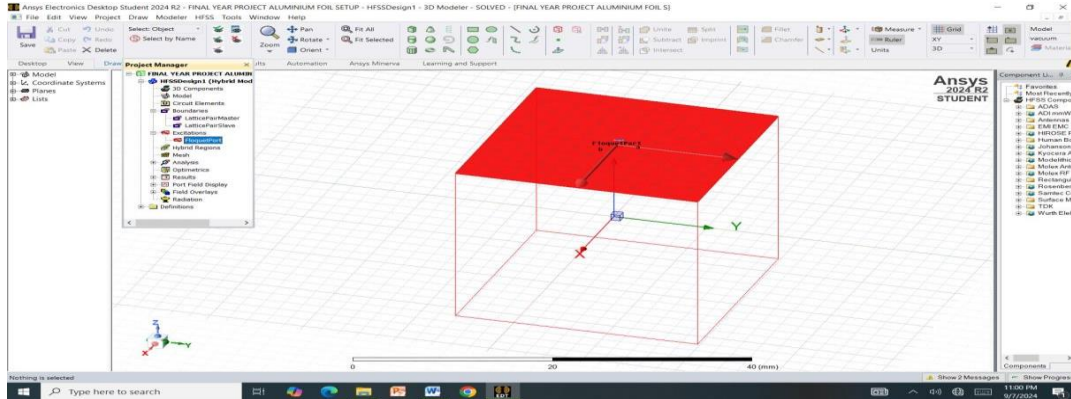
An open radiation region was created at 12 GHz within the target's surroundings, where a lattice pair boundary condition was assigned to the major and minor diagonal surfaces to simulate a periodic, infinite-sheet approximation, which suits thin-foil analysis.



- 507 *Cite this paper as:*  
Joseph, J.I., Ahmed, R.B., Omiogbemi, I. M-B., Omidiji, I.I., & Abdullahi, A.N. (2026). Electromagnetic shielding performance of aluminium foil for stealth applications. In Proceedings of the 1<sup>st</sup> International Conference and Exhibition on Research, Innovation and Development (ICERID), Ignatius Ajuru University of Education, Port Harcourt, Nigeria (Vol. 1, pp. 505-514).

**Figure 2: Major Lattice pair****Excitations**

For the excitation condition, the Floquet Port was assigned to the top surface as shown in [Figure 3](#).

**Figure 3: Floquet Port****Solution Setup**

Electric and magnetic field distributions were used to constitute aluminium's field response.

This was achieved by the analysis setup option, with an assigned frequency of 10GHz. The number of passes was set to 12, and a sweep ratio ranged from 4- 18 GHz (this frequency sweep was used because the operating frequency of a military airdrome for surveillance can be categorised under the X-band radar, which is within 8-12 GHz (Peng et al., 2022). The result was plotted in the S-parameter Floquet and at sweep frequencies.

**Equations**

The simulation solves for  $|S_{11}|$ , which is the reflection loss of a model.

$$|S_{11}| = \frac{V_r(\text{reflected voltage})}{V_i(\text{input signal voltage})} \quad (1)$$

For the ideal case when  $|S_{11}| = -\infty$  (which means no signal is reflected)

Reflection coefficient,  $\Gamma$

$$\Gamma = \frac{S_{11} - S_{21}}{S_{11} + S_{21}} \approx 1 - 10^{\frac{RL}{20}} \quad (2)$$

$$\text{Where Return loss } RL = -20 \log_{10} |S_{11}| \quad (3)$$

**Experimental Setup (Faraday's Cage)**

A physical experimental procedure was carried out to test the attenuation property of aluminium foil. A radar system is very expensive and hard to come by. To improvise for that, a homemade GPS RADAR setup procedure was carried out to simulate the radar system and display the effectiveness of Aluminium foil in reducing EM waves. This procedure is known as Faraday's cage. Faraday's cage is an EMI shielding effect that harnesses Faraday's principles to block or shield electromagnetic radiation (RF for this case study) (Chapman et al., 2015; <https://www.wikihow.com/Make-a-Faraday-Cage>).

**Equipment and Materials**

- Two mobile phones {Phone A and Phone B} Mobile phones: MTN and GLO SIM-enabled phones
- Aluminium foil: Standard household grade
- Notebook and pen for recording observations.

## Preparation

**Phone Preparation:** Ensure both mobile phones are fully charged and in working condition. Insert an MTN SIM card into one phone and a GLO SIM card into the other.

**Aluminium Foil Preparation:** Cut Aluminium foil into sheets large enough to wrap the phones completely, ensuring that the foil covers all sides of the phones without gaps.

Procedure

### Baseline Measurement:

- Step 1: Place the MTN phone on a flat surface.
- Step 2: Call the MTN number from phone B. Record whether the phone rings.
- Step 3: Repeat the above step for the GLO phone.
- Step 4: Record the results in a table.

### Testing with Aluminium Foil:

- Step 1: Wrap the MTN phone completely with aluminium foil.
- Step 2: Call the MTN number from another phone. Record whether the phone rings.
- Step 3: Repeat the above step for the GLO phone.
- Step 4: Record the results in a table.



Figure 4: Phone B wrapped in Aluminium foil

## Results

This study compares the electromagnetic attenuation of aluminium derived from ANSYS HFSS simulations with the physical shielding effectiveness measured in a Faraday Cage experiment.

### Simulation Results

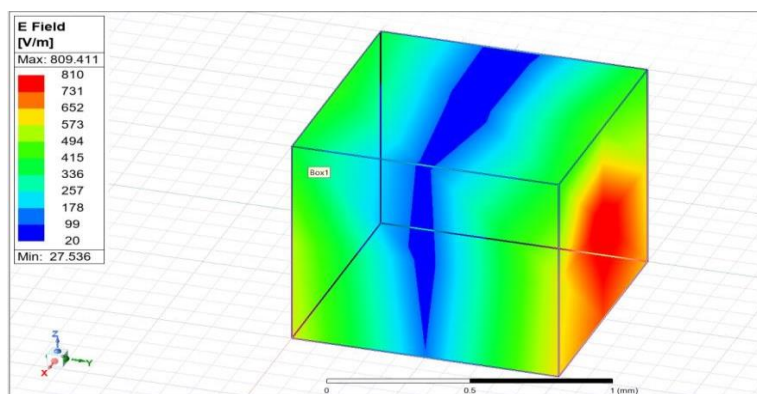


Figure 5: Electric Field Plot of Aluminium

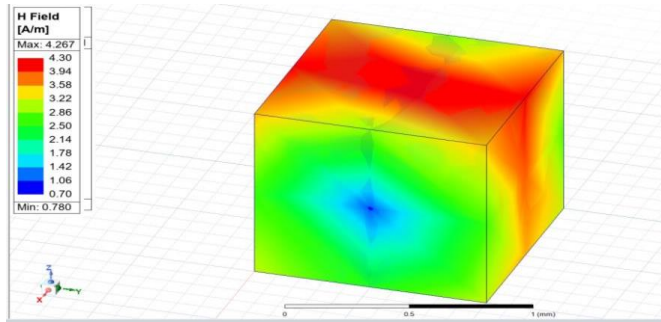


Figure 6: Magnetic Field Plot of Aluminium

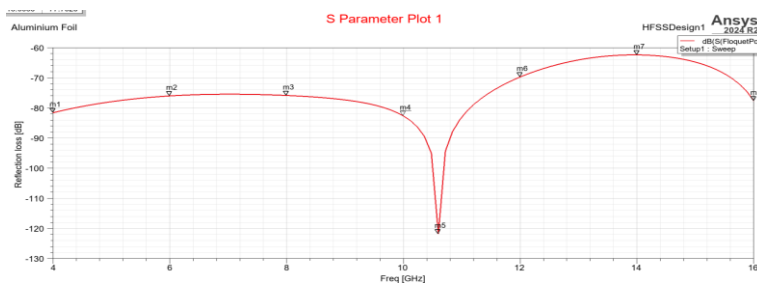


Figure 7: Simulated result of reflected loss to Frequency

**Table 1: Data Recording of Simulation Set- Up**

| S/N | Reflected loss [dB] | Frequency [GHz] |
|-----|---------------------|-----------------|
| 1   | -81.6553            | 4               |
| 2   | -76.0410            | 6               |
| 3   | -75.8841            | 8               |
| 4   | -82.6670            | 10              |
| 5   | -69.7650            | 12              |
| 6   | -62.4455            | 14              |

**Experimental Set-Up Results**

The physical experiment produced the results in the table below:

**Table 2: Data Recording of Experimental Set- Up**

| Number of Trials | Conditions                | Phone Network | Result (Rings/Number of Rings) |
|------------------|---------------------------|---------------|--------------------------------|
| 1                | No Foil                   | MTN           | Rings                          |
| 2                | No Foil                   | GLO           | Rings                          |
| 3                | Wrapped in aluminium Foil | MTN           | No Ring                        |
| 4                | Wrapped in aluminium Foil | GLO           | No Ring                        |

**Simulation Discussion**

The electric field plot distribution shown in Figure 5, also known as the E-field plot, has a concentrated intensity at both faces of the X-Z planes and fades across the other faces. The target box thickness of 1 mm shows a maximum electric field value of 809.411v/m and a minimum field intensity of 27.536v/m at a setup frequency of 10 GHz; these values validate the good electrical conductivity of aluminium foil. On the other hand, the magnetic field plot (H field plot) shown in Figure 6 shows a weak magnetic field concentration at both faces of the Y-Z plane, and it is intensified around the other faces towards the centre of the plane, generating a maximum value of 4.267A/m and minimum at 0.780A/m. The low values of the magnetic field explain its magnetic characteristics and show how weak it is at a high frequency of 10GHz frequency, validating the weak magnetic property of aluminium foil. With these deductions, aluminium foil stands as a good candidate for the reduction of EM waves on a target (Geetha *et al.*, 2009; Zhang *et al.*, 2014).

The S-parameter Floquet port is also known as |S11|, which is the reflection loss, as plotted by the analysis simulator to give the loss at different sweep frequencies. At (4, 6, 8, 10, 12 and 14) GHz frequencies, the respective reflection loss was given to be approximately (-81.6553, -76.0410, -75.884, -82.6670, -69.7650 and -62.4455) dB. The graduation in variation shows that the S-parameter has a significant amount of loss, showing less reflection back to the original transmission, indicating its potential as a Radar Absorbing Material for stealth applications. Additionally, S11 reflection loss constitutes the proportion of incident energy not returned at the simulated port boundary. This can be referred to as evidence of strong field interaction and energy redistribution consistent with shielding behaviour, instead of being a direct, calibrated measurement of radar cross-section reduction, which would require a full bistatic or monostatic RCS measurement setup (Roy & Wu, 2024).

**Experimental Discussion (Faraday's Cage)**

Cell phone emissions fall in the radio wave frequency portion of the electromagnetic spectrum, between 0.7 and 2.7 GHz. (*Cell Phones and Cancer Risk Fact Sheet - NCI*, n.d.) Aluminium foil, with its outstanding electrical conductivity and weak magnetic properties, emerges as an Electromagnetic shield when wrapped around a cell phone; it works basically by Faraday's Principles. According to Faraday's Law, a conductive material surrounding an object can block external electromagnetic fields by redistributing charges on its surface, thereby neutralising incoming signals (Szczerbiński, 2000). The fact that the phone cannot accept calls while covered in aluminium foil suggests that the foil hinders both outgoing and incoming signals. Theoretical results on signal attenuation in shielding materials are in line with this (Furulevi, n.d.). It can be confirmed from this that aluminium foil, with its attenuation qualities, makes a suitable choice for a radar absorption material for stealth applications.

## Practical Implication

Both the simulation and experimental results validate the cost-effectiveness of aluminium foil, its availability for EM-shielding applications coupled with its stealth performance. Aluminium foil, which is lightweight, mechanically durable and easily fabricated, gives practical advantages when compared with complex RAMs (García-Martínez *et al.*, 2023), irrespective of the absorption efficiency under RAM, which tends to be comparatively moderate and would greatly benefit from further improvement through surface treatment, layering or integration of composites in future projects.

## Conclusion

This study effectively demonstrates the dual approach of utilizing computerized simulation analysis through ANSYS HFSS and physical experimentation based on the principles of Faraday's cage. This is to evaluate aluminium foil's electromagnetic shielding performance for stealth-related applications. The simulation results reveal that aluminium exhibits exceptional electrical conductivity, which significantly enhances its radar-absorbing capabilities. The S-parameter measurements ranged from -81.6553 dB to -62.4455 dB, indicating substantial reflection loss across various frequencies. Additionally, the electromagnetic and reflective properties highlighted insights into energy storage in both magnetic and electric fields. These results were further supported by a complementary Faraday cage experiment that effectively blocked cellphone radio frequencies between 0.7 and 2.5 GHz, proving aluminium's ability to hinder electromagnetic waves. The theoretical understanding obtained from the simulations is strengthened by this real-world application. The dual findings confirm aluminium foil as a viable, cost-effective material for electromagnetic shielding applications related to stealth design, which is very useful where advanced composite RAMs are limited. The result gotten is proof of shielding and attenuation performance. Future research on calibrated RCS measurement would be required to improve aluminium foil's performance while considering strict radar absorption.

## Recommendations

From the results of the utilisation of aluminium foil as a RAM for stealth applications, the following are some of the recommendations;

1. Further research should focus on enhancing the properties of aluminium to boost its radar absorption capabilities (Shao *et al.*, 2020; Ruiz-Perez *et al.*, 2022).
2. Investigate aluminium's behaviour across a broader frequency spectrum to identify any potential limitations (Ka & Hasan, 2024). A very high Frequency can effectively penetrate the foil (Chevalier *et al.*, 1972).
3. Explore how aluminium's attenuation properties can be utilised in practical scenarios for shielding against electromagnetic interference or reducing radiofrequency interference.
4. The Nigerian military heavily depends on foreign technology with little or no reinforcement in stealth technology; this study could be a stepping stone in innovating our stealth technology in Nigeria

## References

- Atay, H. Y. (2016). Multi-functional materials for military aircraft: radar-absorbing and flame retardant composites. *Research on Engineering Structures and Materials*.  
<https://doi.org/10.17515/resm2016.38ma0204>
- Aynalem, G. F. (2020). Processing Methods and Mechanical Properties of Aluminium Matrix Composites. *Advances in Materials Science and Engineering*, 2020(1). <https://doi.org/10.1155/2020/3765791>
- Aytaç, A., İpek, H., Aztekin, K., & Çanakçı, B. (2020). A review of radar absorber materials and structures. *Scientific Journal of the Military University of Land Forces*, 198(4), 931–946.  
<https://doi.org/10.5604/01.3001.014.6064>
- Bae, G., & Kim, C. (2015). Design of Multi-Layer Radar Absorbing Coating and Transparent Shielding Film for RCS Reduction of Complex Targets. *Applied Mechanics and Materials*, 799–800  
<https://doi.org/10.4028/www.scientific.net/AMM.799-800.1370>
- Balaji Ananth, P., Abhiram, N., Hari Krishna, K., & Nisha, M. S. (2021). Synthesis of radar absorption material for stealth applications. *Materials Today: Proceedings*, 47(June), 4872–4878.  
<https://doi.org/10.1016/j.matpr.2021.06.196>
- Ball, J., & Younan, N. (2017). Radar and Radio Signal Processing. *Electronics*, 6(3), 64.  
<https://doi.org/10.3390/electronics6030064>
- Cell Phones and Cancer Risk Fact Sheet - NCI*. (n.d.). Retrieved September 7, 2024, from

- <https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/cell-phones-fact-sheet>
- Chakrapani, P., & Suryakumari, T. S. A. (2021). Mechanical properties of aluminium metal matrix composites-A review. *Materials Today: Proceedings*, 45, 5960–5964. <https://doi.org/10.1016/j.matpr.2020.09.247>.
- Chapman, S. J., Hewett, D. P., & Trefethen, L. N. (2015). Mathematics of the Faraday cage. *SIAM Review*, 57(3), 398–417. <https://doi.org/10.1137/140984452>.
- Chen, K., Wang, P., Li, H., Cao, W., & Zheng, H. (2024). Enhanced microwave absorption in graphene-based composites: A study on the synergistic effect of ferrite integration and electromagnetic coupling. *Applied Surface Science*, 669, 160531. <https://doi.org/10.1016/j.apsusc.2024.160531>
- Divya, Srivastava, K., & Mishra, S. (2022). A Review on Composition & Mechanical Strength of Wrought Aluminium Alloy Series. *International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)*, 9(8), 12–14. <https://doi.org/10.36647/IJERMCE/09.08.A003>
- Furulevi. (n.d.). *Smartphone signal blocking (Aluminium foil, Samsung Galaxy J5, and Samsung S20+ 5G* [Video recording].
- García-Martínez, E., Miguel, V., Mancebo, Á., & Martínez-Martínez, A. (2023). *Determination of Cost-Effective Machining Strategies for Rough Pocket Milling of Aluminium by Computer-Aided Manufacturing*. 176–183.
- Geetha, S., Satheesh Kumar, K. K., Chepuri, R. K., & Vijayan, M. (2009). Electromagnetic shielding: Methods and materials—A review. *Journal of Applied Polymer Science*, 112(4), 2073–2086. <https://doi.org/10.1002/app.29812>
- Gurbuz, S. (2020). Radar systems, signals, and phenomenology. In *Deep Neural Network Design for Radar Applications* (pp. 11–42). Institution of Engineering and Technology. [https://doi.org/10.1049/SBRA529E\\_ch1](https://doi.org/10.1049/SBRA529E_ch1)
- How to Make a Faraday Cage: 6 Steps (with Pictures)* - wikiHow. (n.d.). Retrieved September 7, 2024, from <https://www.wikihow.com/Make-a-Faraday-Cage>
- Hwang, U., & Nam, J.-D. (2024). Frequency-Selective Radar-Absorbing Composites Using Hybrid Core–Shell Spheres. *ACS Nano*, 18(19), 12225–12234. <https://doi.org/10.1021/acsnano.4c00624>
- Ka, H., & Hasan, M. (2024). Study on Development of Radar Technology and its Future. *Scientific Research Journal (SCIRJ)*, XII, 37. <https://doi.org/10.31364/SCIRJ/v12.i05.2024.P0524XX>
- Kim, S., Lee, S., Zhang, Y., Park, S., & Gu, J. (2023). Carbon-Based Radar Absorbing Materials toward Stealth Technologies. *Advanced Science*, 10(32), 1–22. <https://doi.org/10.1002/advs.202303104>
- Liu, K., Li, J., Yuan, Z., Xu, G., & Wang, P. (2023). Performance analysis of wedge-shaped absorber for aircraft stealth. In X. Chen & H. M. Srivastava (Eds.), *3rd International Conference on Applied Mathematics, Modelling, and Intelligent Computing (CAMMIC 2023)* (p. 124). SPIE. <https://doi.org/10.1117/12.2686047>
- Memorandum, T. (2005). *Review of Radar Absorbing Materials Defence R & D Canada – Atlantic*. January.
- Micheli, D., Vricella, A., Pastore, R., & Marchetti, M. (2014). Synthesis and electromagnetic characterisation of frequency selective radar absorbing materials using carbon nanopowders. *Carbon*, 77, 756–774. <https://doi.org/10.1016/j.carbon.2014.05.080>
- Padhy, S., Sanyal, S., Meena, R. S., Chatterjee, R., & Bose, A. (2013). Characterisation and performance evaluation of radar absorbing materials. *Journal of Electromagnetic Waves and Applications*, 27(2), 191–204. <https://doi.org/10.1080/09205071.2013.743447>
- Peev, D., Kolev, N., & Sivkov, Y. (2022). Stratified Layer Composite Material for Radar Anti-reflective Coating. *2022 22nd International Symposium on Electrical Apparatus and Technologies (SIELA)*, 1–6. <https://doi.org/10.1109/SIELA54794.2022.9845738>
- Peixoto, G. G., Paula, A. L., Andrade, L. A., Lopes, C. M. A., & Rezende, M. C. (2005). *Radar-absorbing material (RAM) and shaping on radar cross section reduction of dihedral corners*. <https://doi.org/10.1109/IMOC.2005.1580044>
- Peng, Z., Li, C., & Ran, L. (2022). Modern Radar for Automotive Applications. In *Modern Radar for Automotive Applications* (pp. 1–5). Institution of Engineering and Technology. [https://doi.org/10.1049/SBRA553E\\_ch1](https://doi.org/10.1049/SBRA553E_ch1)
- Roy, C., & Wu, K. (2024). A Review of Electromagnetics-Based Microwave Circuit Design Optimisation. *IEEE Microwave Magazine*, 25(7), 16–40. <https://doi.org/10.1109/MMM.2024.3387036>
- Ruiz-Pérez, F., López-Estrada, S. M., Tolentino-Hernández, R. V., & Caballero-Briones, F. (2022). Carbon-based radar-absorbing materials: A critical review. In *Journal of Science: Advanced Materials and Devices* (Vol. 7, Issue 3). Elsevier B.V. <https://doi.org/10.1016/j.jsamd.2022.100454>
- Shao, T., Ma, H., Feng, M., Wang, J., Yan, M., Wang, J., Zhao, S., & Qu, S. (2020). A thin dielectric ceramic

- coating with good absorbing properties composed of tungsten carbide and alumina. *Journal of Alloys and Compounds*, 818, 152851. <https://doi.org/10.1016/j.jallcom.2019.152851>
- Smitha, P., Singh, I., Najim, M., Panwar, R., Singh, D., Agarwala, V., & Das Varma, G. (2016). Development of thin broadband radar absorbing materials using nanostructured spinel ferrites. *Journal of Materials Science: Materials in Electronics*, 27(8), 7731–7737. <https://doi.org/10.1007/s10854-016-4760-6>
- Stealth technology* - Wikipedia. (n.d.). Retrieved September 1, 2024, from [https://en.wikipedia.org/wiki/Stealth\\_technology#History](https://en.wikipedia.org/wiki/Stealth_technology#History)
- Szczerbiński, M. (2000). A discussion of 'Faraday cage' lightning protection and application to real building structures. *Journal of Electrostatics*, 48(2), 145–154. [https://doi.org/10.1016/S0304-3886\(99\)00062-5](https://doi.org/10.1016/S0304-3886(99)00062-5)
- Wang, Y., Li, T., Zhao, L., Hu, Z., & Gu, Y. (2011). Research Progress on Nanostructured Radar-Absorbing Materials. *Energy and Power Engineering*, 03(04), 580–584. <https://doi.org/10.4236/epe.2011.34072>
- Yang, Z., Gao, L., Ren, W., Zhang, R., Chen, Y., Zhou, Q., Sun, K., Jie, Z., & Jia, Y. (2022). Study on Electromagnetic Performance of La<sub>0.5</sub>Sr<sub>0.5</sub>CoO<sub>3</sub>/Al<sub>2</sub>O<sub>3</sub> Ceramic with Metal Periodic Structure at X-Band. *Materials*, 15(22), 8147. <https://doi.org/10.3390/ma15228147>
- Yu, Z. (2019). Research on absorbing properties of new porous metal materials with light weight. *Key Engineering Materials*, 815, KEM, 42–47. <https://doi.org/10.4028/www.scientific.net/KEM.815.42>
- Zhang, X., Jiang, D., Chen, Y., Huang, Y., & Gong, X. (2014). Electromagnetic interference shielding Effectiveness of aluminium foams with different porosity. *Journal of Alloys and Compounds*, 617, 207–213. <https://doi.org/10.1016/j.jallcom.2014.07.188>