NON- CONVENTIONAL MATERIALS FOR ELECTROMAGNETIC NOISE SUPPRESSION

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Keywords:

Electromagnetic Interference (EMI), Noise, Shielding Effectiveness and EMF paints.

Introduction:

Electromagnetic Interference or EMI refers to the unwanted noise caused by electrical paths or electronic circuits which create a disruption in the functioning of other electronic systems. Therefore, it is necessary to block these signals. The phenomenon of blocking the EMI noise from entering one medium to another is called EMI Shielding. There are materials which can be used for this purpose. One of such applications is in shielding paints. Shielding paints can be used for protection against high-frequency electromagnetic fields, low frequency electric fields and RF/Microwave radiation. Interior application on walls, ceiling and floors.

[2] In one of the studies, it was mentioned that the chances of getting incurable respiratory diseases and diabetes increases.[3] In another research article it is also been found that prolonged exposure even at low intensities may lead to the production of stress hormones, which may lead to increases to sudden increase in heart rate, high blood pressures, etc. Therefore, the urgent need of the hour is to reduce the exposure to these signals. This can be done by using shielding materials which can reduce the exposure to radiation drastically.

Presently the materials used for EMI shielding paints are Nickel filled acrylic coatings, carbon conducting coating, etc. The conventional materials used for shielding are metals like silver, aluminium, copper, nickel, etc which are prone to oxidation and even carbon-based conductive paints are used. But the material which we are trying to design will use a different magnetic filler which is electroless plated iron on graphite which can be prepared commercially at low cost and not prone to oxidation.

Objectives:

The objectives of our project are to prepare the nanomaterial Fe@Graphite and to carry out the characterization of the material prepared which will be used as a magnetic filler. The characterization tests that are performed are SEM, XRD, FTIR and VSM. Then to prepare samples with varying concentrations of MWCNT, graphene, Fe@Graphite with Low Density Polyethylene (LDPE) as a matrix into testable form. MWCNT and graphene are known for their highly conductive nature and are used as conductive filler. Then we find the shielding effectiveness of the material for varying concentration of the filler and determine the critical concentration at which better shielding occurs.

Methodology:

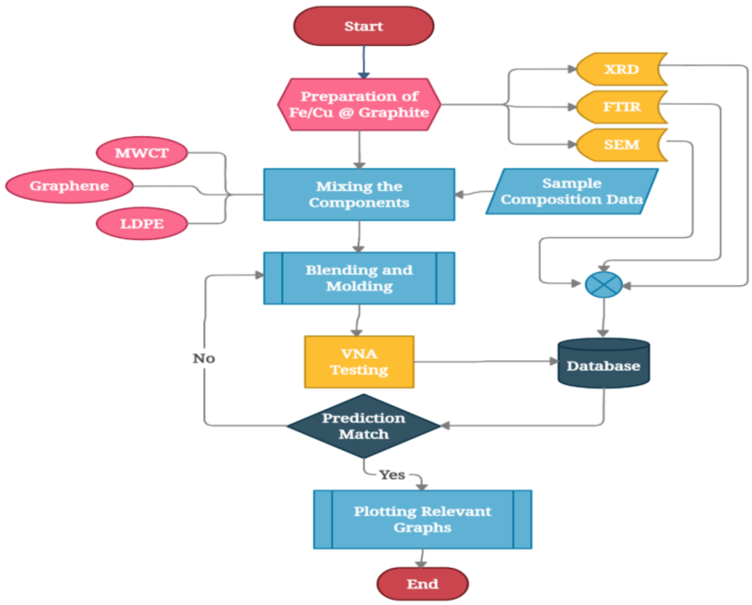
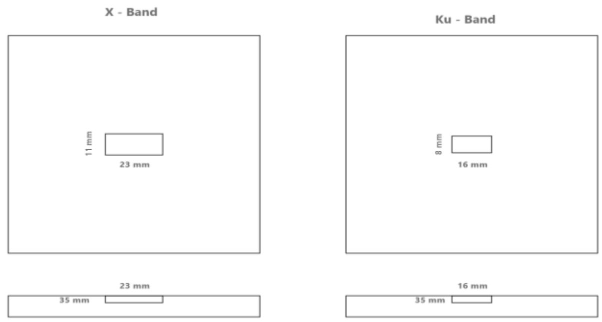


Figure: Flow Diagram explaining the Methodology

Achieve EMI Shielding in X band and Ku Band. Samples of Nanomaterials prepared to replace conventional Metals. In this proposed work the electromagnetic shielding of the noise generated by using nano material with composition of Fe on Graphite, Graphene and Low Density Poly-Ethylene (LDPE). The Nanomaterials are mixed with LDPE polymer by stirring and its effect on the EMI (Electromagnetic Interference) shielding results to be reported in X-band and Ku-band. XRD (X-ray powder Diffraction) and SEM (Scanning Electron Microscope) images will be recorded for all the investigated samples. XRD analysis to calculate the average particle size and morphological analysis of samples carried out by using SEM. Prepare Samples of different weight % of Nanomaterials for comparison. Testing the samples for Conductivity, Magnetic Property. The SE (Shielding Effectiveness) measurements will be carried out using a rectangular waveguide connected to a network analyser. The Shielding effectiveness will be calculated. Create a Comparative Account of Samples and Shielding Efficiency and determine the best composition.

Molding the Samples:



LDPE along with MWCNT and Graphene were added in the Brabender machine (Plant-holder-Kelton, - 16CME SPL SPL Germany) followed by the melting of the mixture at 160°C. Fe@Graphite was then introduced and dispersed at 10 rpm. The various compositions prepared are given in Table.

Composition Table:

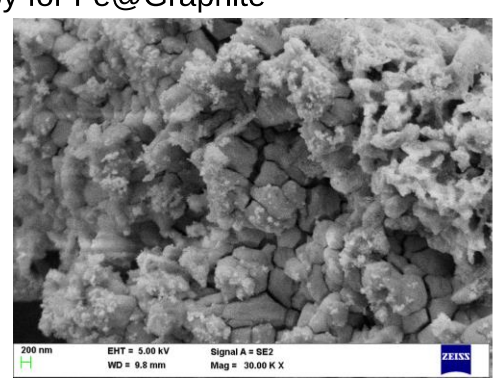
Composition Table in Weight percentage				
sl.no	Polymer	Conducting Filler		Magnetic Filler
	LDPE	MWCNT	Graphene	Fe @Graphite
1	50	5	45	0
2	50	5	35	10
3	50	5	25	20
4	50	0	0	50
5	50	0	50	0
6	100	0	0	0
7	50	5	40	5

Results and Discussion:

The following characterization were conducted for the Fe@Graphite, which are:

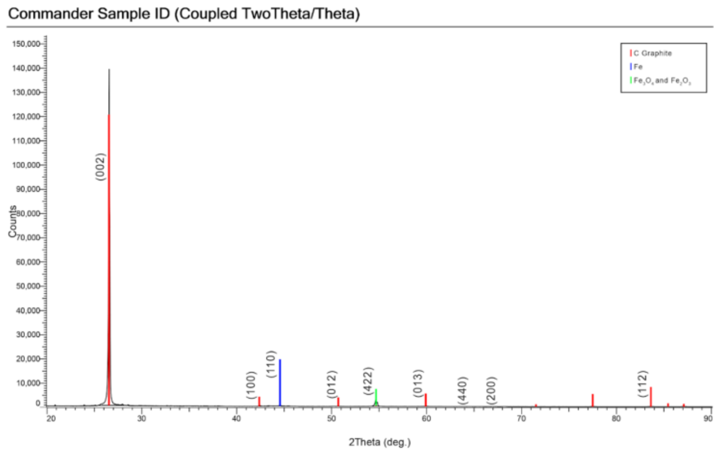
SEM

Scanning Electron Microscopy for Fe@Graphite



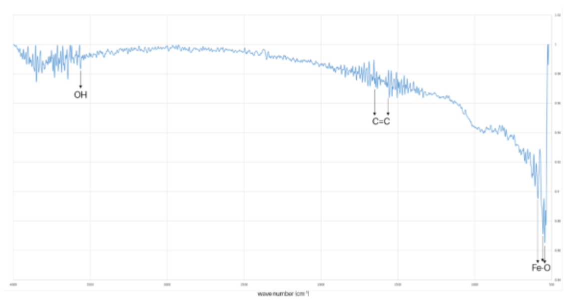
In the SEM results we can clearly see that the graphite flakes are covered with iron nanoparticles which were prepared by electroless plating.

XRD



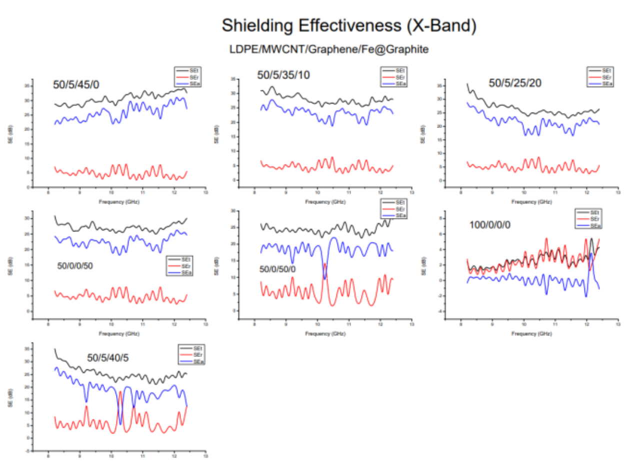
In the results above we observe sharp spikes in the nanomaterial prepared which indicates that the given sample is crystalline; it also indicates the presence of Graphite iron and iron oxide spikes at 26.555°,44.572°and 54.7°.

FTIR



Characterization of vibration done using FTIR to determine the functional groups in the Fe-Graphite nanoparticle sample. The spectrum gave us peaks at 1550 cm^{-1} and 1700 cm^{-1} C–C and C=C. The peaks at 545 cm^{-1} and 589 cm^{-1} indicate the presence of Fe–O.

Shielding Effectiveness



Shielding Effectiveness is a critical index to evaluate the Shielding Performance and is defined as the sum of three terms which include Reflection Loss, Absorption Loss and Multiple Reflection Loss.

Were,

Reflection Loss - $SE_R = 10\log_{10}(1/(1-|S_{11}|^2))$

Absorption Loss - $SE_A = 10\ log \frac{(1-s_{11}{}^2)}{s_{12}{}^2}$

Multiple Reflection Loss - Negligible

The Shielding Effectiveness of the samples were obtained using VNA via S-Parameters. From the above diagram we can conclude that the highest shielding effectiveness was obtained at the critical concentration of 50/5/35/10 which was 33dB.

Scope for Future work:

1. To try and use a different matrix and test its shielding ability: This is because a different matrix may give different mechanical and material properties.
2. To use different conductive fillers other than graphene and MWCNT: The reason is because the synergistic effect obtained will be different for different conductive fillers which may lead to pronounced shielding effectiveness.
3. To use varied thickness of samples and obtain shielding effectiveness: It is well established fact that the shielding effectiveness decreases with decreasing thickness. Therefore, it would be better to understand by what value the shielding effectiveness has gone down.
4. Shielding effectiveness tested for different frequency bands: For the sake of simplicity shielding effectiveness was tested for X-Band. But the same material can be tested for shielding effectiveness in other frequency ranges. This will help in determining how good of a shielding material is for wide frequency ranges.

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