LA-SiGMA
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Microwave Absorption Properties of Surfactant Treated Carbon Nanotubes in Epoxy Composites in 1 - 40 GHz

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Abstract

In this work, multiwall carbon nanotubes (MWCNTs) treated with surfactant sodium dodecylbenzenesulfonate (SDBS) were used in epoxy composites. MWCNTs outer diameter (OD) were 8- 15 nm. The reflection loss, transmission, and absorption ratio of the MWCNTs-epoxy composite samples were investigated. The MWCNT loading was controlled at 3wt% with different SDBS ratios. An Agilent PNA network analyzer was utilized in the measurements of microwave absorption (MA) properties by using coaxial and waveguide methods for frequency ranges 1 to 26.5 GHz and 26.5 to 40 GHz. The measurement results showed that the microwave absorption properties of the MWCNTs-epoxy composites strongly depend on the ratios between the surfactant and MWCNTs.

Motivation

The aim is to investigate a fix 3wt% MWCNT loading with different ratios of MWCNTs/SDBS.

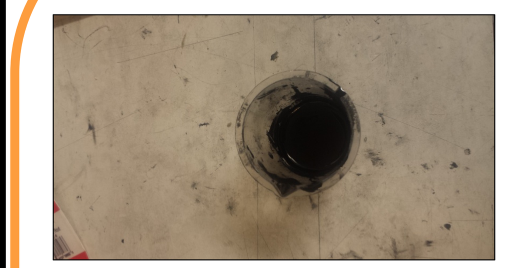
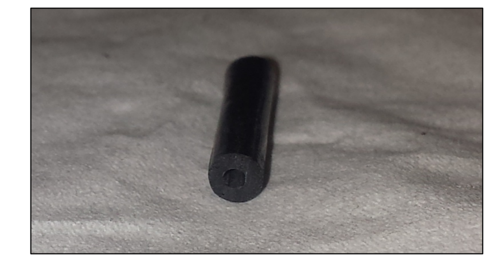
Surfactant (SDBS) can change the distribution of CNTs in polymer such as epoxy. Epoxy is an attractive polymer because of its mechanical properties and easy processing.

Microwave absorption (MA) materials are designed to provide electromagnetic wave (EMW). Carbon nanotubes (CNTs) are good EMW absorption material.

Method

- MWCNTs-epoxy composites were fabricated via mechanical mixture methods. The goal is to make the MWCNTs/SDBS well distributed in the epoxy solvent.
- The MWCNTs and surfactant ratios were controlled from 1:0, 1:0.5, 1:1, 1:2, 1:3, and 1:4, respectively.
- For coaxial method, samples with inner and outer diameters of 1.5 mm and 3.5 mm were carefully cut to thickness of 3mm. Samples were also made for waveguide measurements (7.0 mm x 3.5 mm x 3.0 mm).
- Agilent Network Analyzer N5230c and Agilent 85071 measurement software were used for the measurements of microwave absorption.

Coaxial

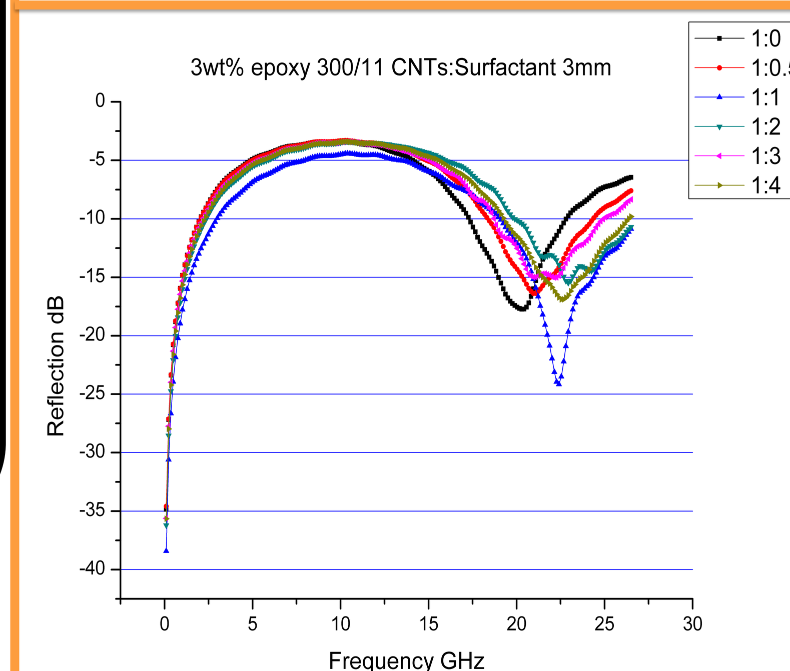


Fig. 1 The reflection losses of different MWCNTs and surfactant composite samples.

Fig 1 shows that the composites with different ratios of MWCNT/ SDBS have different reflection loss properties. The loss peaks shift to higher frequencies by using SDBS.

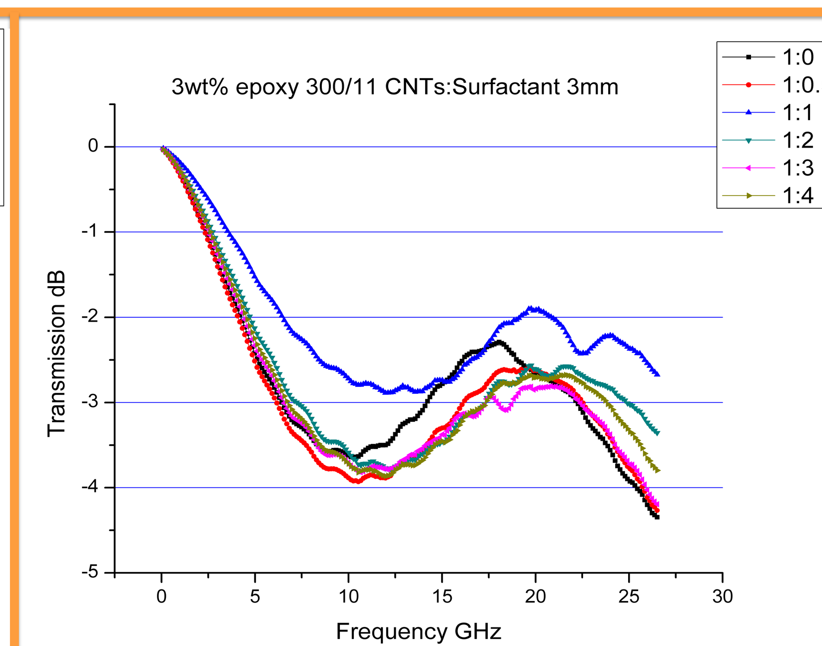


Fig. 2 The transmission losses of different MWCNTs and surfactant composite samples.

Fig 2 shows that composites with different ratios of surfactant have different transmission loss properties. Ratios from 1:0.5- 1:4 is better than 1:0 (no surfactant) except ratio 1:1.

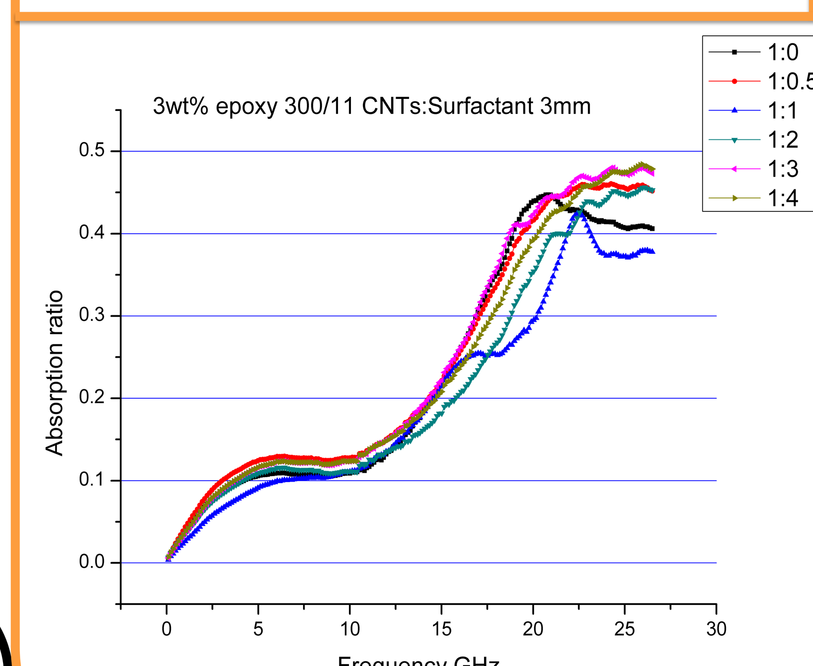
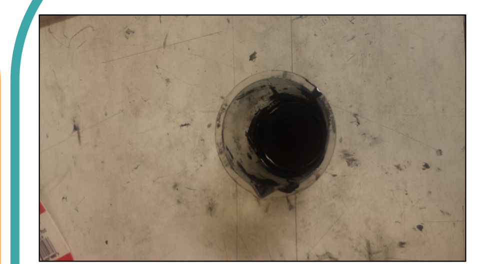
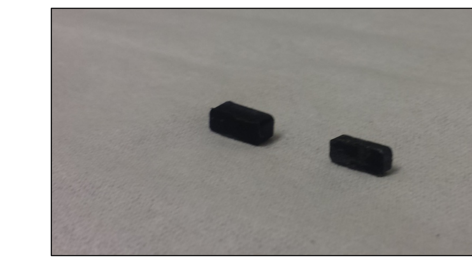


Fig. 3 The absorption ratio of different MWCNTs and surfactant composite samples.

Fig 3 shows that composites with different ratios of surfactant have different microwave absorption properties. The higher ratios of surfactant have better absorption in 24-26 GHz.

Waveguide

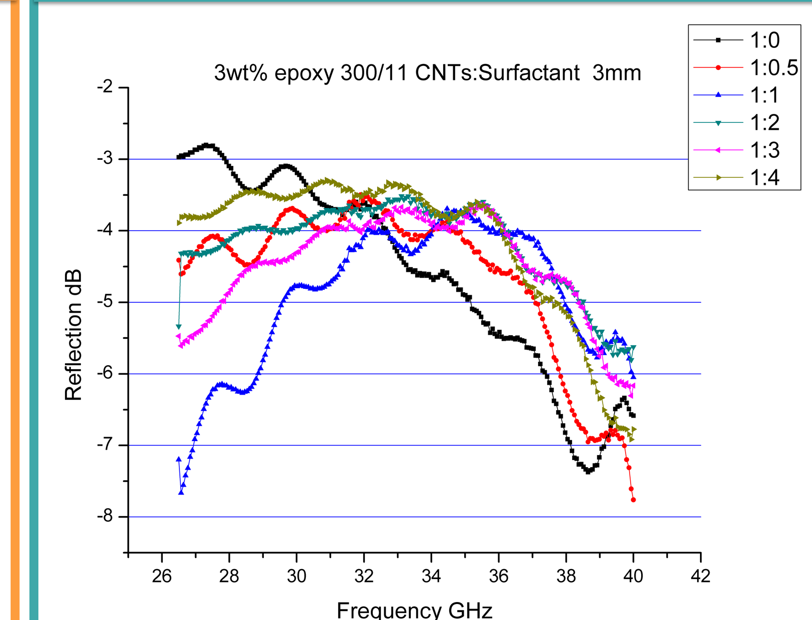


Fig. 4 The reflection losses of different MWCNTs and surfactant composite samples.

Fig 4 shows that the composites with different ratios of surfactant have different reflection losses in 26-40GHz. However, for SDBS ratios 1:0.5-1:4, the loss peak values goes up and down, showing complexity.

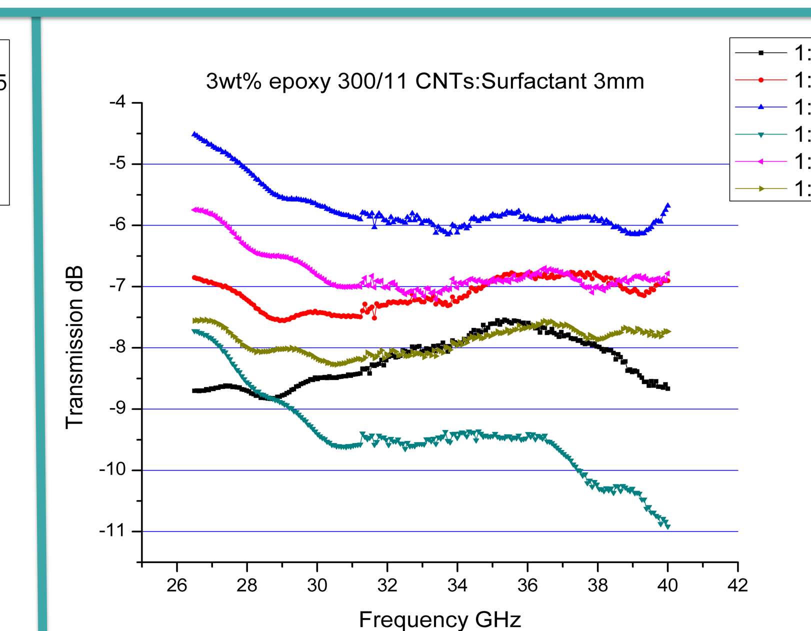


Fig. 5 The transmission losses of different MWCNTs and surfactant composite samples.

Fig 5 shows that composites with different ratios of surfactant have different transmission loss properties. Ratio 1:2 is better from 28-40 GHz.

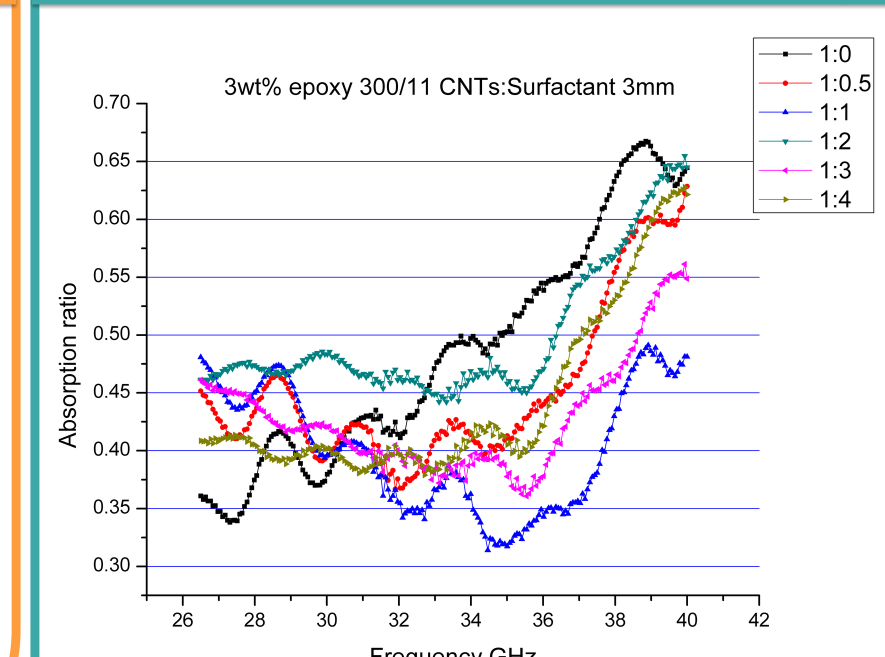


Fig. 6 The absorption ratio of different MWCNTs and surfactant ratio in composites.

Fig 6 shows that composites with different ratios of CNT/ SDBS have different absorption properties in the frequency range from 26- 33 GHz. Moreover, from frequency 35-40GHz, the absorption ratios gradually increase.

Conclusion

In this work, we fabricated MWCNTs-epoxy composites by using surfactant (SDBS). Their electromagnetic wave absorption (EMWA) properties were tested by using coaxial and waveguide methods for frequency range 1 to 40 GHz. We analyzed reflection loss, transmission loss, and absorption ratio of the composite samples. The results showed that the surfactant can enhance the distribution of MWCNTs and the microwave absorption properties of the composites in different frequency ranges.

Questions? Comments? Concerns?

Acknowledgements

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