

Towards Green Conductive Nanocomposites Based on Epoxidized Soybean Oil (ESO) for Electromagnetic Shielding and Antistatic Application: Effect of Hybridization of Carbon Nanotubes and Graphene

Carlos Bruno Barreto Luna¹, Eduardo da Silva Barbosa Ferreira¹, José Vinícius Melo Barreto¹, Ingridy Dayane Silva¹, Debora Pereira Schmitz², Bluma Guenther Soares², Renate Maria Ramos Wellen³, Edcleide Maria Araújo¹

¹Federal University of Campina Grande, Av. Aprígio Veloso, 882 - Bodocongó, 58429-900, Campina Grande - Paraíba, Brazil.

²Department of Metallurgical and Materials Engineering - COPPE, PEMM-COPPE, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.

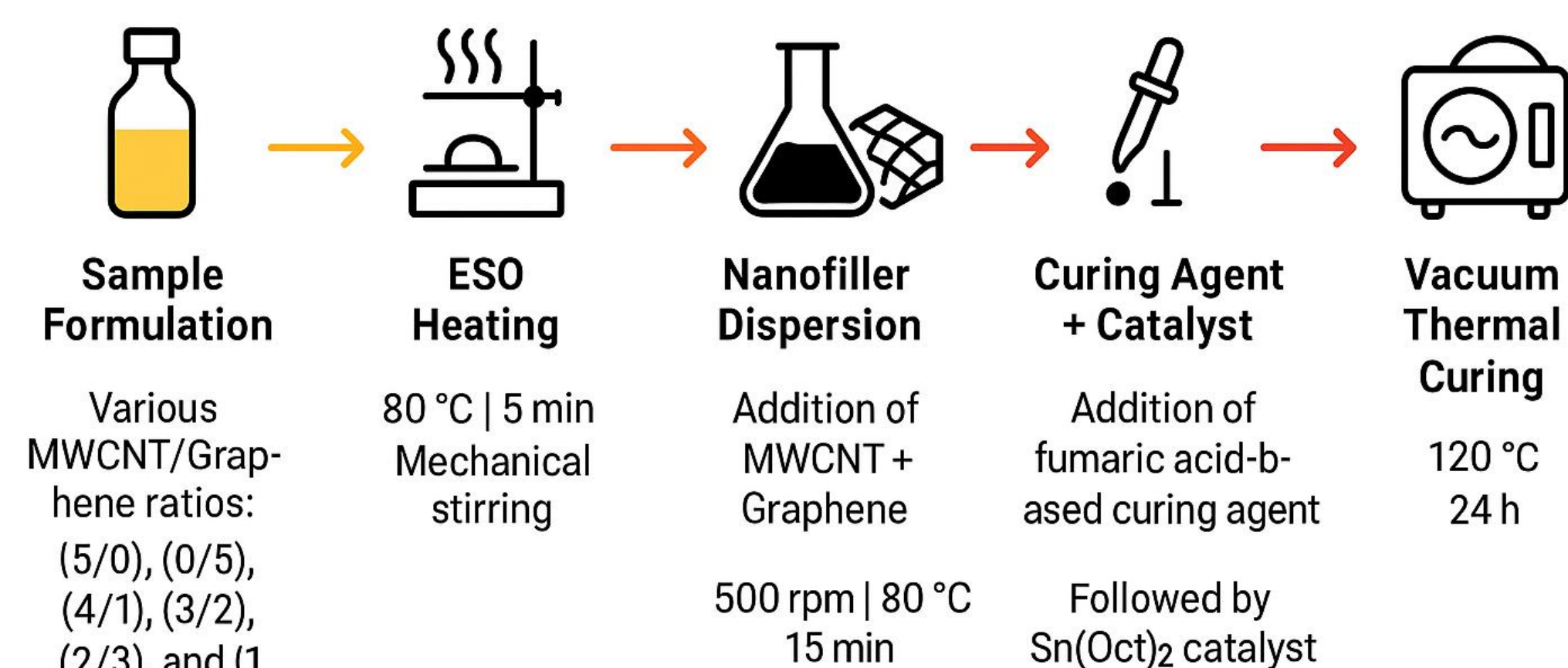
³Department of Materials Engineering, Federal University of Paraíba, Cidade Universitária, 58051-900, João Pessoa-PB, Brazil.

INTRODUCTION & AIM

Eco-friendly materials designed for electromagnetic shielding represent a strategic and sustainable alternative in response to the growing use of electronic devices and the consequent need to mitigate electromagnetic interference (EMI). In this context, the development of bio-based polymer nanocomposites incorporated with conductive fillers such as carbon nanotubes and graphene has emerged as a promising solution. The use of epoxidized soybean oil (ESO) in the production of conductive nanocomposites is highly relevant from both scientific and technological perspectives, especially within the field of sustainable materials engineering. ESO is of renewable origin, derived from abundant and low-cost agricultural resources, making it an environmentally responsible alternative to conventional petrochemical additives, aimed at its use in the production of functional nanocomposites. Therefore, the present work aimed to prepare hybrid nanocomposites based on ESO with carbon nanotubes and graphene, in order to evaluate their electrical conductivity and electromagnetic shielding performance.

METHOD

Experimental Workflow – ESO/MWCNT/G Nanocomposites



FUTURE WORK

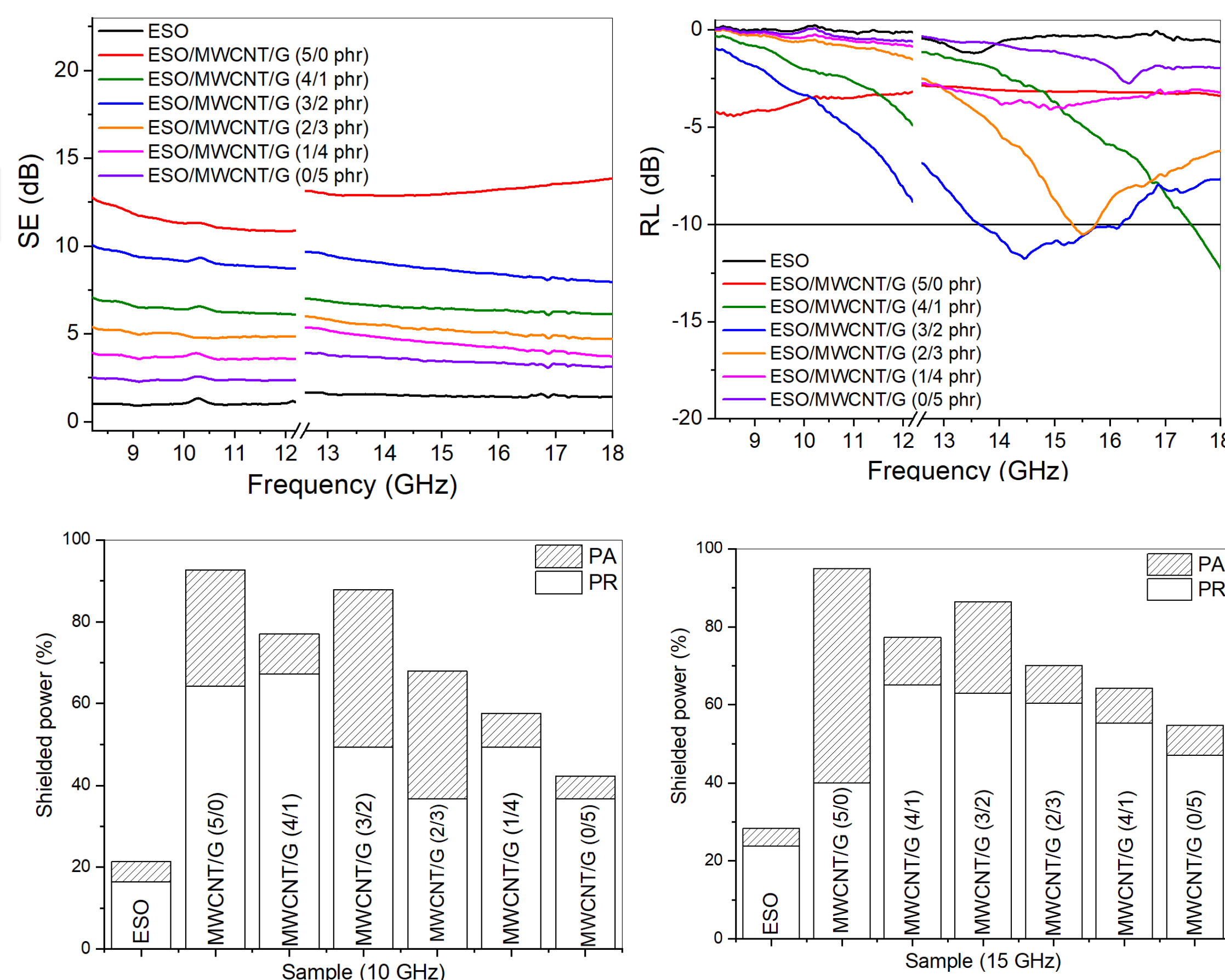
- Evaluate methods to improve dispersion (sonication, combined sonication + mechanical mixing).
- Perform mechanical, thermomechanical, and thermal tests to establish a complete characterization protocol for the nanocomposites.
- Investigate plasma-based physical functionalization of MWCNT and graphene to enhance their interaction with ESO.
- Investigate advanced microscopy techniques to evaluate the distribution and dispersion of the nanofillers in ESO.

RESULTS & DISCUSSION

Electrical Conductivity

Samples	σ (S/cm)
ESO	1.62×10^{-11}
ESO/MWCNT/G (5/0 phr)	5.81×10^{-5}
ESO/MWCNT/G (0/5 phr)	1.89×10^{-9}
ESO/MWCNT/G (4/1 phr)	1.28×10^{-5}
ESO/MWCNT/G (3/2 phr)	5.42×10^{-5}
ESO/MWCNT/G (2/3 phr)	3.89×10^{-6}
ESO/MWCNT/G (1/4 phr)	3.46×10^{-9}

Electromagnetic Shielding (EMI)



CONCLUSION

- The use of resins derived from epoxidized soybean oil (ESO) promotes advances in sustainable materials and reduces carbon footprint.
- ESO/MWCNT/G nanocomposites show technological potential, aligning functional properties with mitigating environmental impact.
- The ESO nanocomposite with MWCNT/G (5/0 phr) showed the highest electrical conductivity value of 5.81×10^{-5} S/cm, leading to the highest magnetic shielding performance between 12–15 dB.
- The results suggest potential for application as a coating for static charge dissipation.