Developing Electromagnetic Shielding Textile for Personal Protection

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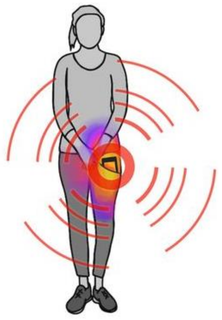
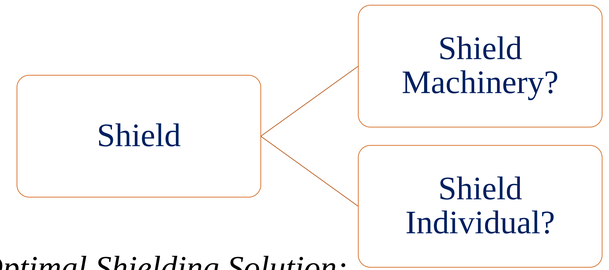
Introduction

- Electromagnetic Fields (EMFs) are classified as possible 2B Group human carcinogens by International Agency for Research on Cancer [1,2].
- Pathological syndrome in humans called electro-hypersensitivity (EHS) or 'microwave syndrome' that causes a headache, anxiety, sleep disorders, fatigue, etc. have increased massively in the last decades which could have been associated with increased EMFs due to the excessive developments in electronic devices [3-5].



Methods



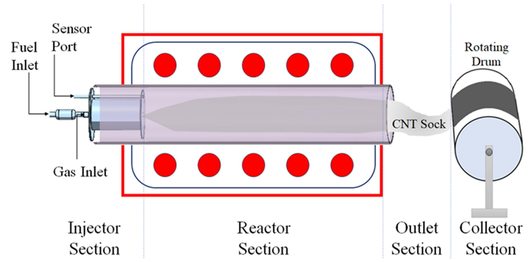
Optimal Shielding Solution:

Manufacture Electronic Devices using Lightweight Shield.

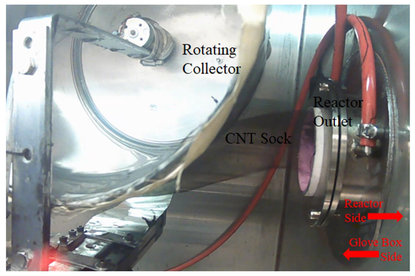
Use flexible shield to prepare PPE for individuals working in radiative environments such as radiology labs and radio towers to ensure occupational safety.

Obtained Results

- FCCVD Reactor system available at Nanoworld Laboratories was used to manufacture thin and lightweight CNT sheet hybrid composites.



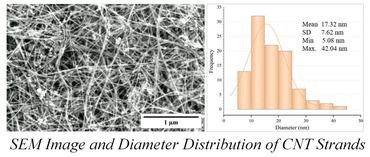
Schematics of FCCVD Reactor



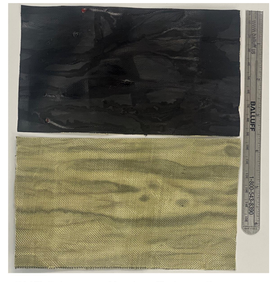
CNT Sheet Synthesis in FCCVD Reactor

- Pristine CNT sheets, CNT-silicone composite sheets, and CNT-silicone/Kevlar composite sheets were manufactured.
- The sheets have a dimension of 90cm × 25cm. The thickness of the pristine sheet was 20µm, CNT-silicone sheet was 22µm, CNT-silicone/ Kevlar Fabric was 116µm, CNT-silicone/ Kevlar Yarn was 435µm, CNT/Kevlar Veil was 90µm, and CNT-silicone/Kevlar veil was 95µm.

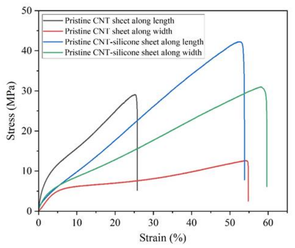
Pristine CNT Sheet



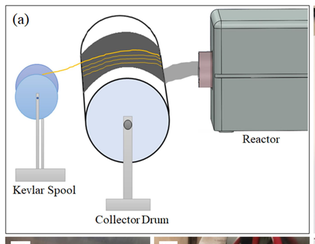
SEM Image and Diameter Distribution of CNT Strands



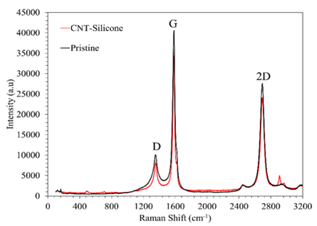
CNT-Silicone/ Kevlar Fabric Composite



Tensile Strength of CNT Sheet and CNT-silicone Sheet



Synthesis of CNT-Silicone/ Kevlar Yarn Composite



Raman Spectra of CNT Sheet and CNT-silicone Sheet

Table. Density, Resistivity, and Conductivity Anisotropy Ratios. The data is for in-plane properties. The results include contact resistance.

CNT Sheet Type	Density (g/cc)	Resistivity (Ω·cm)		Anisotropy Ratio, k∥/k⊥
		Along Length	Along Width	
Pristine CNT	0.25	0.0043	0.0091	2.12
CNT-silicone	0.56	0.0059	0.0163	2.76
CNT-silicone/Kevlar yarn	0.20	0.06	0.11	1.83
CNT-silicone/Kevlar fabric	0.90	0.11	0.26	2.36
CNT-silicone/Kevlar veil	0.30	0.09	0.09	1.89
CNT/Kevlar veil	0.17	0.06	0.06	1.67

- The pristine and composite sheets were lightweight, conductive and they passed Vertical Flame Test ASTM D6413/D6523M-15 and Forced Air Oven Test NFPA 1971.

Conclusion

- Macroscale CNT-silicone/Kevlar composites were manufactured by reinforcing a CNT-silicone matrix with Kevlar yarns, fabrics, and veil materials.
- The hybrid composites are flexible, conductive, and flame resistant.
- The synthesis of CNT-silicone membranes with Kevlar helps us to achieve the pristine strength of Kevlar veil, fabrics, and yarns whilst utilizing the multifunctional properties of CNT and CNT-silicone composites.
- The strength of Kevlar combined with the CNT and silicone properties may be beneficial in EMF shielding applications.
- The composite fabric can be used for manufacturing of electronic devices. On the one hand they will be beneficial for EMF shielding, on the other hand their thermal conductivity can help electronic devices in heat dissipation, i.e. thermal management.
- The fabrics can also be used to prepare personal protective equipment for workers requiring occupational safety in radiative environment such as radiology labs and radio towers.
- Future work: Analysis of EMF shielding efficiency of the various CNT composite materials.

Acknowledgements

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References

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*Some schematic images were obtained through: https://www.pinterest.com.