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11th INTERM 2024
International Congress on Microscopy & Spectroscopy
Liberty Hotels Lykia /Oludeniz - Turkey
April 18-24, 2024

CARBON NANOMATERIALS WITH PERFORMANCE IN EMI SHIELDING: GROWTH, STRUCTURING AND CHARACTERIZATION OF MATERIALS

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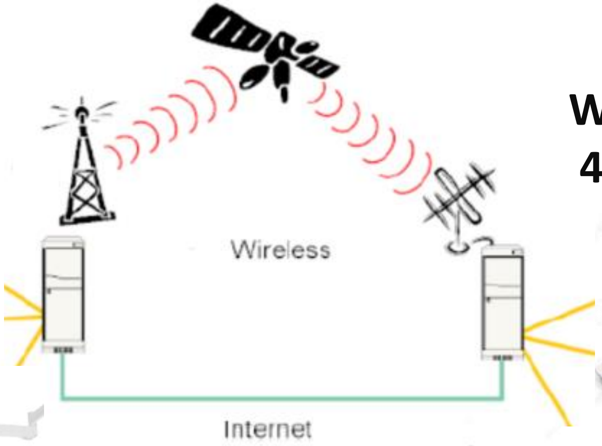
WHY Do we need EMI (Electromagnetic Interference) shielding ?

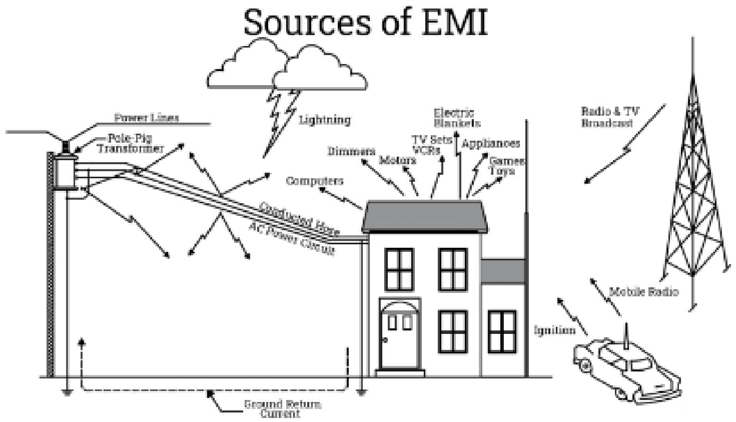
Communication Equipment

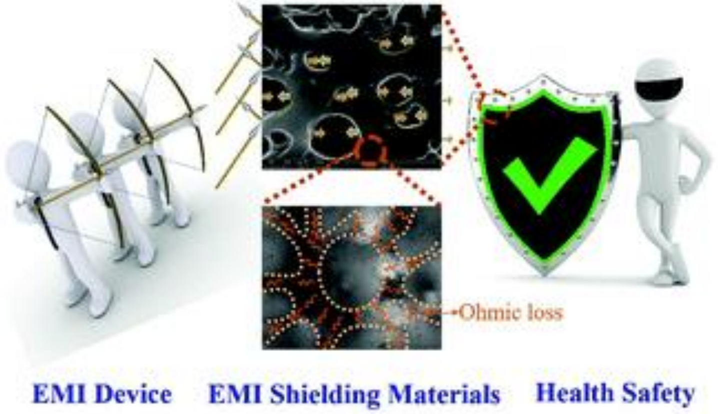


WiFi, Bluetooth
4G, 5G

X-ray

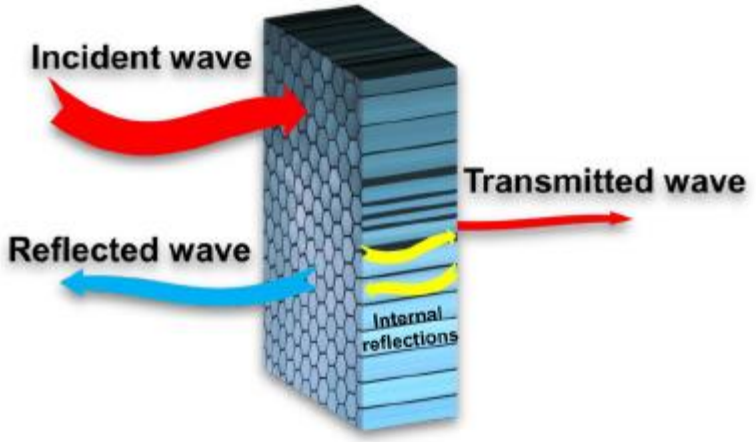
Signal Transmission and Reception



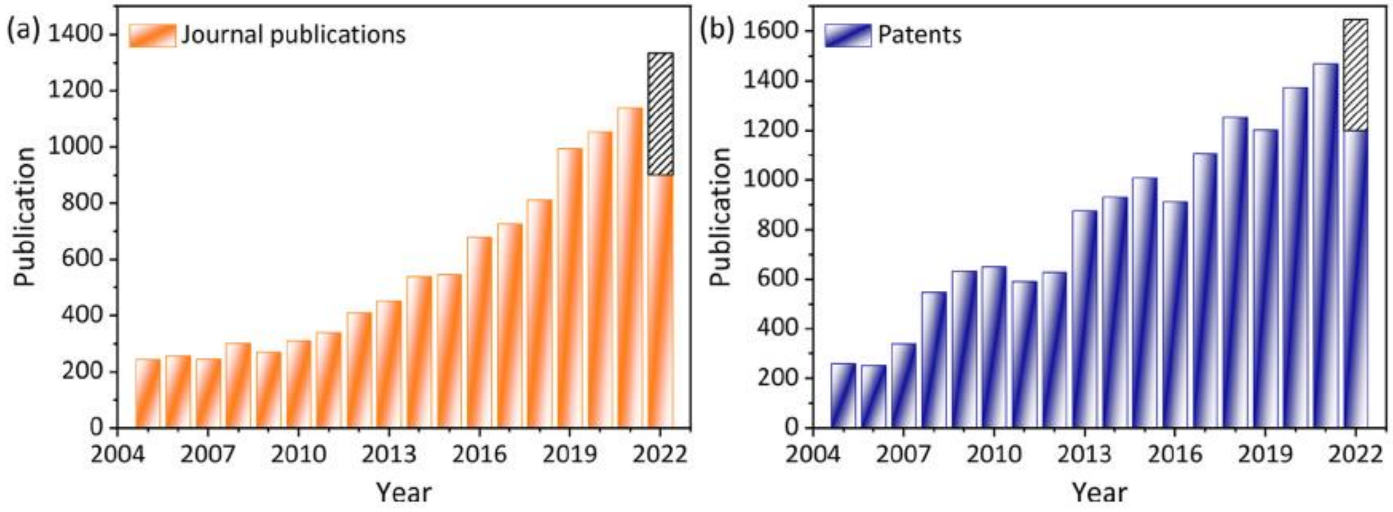


Protect human

Principle of the mechanism of EMI shielding material

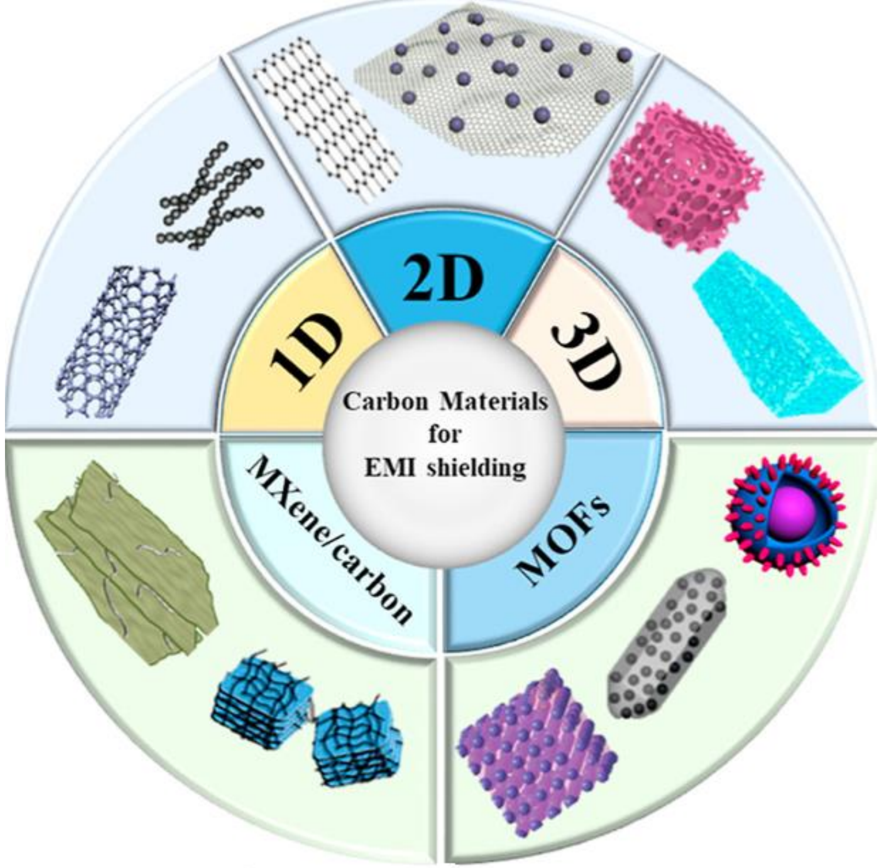


EMI shielding material



Evolution of EMI shielding materials

Carbon based materials for electromagnetic interference shielding



Metals / Metallic Coatings: Metals such as aluminum, copper, and steel

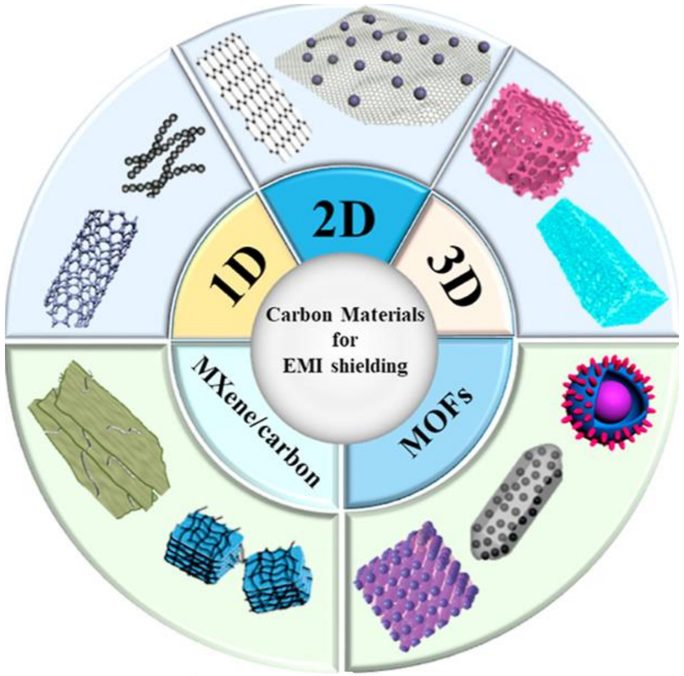
Conductive Polymers: **PANI,** PEDOT, **PA**

Carbonic materials:

- **0D** fullerene, UNCD, graphene dots
- **1D** MWCNTs. SWCNTs, CNHs, NCG
- **2D** Graphene, GW,
- **3D** ML Graphitic sheets, CNT networks, diamonds

PROPRIETIES for EMI shielding materials: lightweight, high electrical conductivity, corrosion-resistant, chemical inertness , flexible, easy-to-handle, low cost

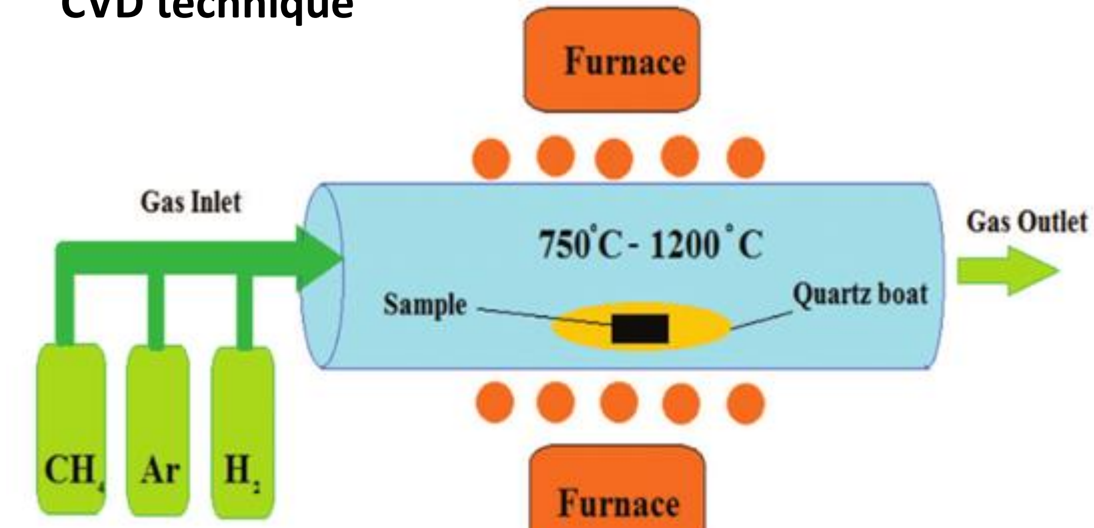
Short history of carbon nanomaterials for EMI shielding



- materials begins from 0-dimensional carbon black in the 1980s
- two-dimensional sp2 carbon shielding materials can be dated back to the 1990s
- 2000 the shielding performance of monolayer GF prepared by chemical vapor deposition (CVD) method
- most accessible precursor of graphene, graphene oxide (GO) came on board from 2010s
- 2020 – industrial GF film
- as time goes onto 2022, an industrial- scale modulation-doped roll-to-roll CVD growth process

Fabrication methods of carbon nanomaterials

CVD technique



SiH4 O2

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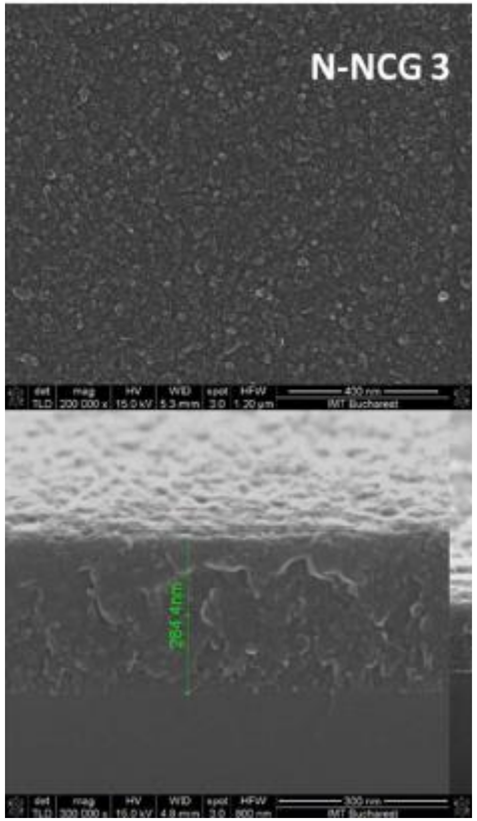
PECVD fabrication methods of carbonic nanomaterials

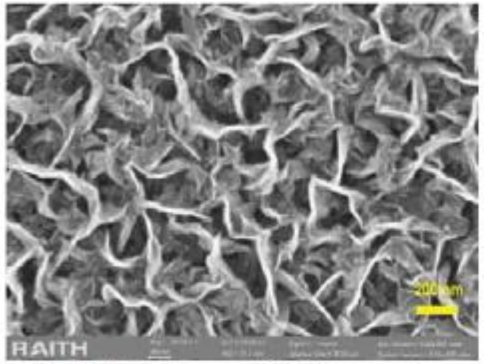
CABABILITY	
Gases available	NH3, Ar, H2, CH4, N2, N2O, O2, SiH4, CF4
Table temperature	PECVD: from RT to 700°C with standard depositions at 400°C ICP PECVD: from RT to 400°C with standard depositions at 100°C
Sample size	6" wafers max
RF power max	PECVD: 300W ICP PECVD: 600W
Pressure max	PECVD: 5000mTorr ICP PECVD: 100mTorr

Table 1 CNs materials growth PCV process parameters

Materials/substrate	Temperature /Time	RF Power	Pressure	Precursors	Thickness
Single-layer graphene (SLG)/ SiO_2	1080 °C /60 min	-	400	$Ar:H_2:CH_4$	
Graphene/graphite nanowalls (GNW) / SiO_2	750 ºC / 60 min	300	40	$Ar:CH_4$	≅200 nm
Nanocrystalline graphite (NCG) / SiO_2	890-900 ºC / 120 min	100	200	$H_2:CH_4$	≅360–380 nm

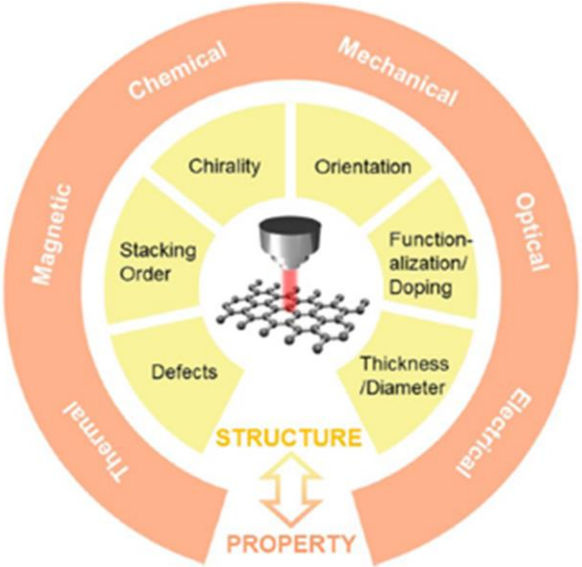


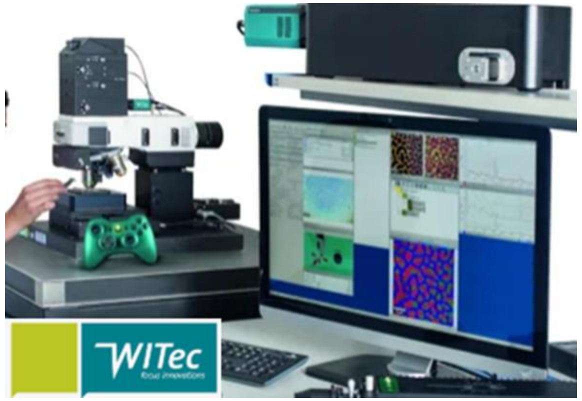
SEM Image of NCG



SEM Image of GNW

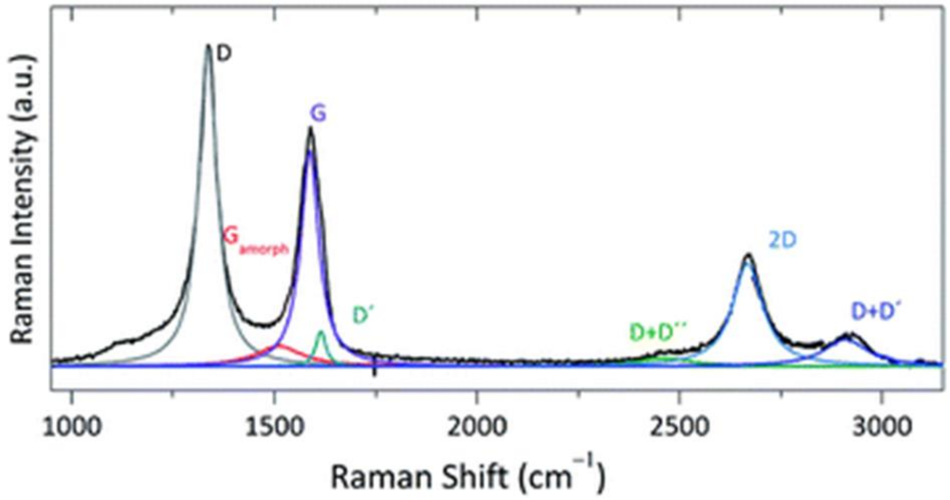
Raman for carbonic nanomaterials





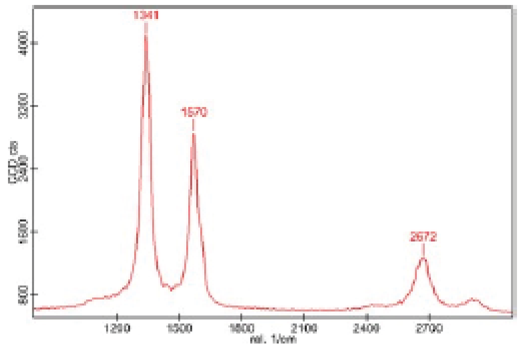
The Raman spectra were recorded with the same system (Witec Alpha 300S/2008 GmbH Germany) using an Nd-YAG laser with 532 nm green excitation.

Table 2 Measurement parameters	
spectral range	10 – 3500 cm^{-1}
integration time	20 s
laser power	1 mW
grating	600 groves/mm
laser spot size	400 nm
spectral resolution	~ 2 cm^{-1}

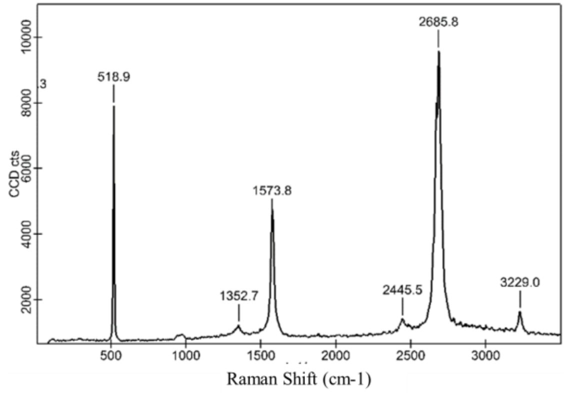


Raman spectrum for GNW

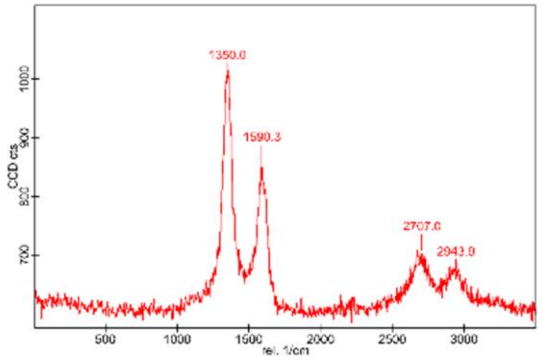
Raman for PCVD carbonic materials



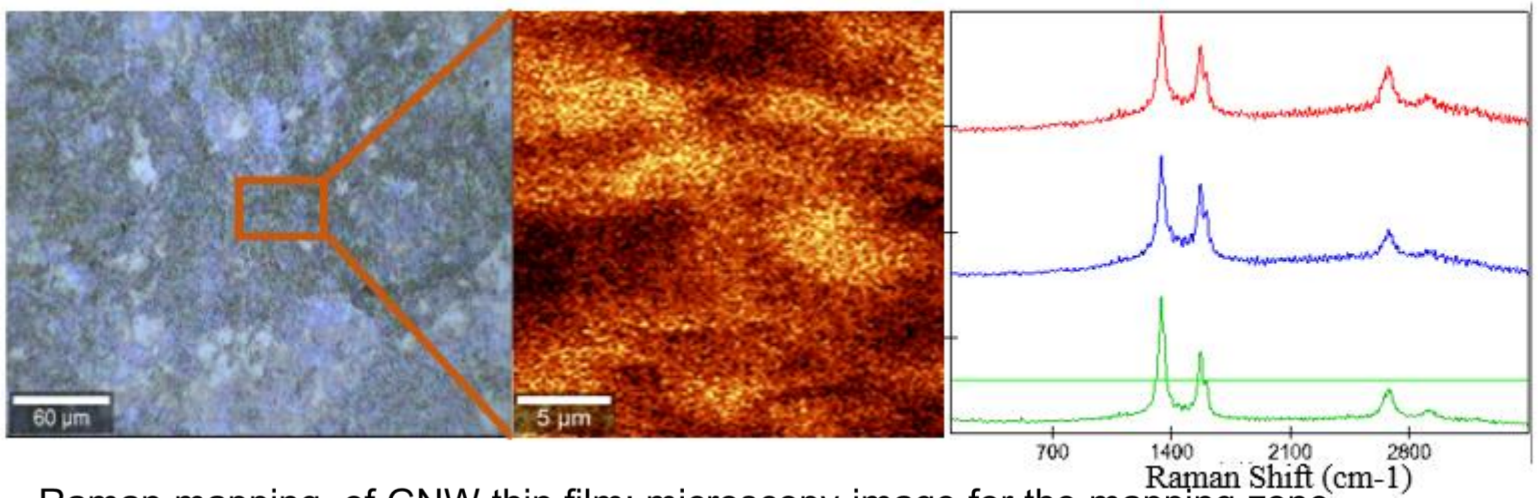
Raman spectrum for GNW



Raman spectrum dor GNW



Raman spectrum for NCG



Material	ID/IG	I2D/IG	ID'/IG
SLG		~1.6	
GWN	~1.97	~0.94	~0.75
NCG	~1.18	~1.22	~0.88

Raman mapping of GNW thin film: microscopy image for the mapping zone (left image); mapping image with the Raman spectra associated in GNW graphs (middle and righs images).

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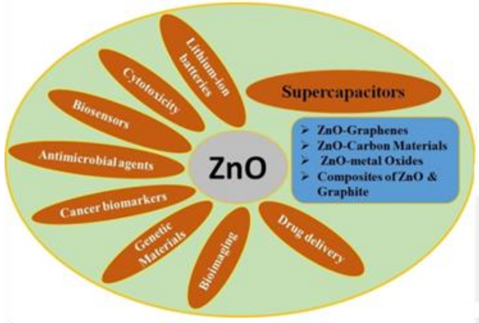
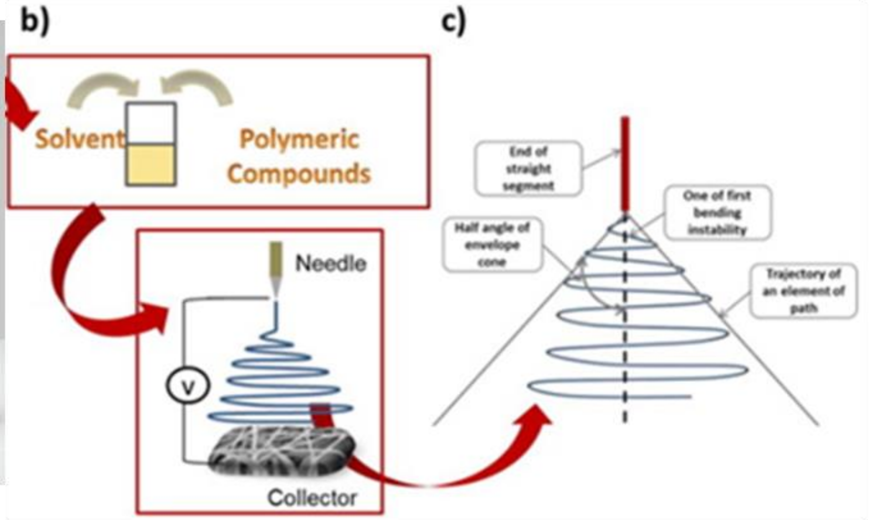
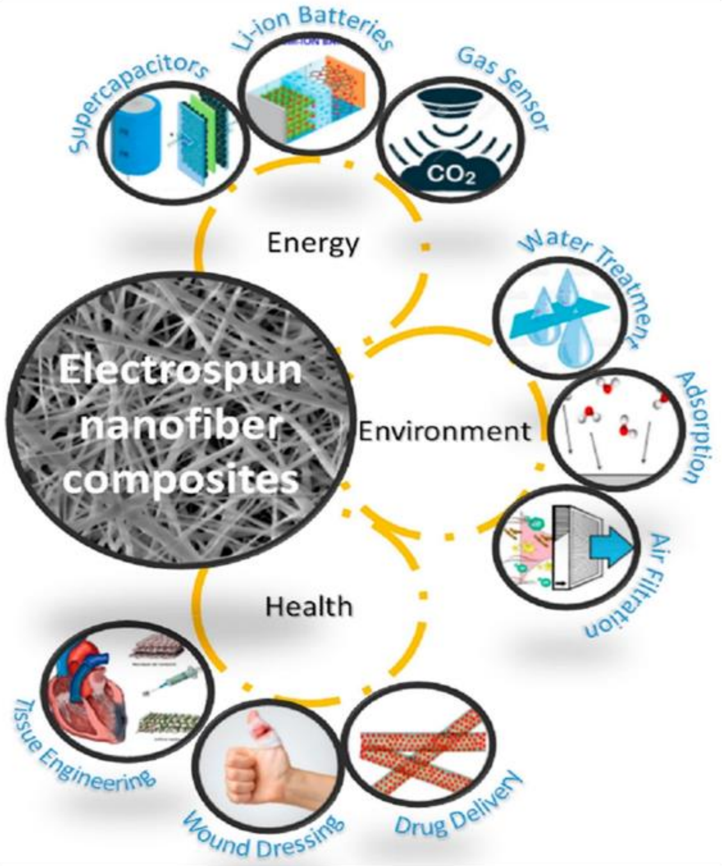
Fabrication of carbonic shielding materials



Now ZnO:RE/Graphene (rare-earth: Er, La, Sm) nanocomposite materials obtained using a two stages method: electrospinning of precursor solutions followed by calcination at 600 ºC (for 2 hours in N2 medium).





a) representation of our electrospinning equipment; b) sketch of electrospinning process, describing how nanofiber mats can be synthetized; **c)** the occurred bending instabilities, which ensure the reduction of polymeric jet diameter to the nano- scale

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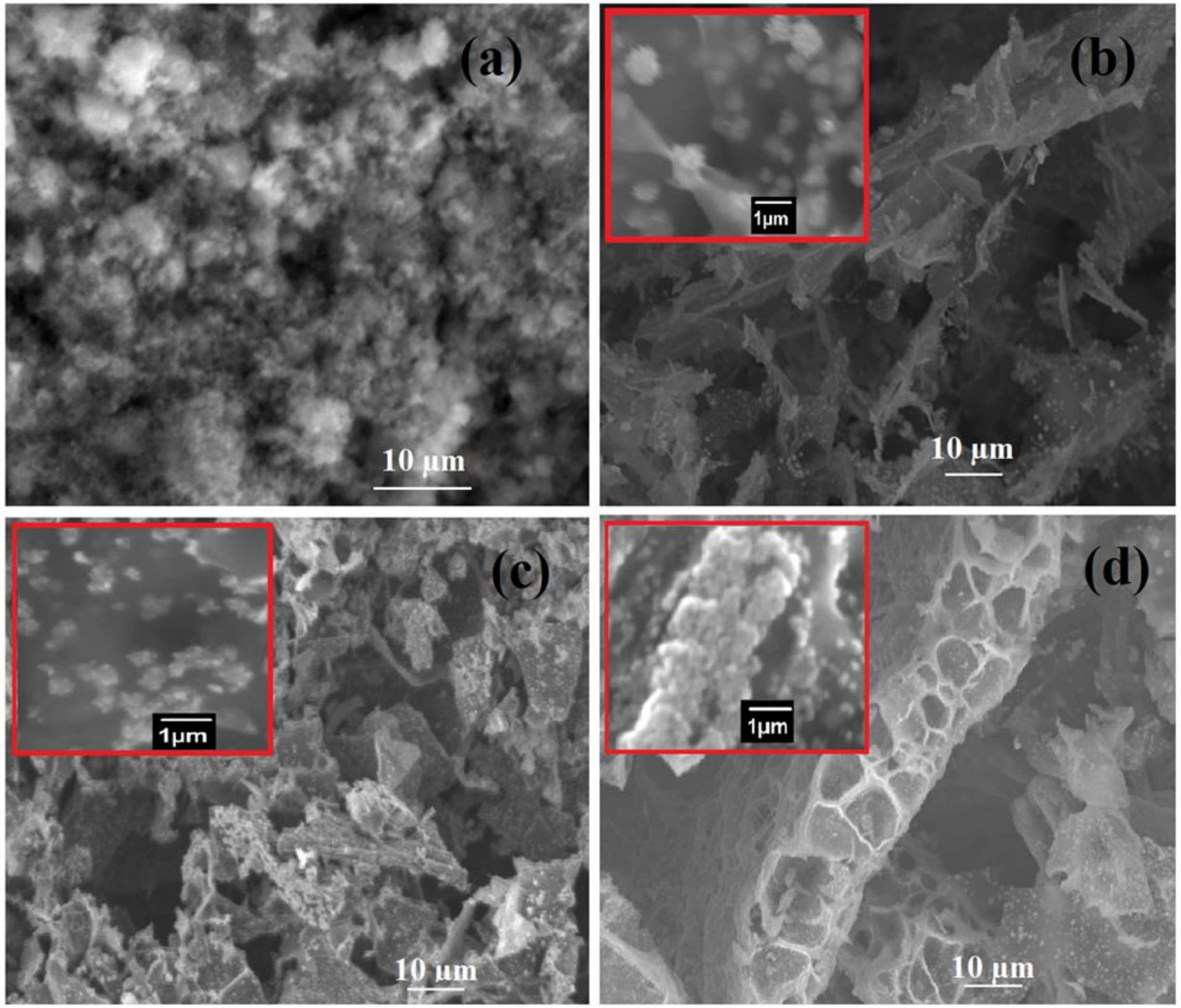
Scanning Electron Microscopy images

(a) ZG – ZnO/Graphene
(b) ZEG– ZnO:Er/Graphene
(c) ZLG – ZnO:La/Graphene
(d) ZSG – ZnO:Sm/Graphene



Detailed morphologic analysis of samples revealed that this kind of doping have a strong effect in all materials.

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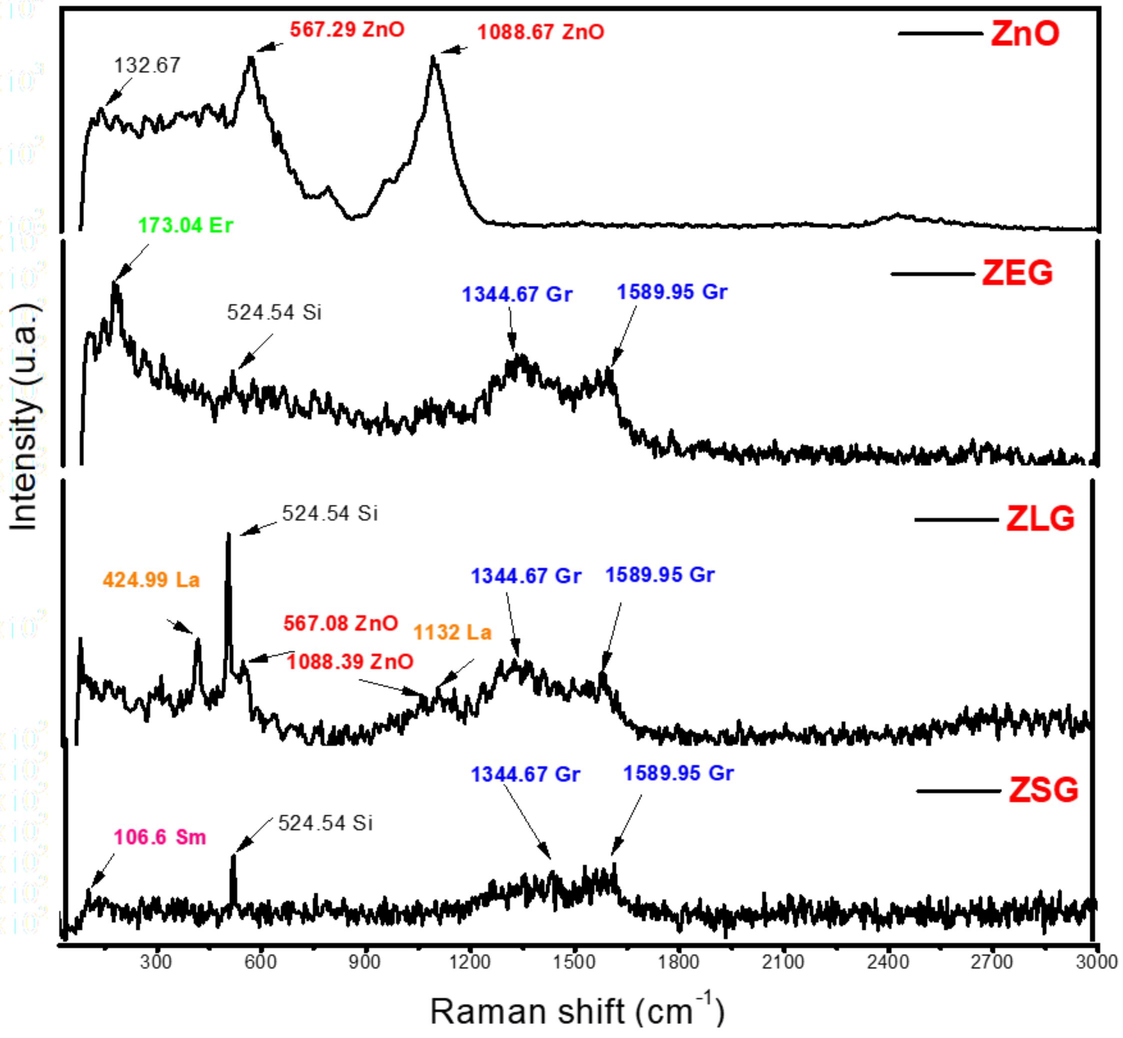
Raman spectroscopy analysis

- In the case of ZnO:Er/Graphene nanocomposites, the peak at 173 cm^{-1} is of T_g-A_g symmetry and is the fingerprint peak with the highest Raman scattering efficiency in C-Er_2O_3
- In the case of ZnO:La/Graphene nanocomposites, peaks at 425 cm^{-1} and 1132 cm^{-1} appears in the Raman spectra of surface La-ZnO doped thick films. The peaks were conjectured to be associated with intrinsic host-lattice defects and was arises by doping with La
- In the case of ZnO:Sm/Graphene nanocomposites, the observed lines at 457 cm^{-1}, 335 cm^{-1}, 152 cm^{-1} can be assigned to A_g modes and 424 cm^{-1} can be assigned to B_g and A_g modes of Sm_2O_3



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What?

Project title: Development of novel nanocomposite materials with tunable conductivity for electromagnetic shielding and potential uses in electronics and optoelectronics applications

Where?

IMT Bucharest

https://pnrrcf23.ro/

When?

July 2023- June 2026

Romania's National Recovery and Resilience Plan (PNRR)

Pillar III. Smart, sustainable and inclusive growth, including economic cohesion, jobs, productivity, competitiveness, research, development, and innovation, and a well-functioning internal market with strong small and medium-sized enterprises (SMEs)

Component C9. SUPPORT FOR THE PRIVATE SECTOR, RESEARCH, DEVELOPMENT AND INNOVATION

"I8. Development of a program to attract highly specialised human resources from abroad in research, development and innovation activities"

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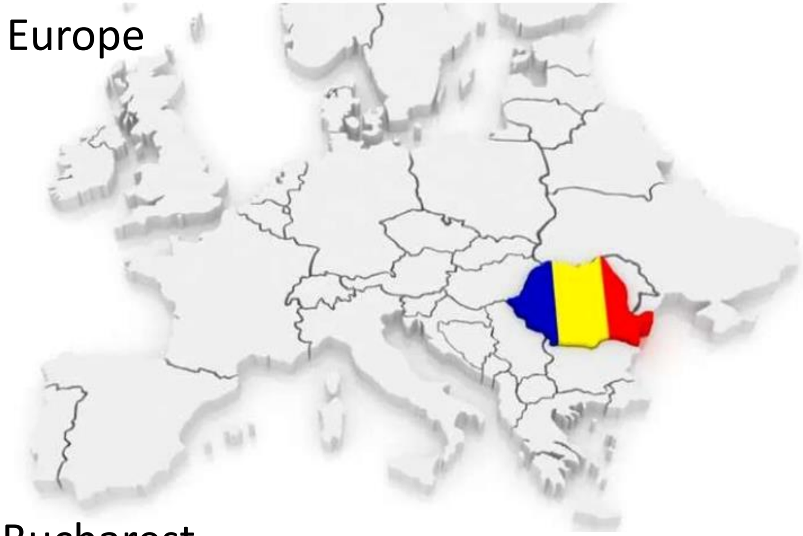
Who are we?

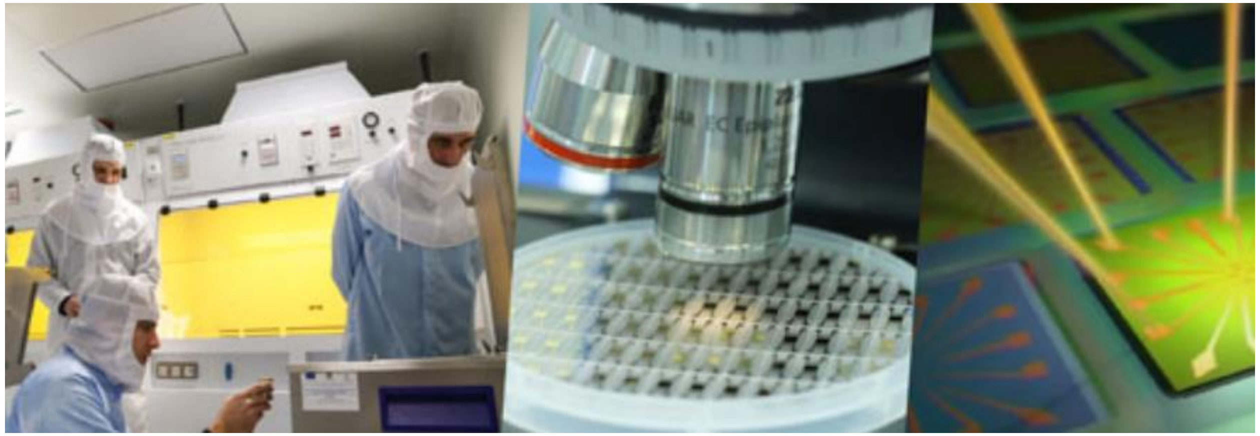
IMT-Bucharest

National Institute for Research and Development in Microtechnologies

Europe



IMT Bucharest develops nanoelectronic devices, advanced materials (graphene), and devices based on graphene and SiC, microsensors, and microsystems for IoT and applications in energy and healthcare.



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Thank you for your attention

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CAS 2024 - an IEEE event

Sinaia, Romania
October 9-11, 2024

IEEE

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