Exploring Carbon Nanohybrid Materials for Chemoresistive Sensor Sensing Films through Raman Studies

ICPAM-15 PAMS-6
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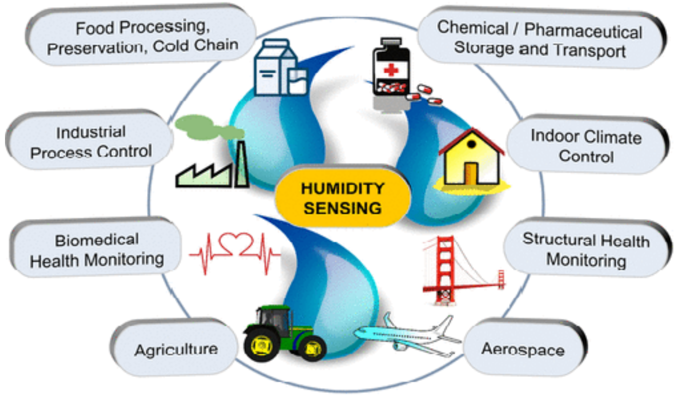
Sharm El Sheikh, Egypt

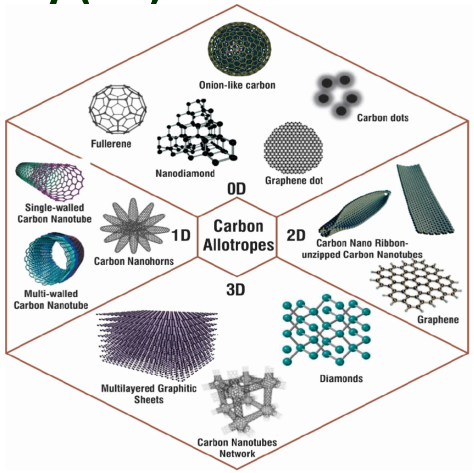
C. Pachiu, O. Simionescu[1], B. Serban[1], R. Marinescu[1], N. Dumbravescu[1], R. Popa[1], O. Buiu[1], M. Serbanescu[1], Gh. Pristavu[2], Gh. Brezeanu2

1 National Institute for R&D in Microtechnologies, Bucharest, Romania, Cristina.pachiu@imt.ro
2 University Politehnica of Bucharest, Faculty of Electronics, Telecommunications and Information Technology, Bucharest, Romania

Cristina.pachiu@imt.ro

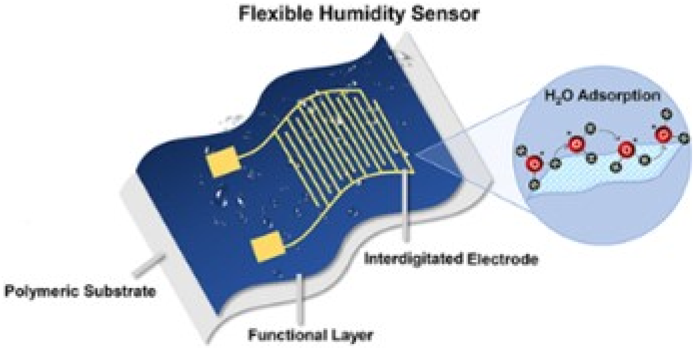
❑ Various application paradigms for Resistive Humidity (RH) Sensors.



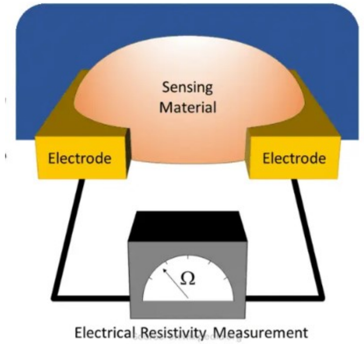


Carbon nanostructures (CN)

❑ Design of RH sensors



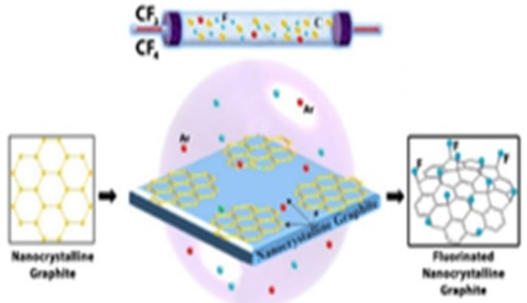
❑ The detection principle of RH sensors



❑ Potential advantages of fluoridated carbon nanohybrid materials (F-CN) in RH sensors

- High Surface Area
- Hydrophobicity
- Chemical Stability
- Tunability of Properties
- Compatibility with Flexible Substrates

❑ Fluoridation of the sensing layer @ by PECVD



F-CN plasma treatments @ 20 Pa and 20 W

Ar (20 sccm)

Ar: CHF3 (20:5 sccm)

Ar: CF4 (20:5 sccm)

for 5” and 10 “

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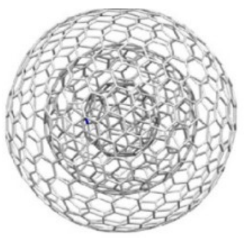
Carbon Nanoonions (CNOs)



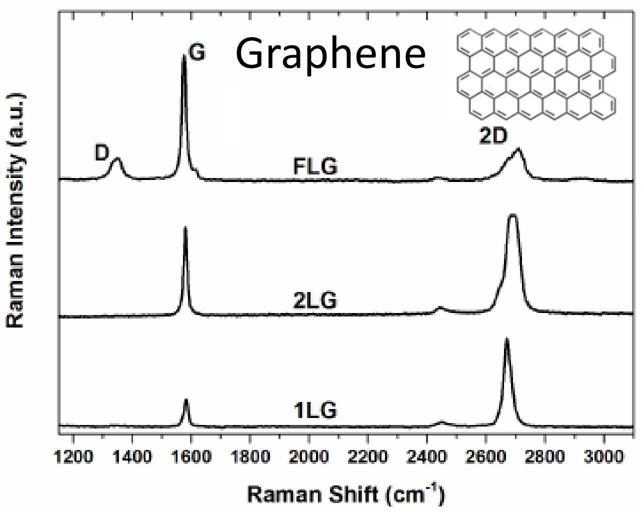
CNO

❑ Advantages of using carbon nanoonions in sensor detection

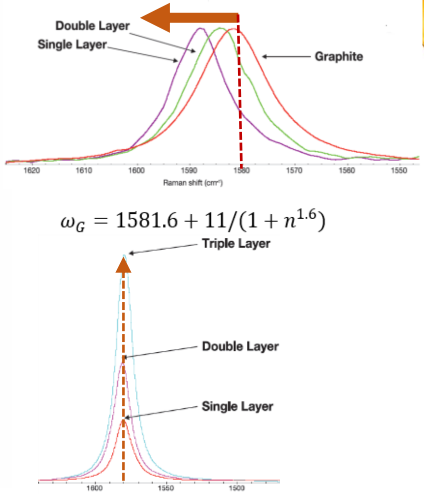
Large Surface Area
Potential for Multi-Functionalization
Electrical Conductivity
Gas Adsorption and Sensing

Peak Position → Peak Intensity → Peak Broadening

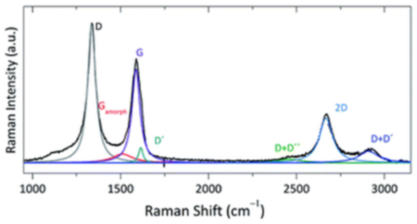
SLG	$\frac{I_D}{I_G}$=0	$\frac{I_{2D}}{I_G}$=2
DLG	$\frac{I_D}{I_G}$=0.05	$\frac{I_{2D}}{I_G}$=1
FLG	$\frac{I_D}{I_G}$=0.1	$\frac{I_{2D}}{I_G}$=0.8



G mode



Raman spectra in doped graphene ?



- ➢ Shift in Raman peak
- ➢ Intensity changes
- ➢ Appearance of new peaks
- ➢ D and 2D band evolution

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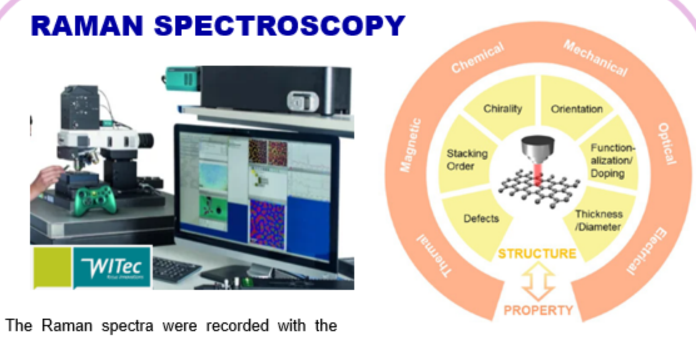
Carbon Nanoonions (CNOs)

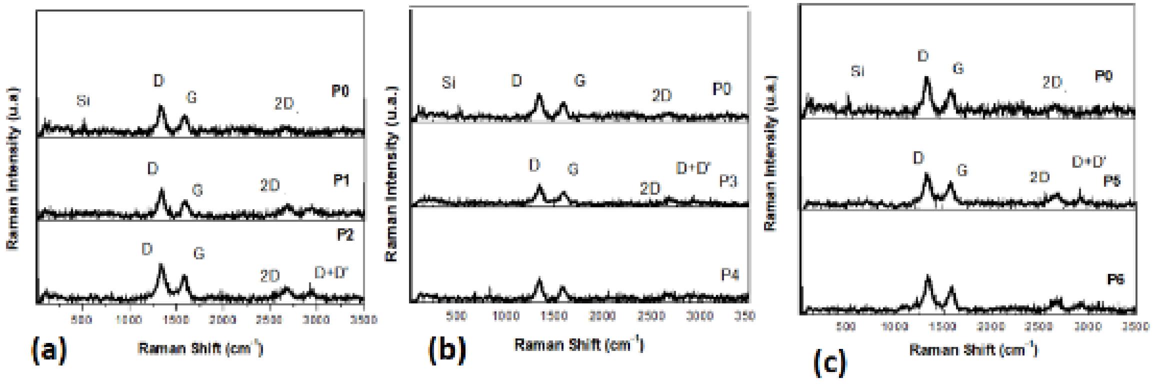
RAMAN SPECTROSCOPY

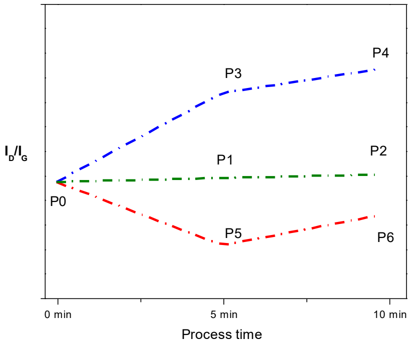


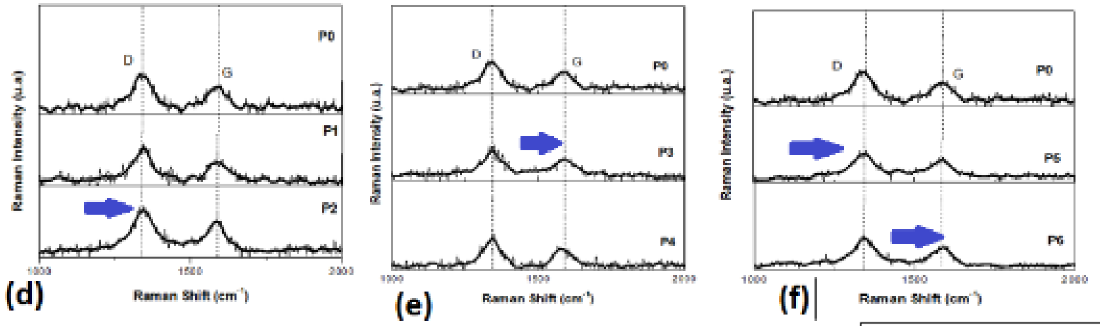
The Raman spectra were recorded with the same system (Witec Alpha 300S/2008 GmbH Germany) using an Nd-YAG laser with 532 nm green excitation.

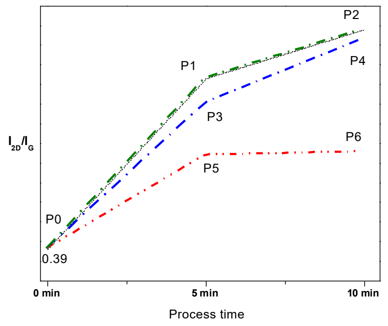
Table 1 Measurement parameters

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}









Samples
P_0-bulk CNOs
P_1-F/CNOs : Ar 5”
P_2-F/CNOs:Ar 10”
P_3-F/CNOs:Ar/CHF_4 5”
P_4-F/CNOs:Ar/CHF_4 10”
P_5-F/CNOs : Ar/CF_3 5”
P_6-F/CNOs:Ar/CF_3 10”

Conclusions

- The position of the D and G bands, shifts slowly to higher values as the fluoridation time increases and the ID/IG ratio increases from 0.39 to NCO to 0.67 for P6 (F-NCO/Ar:CF3) sample.
- This suggests that the nanocarbonic domains are increasing in width along the hexagonal plane in the material. The width of the lateral crystallite size, La, was determined using the method described in Ref. [1], and the results indicate an increase (from 13.39 nm for NCO to 26.34 nm for P6 (F-NCO/Ar:CF3), as shown in Table).
- **Sensing films form fluorographene in various degrees of fluorination and the reaction conditions which lead to the hydrophilicity of the sensitive sample of RH humidity sensors.**

Sample	WD (cm^{-1})	WG (cm^{-1})	I_D/I_G	La	I_{2D}/I_G
P_0-bulk CNOs	61.8	43.06	1.435	13.39	0.390
P_1-F-CNOs:Ar 5”	71.88	49.8	1.443	13.31	0.607
P_2F-CNOs:Ar 10”	90.38	62.32	1.450	13.25	0.669
P_3F-CNOs:Ar/CHF_4 5”	64.95	40.19	1.616	11.89	0.575
P_4F-CNOs:Ar/CHF_4 10”	65.94	39.53	1.668	32.06	0.657
P_5F-CNOs:Ar/CF_3 5”	83.11	63.63	1.306	14.71	0.509
P_6F-CNOs:Ar/CF_3 10”	90.38	65.95	1.370	26.34	0.514

Thank you for your attention.

Cristina.pachiu@imt.ro

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