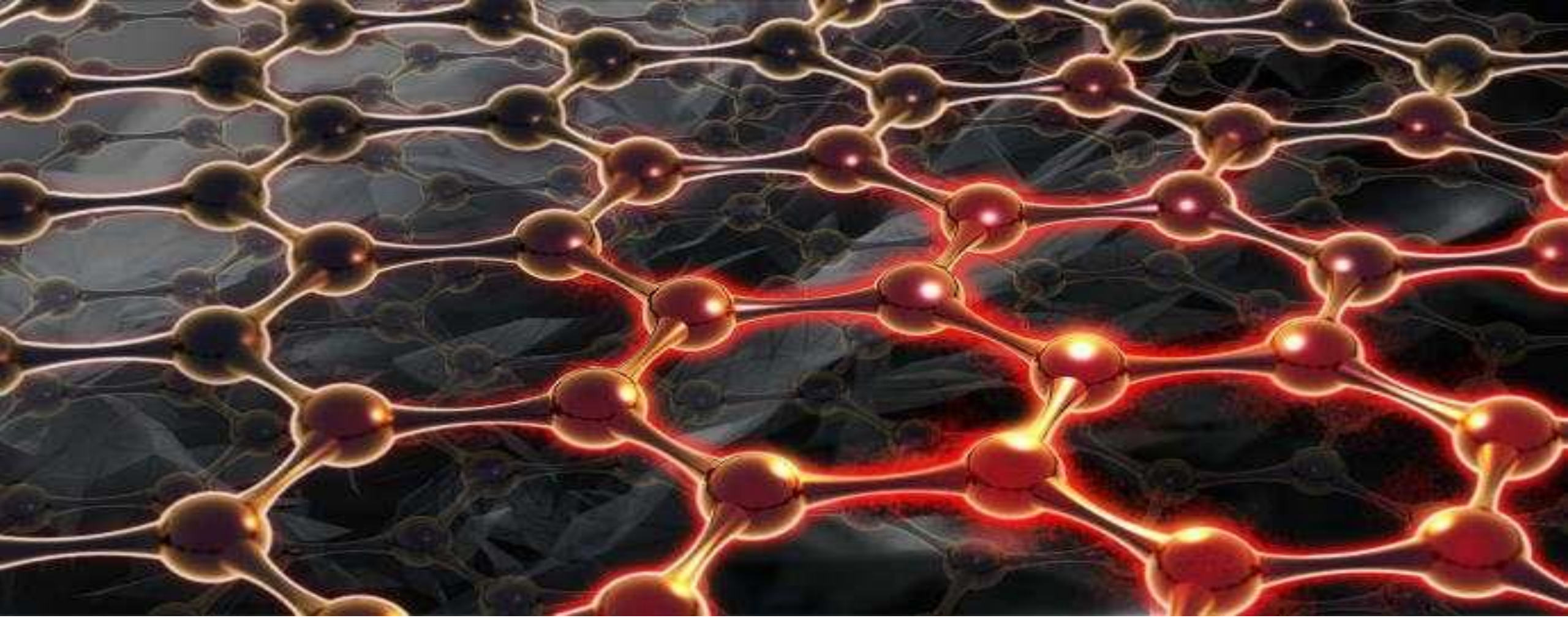


RESEARCH GROUP OF NANOSTRUCTURE AND NANOMATERIAL STUDIES: CURRENT PROJECTS AND PERSPECTIVES

Narek Margaryan

A. I. Alikhanyan National Science Laboratory

THE TEAM

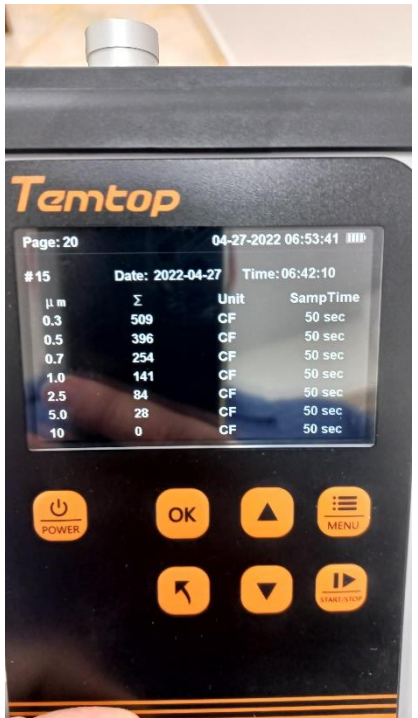
Narek Margaryan

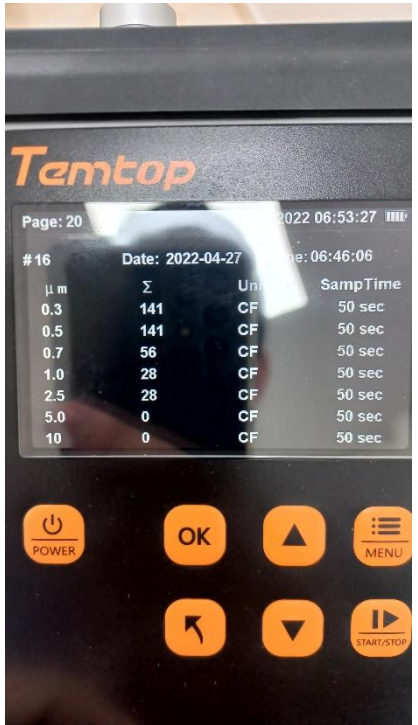
Stela Galstyan

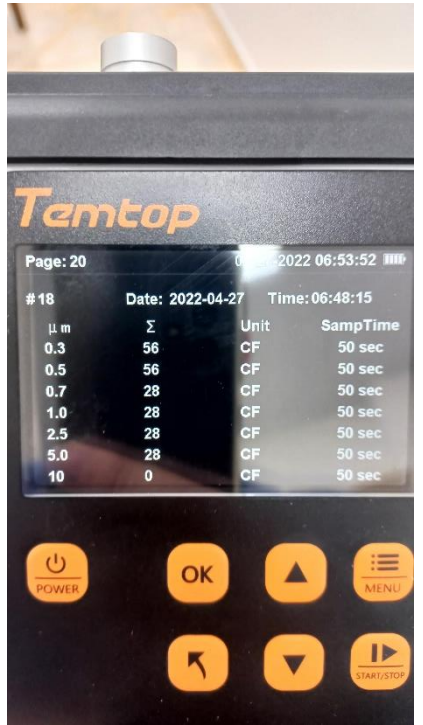
Naira Gasparyan

LAB RESOURCES - CLEANROOM

Class 1000 (ISO 6) cleanroom at AANL







LAB RESOURCES- MATERIAL SYNTHESIS AND THIN FILM DEPOSITION TECHNOLOGIES

CVD

Mini Tube Furnace

PVD

Ultrasonication device

UV Spin Coater

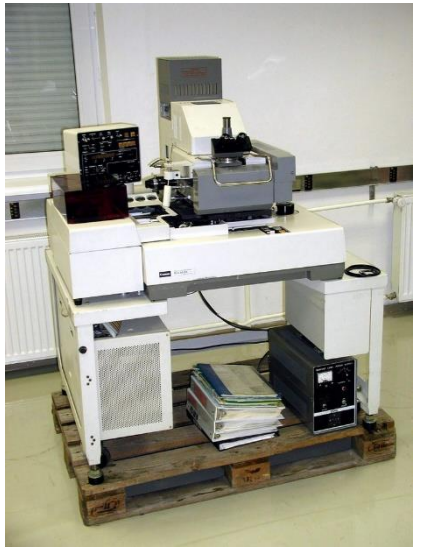
Wet bench (Fume Hood)

LAB RESOURCES-MATERIAL CHARACTERIZATION AND DEVICE MAKING TECHNOLOGIES

Agilent Cary 630 FTIR

Profilometer

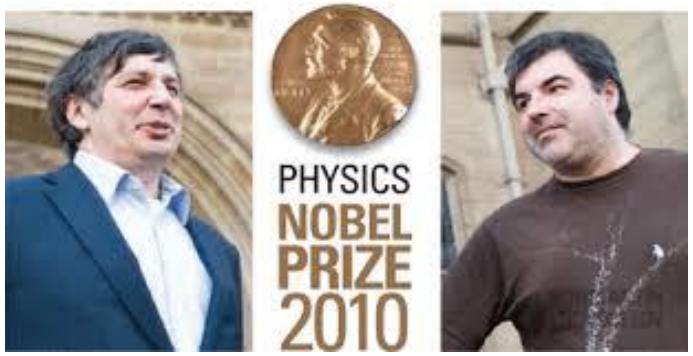
Canon Mask Aligner PLA-501 FA



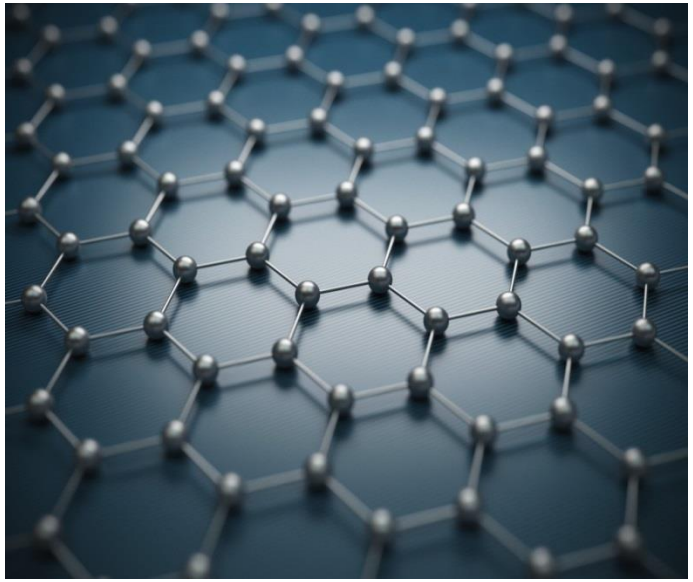
NI MyDaq

Pulse Heat Unit

GRAPHENE RESEARCH



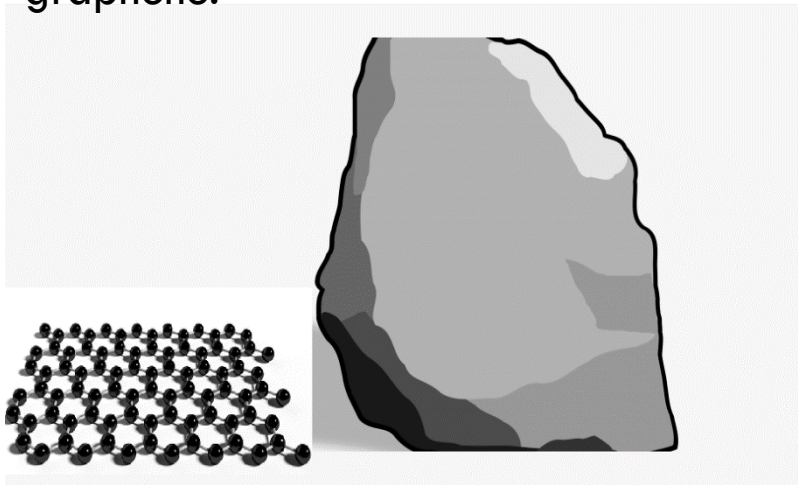
Graphene is internationally recognized as a groundbreaking nanomaterial for its applications in dozens of technical fields. This material may be an alternative with superior electrical, mechanical, and thermal properties.



Comparison of the electron mobility, in existing semiconductors and graphene	
Material Name	Electron Mobility ($cm^2/(V \cdot s)$)
Silicon (Si)	1500
Germanium (Ge)	4000
Gallium Arsenide (GaAs)	10 000
Graphene	200 000

CVD SYSTEM AND ISO6 CLEANROOM FOR GRAPHENE RESEARCH

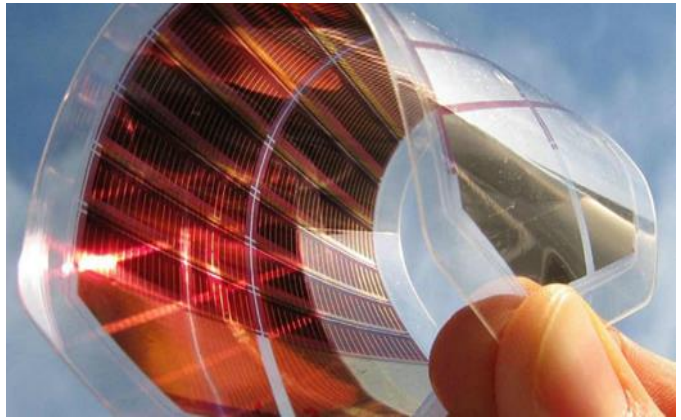
Dust particles are much thicker than graphene.



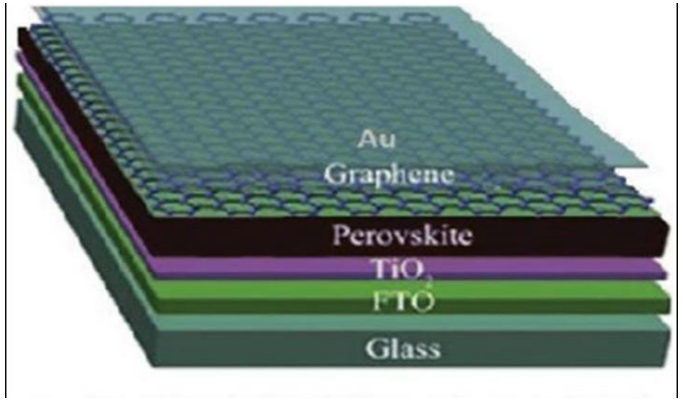
Dust particles are much thicker than graphene. A cleanroom is essential for studying graphene and other nanolayers.

PEROVSKITE/GRAPHENE SOLAR CELLS

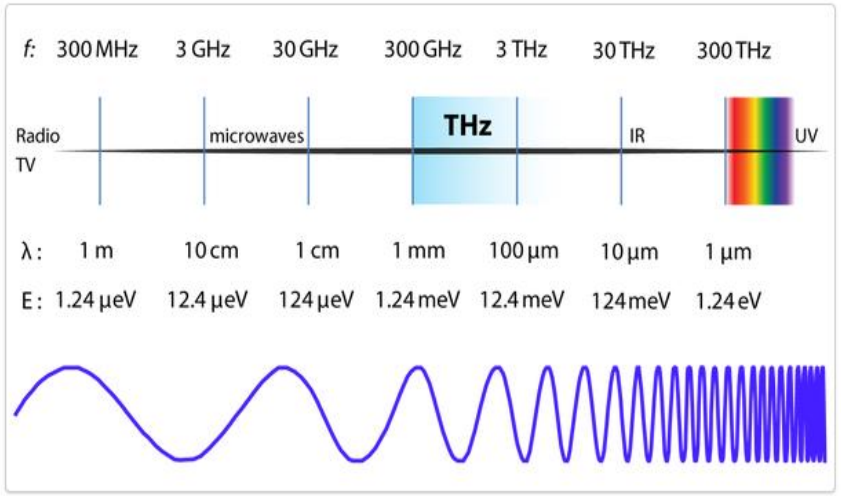
Nanotechnology makes it possible to manufacture flexible solar cells from sustainable materials.

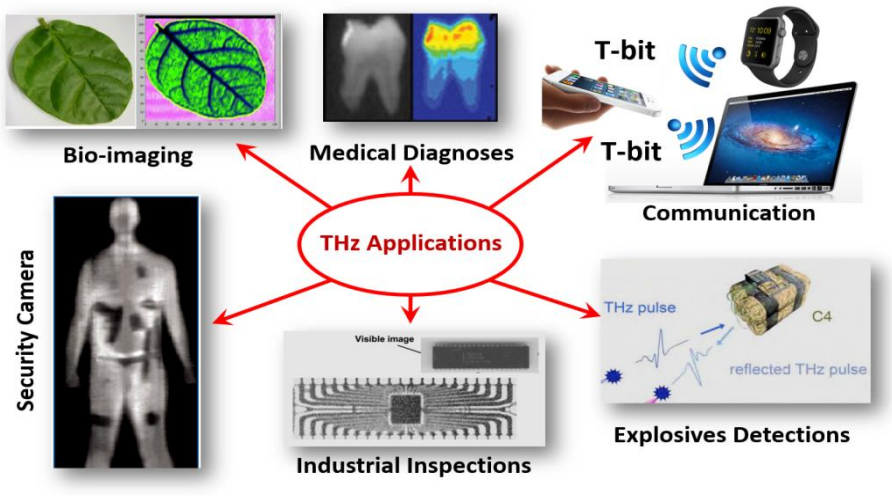


The protective and optoelectronic properties of graphene significantly increase the efficiency of solar cells.

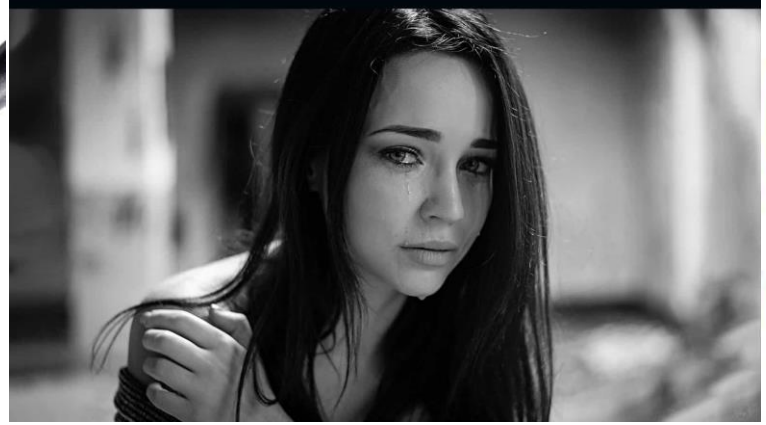


APPLICATION OF GRAPHENE IN THZ TECHNOLOGIES

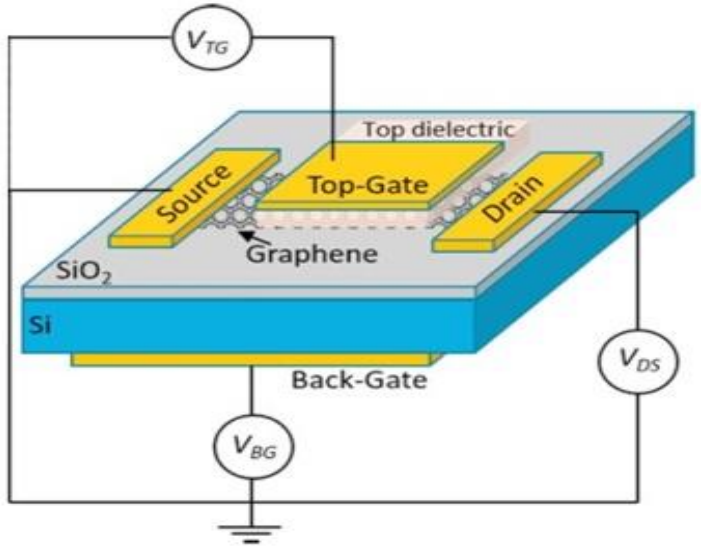


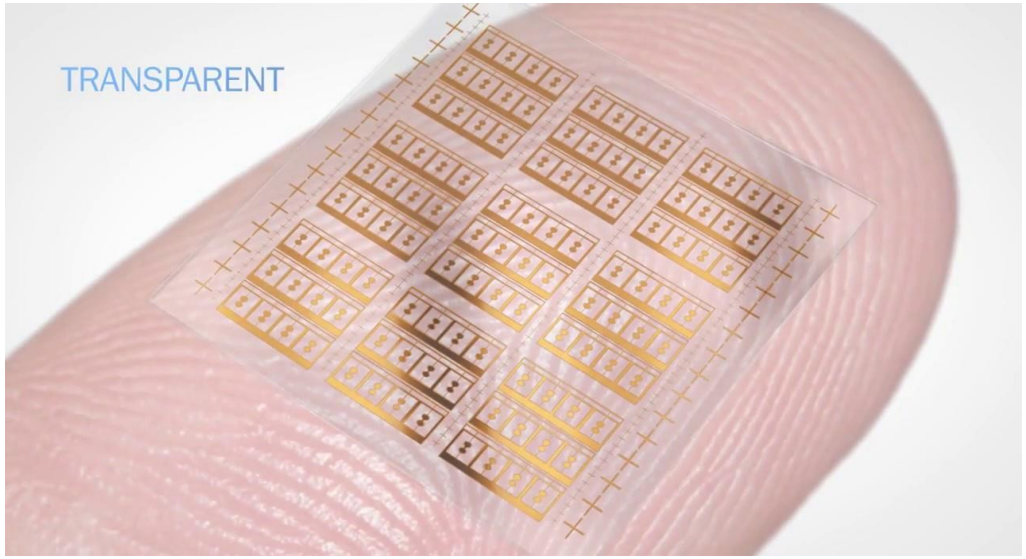


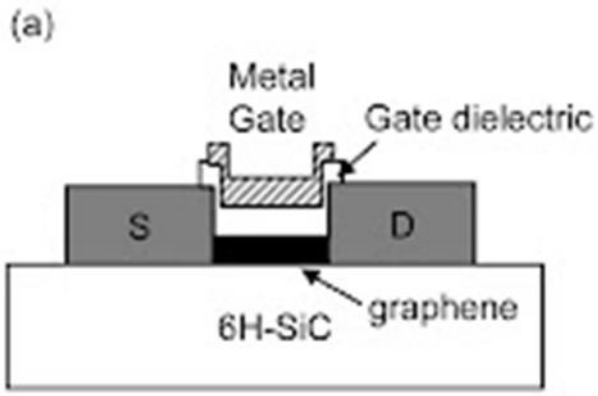
Mechanically strong	Sensitive	Affordable

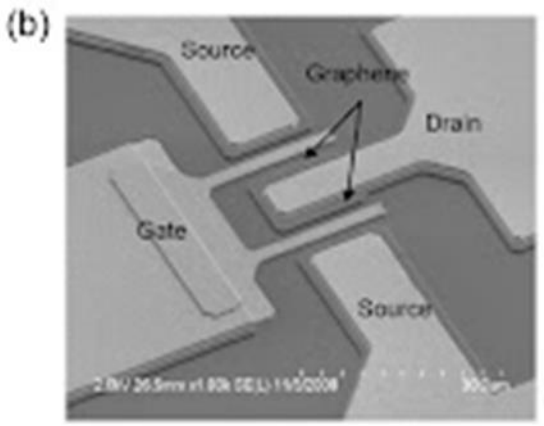


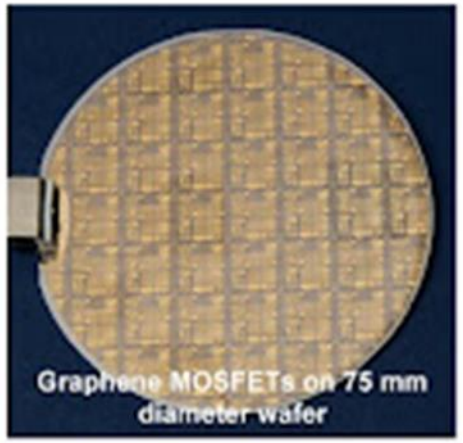
GFET AND THZ DETECTOR







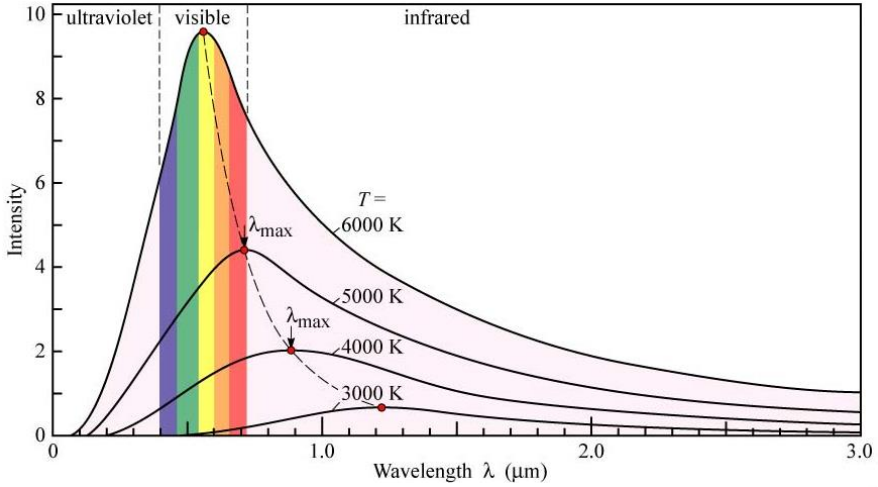




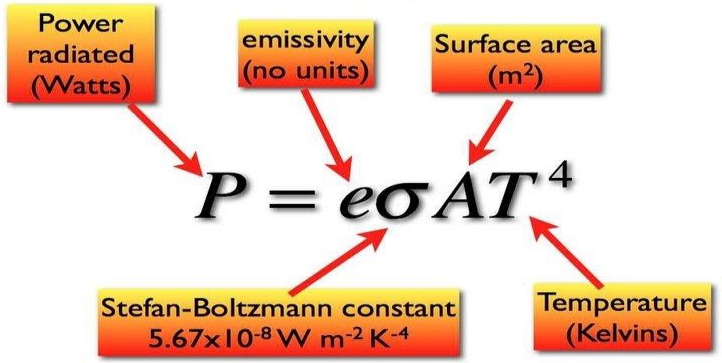
INFRARED RAYS CAN BE DETECTED BY HEAT USING DEVICES

Thermal vision

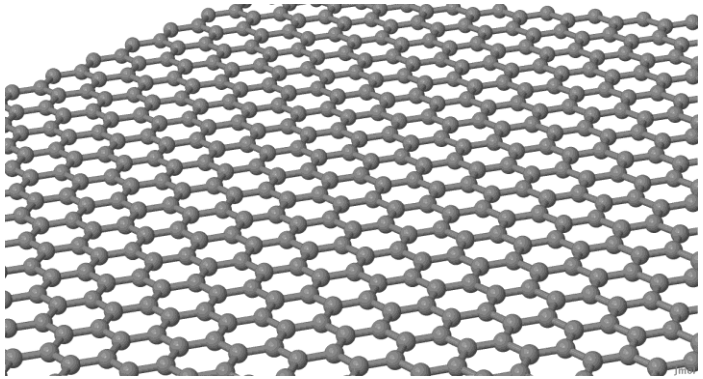
Thermal radiation



Stefan-Boltzmann Law

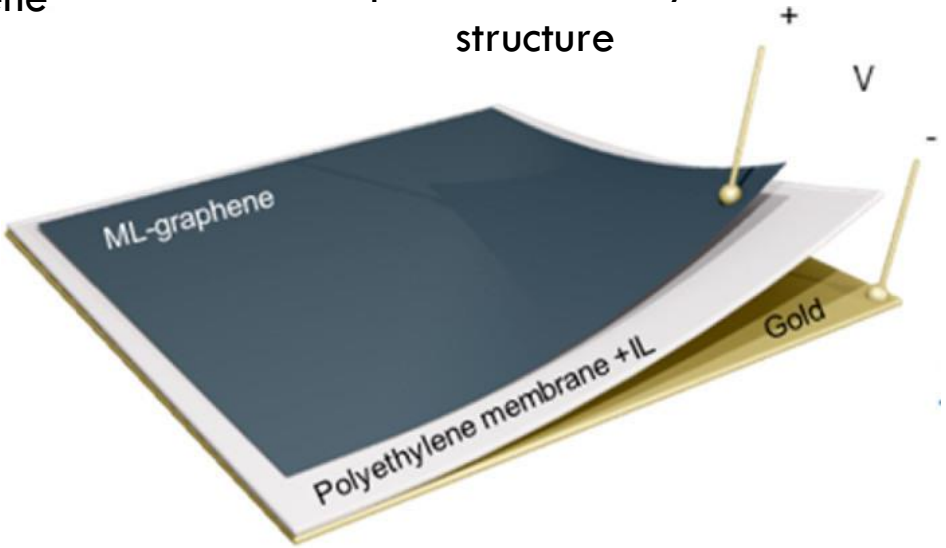


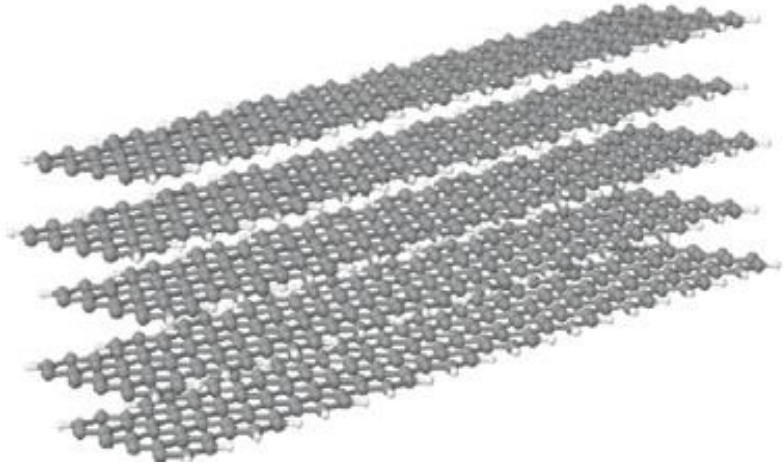
ML GRAPHENE PROVIDES NEW PERSPECTIVES TO CONTROL THE THERMAL RADIATION



Lattice of monolayer graphene

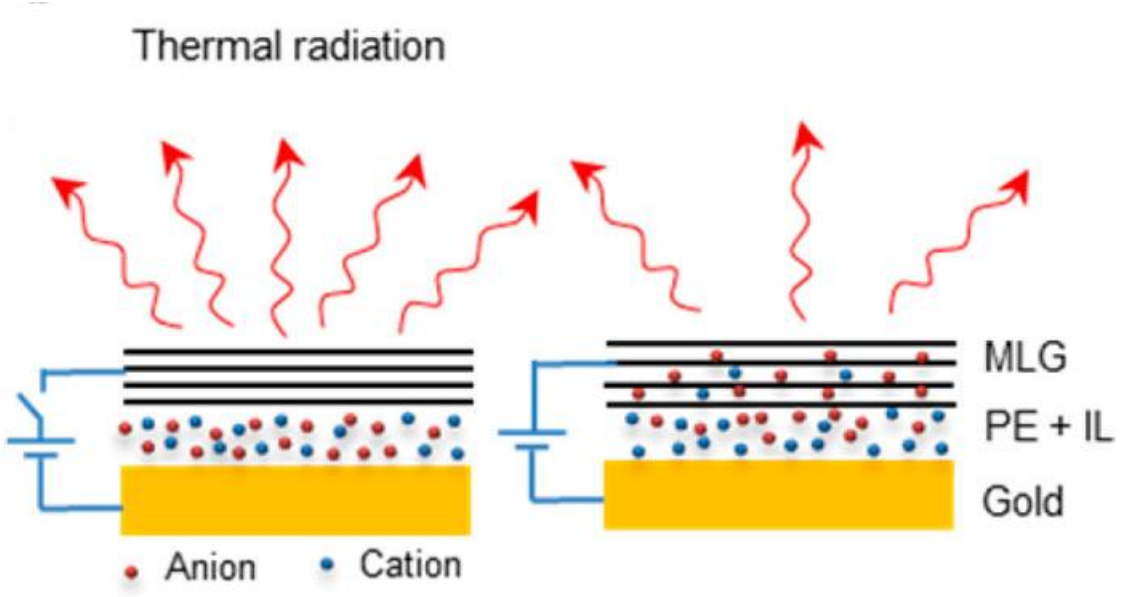
Graphene based layered structure





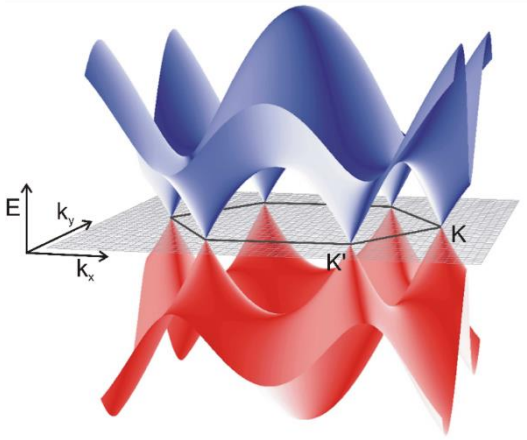
Lattice of multilayer graphene

TUNED DOPING OF GRAPHENE

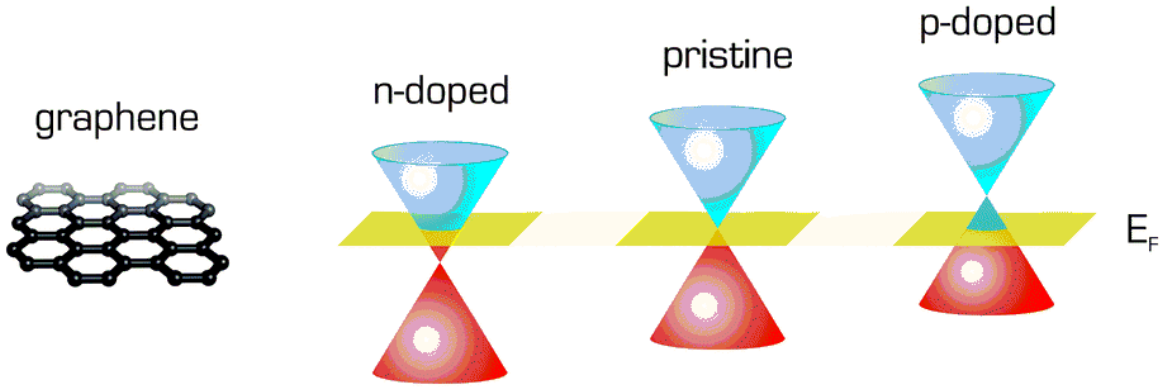


Tuning the doping of ML graphene by voltage.
Coskon Kocabas et al. *Nano Lett.* 2018, 18, 7, 4541–4548

Electronic band structure of graphene

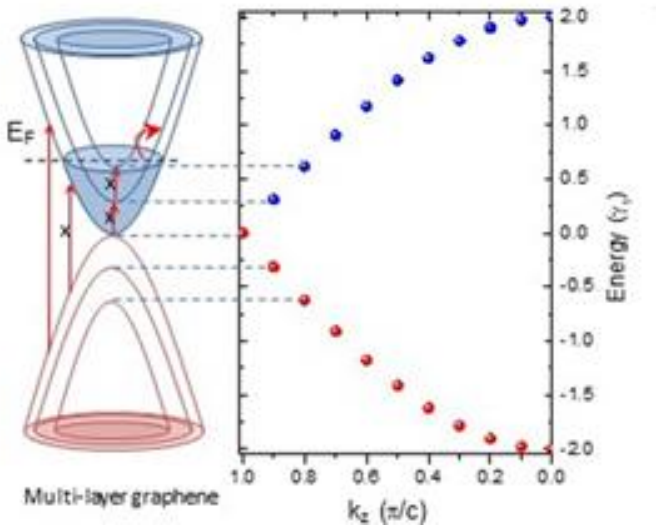


Doping changes the position of Fermi level



DOPING CHANGES THE OPTICAL PROPERTIES OF ML GRAPHENE

Pauli blocking effect



Calculations reveals that both blocking of interband transitions and enhancement of intraband transition due to free carries contributes to the modulation of IR absorption and emissivity. As the Fermi energy increases, IR absorption is suppressed and reflectivity is enhanced.

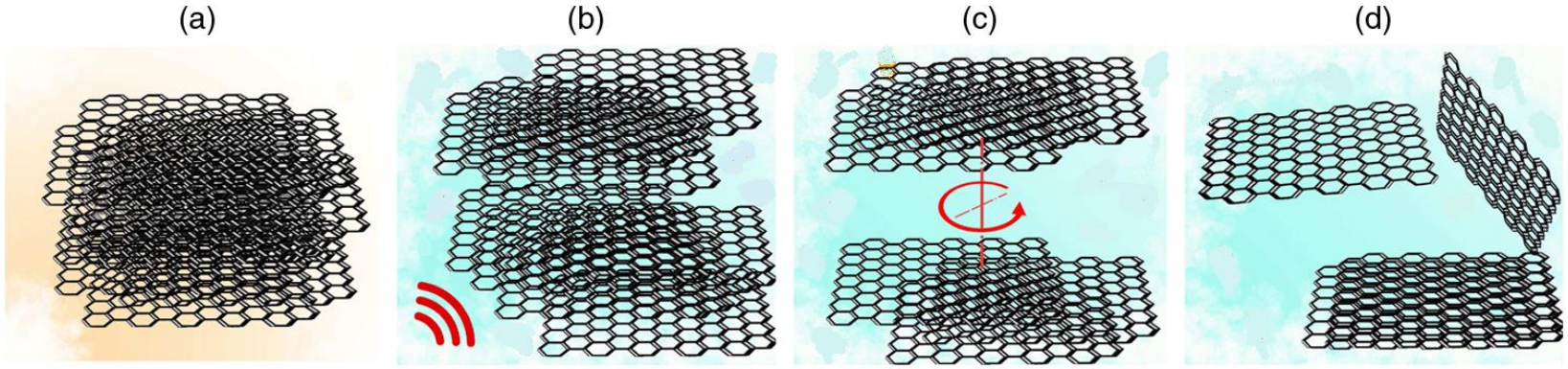
Dielectric permittivity and optical conductivity of graphene

$$\varepsilon(\omega) = \varepsilon \; + i\varepsilon \; = \varepsilon \; + i\frac{4\pi}{} \sigma(\omega)$$

$$\sigma_d = \frac{e_2 E_F N}{\pi\hbar(\gamma - i\omega)}$$

$$(\mathrm{Re}(\sigma_{in}) = \frac{\pi e^2 N}{2h}\left[\tanh(\frac{2E_F + \hbar\omega}{4kT}) - \tanh(\frac{2E_F - \hbar\omega}{4kT}\right]$$

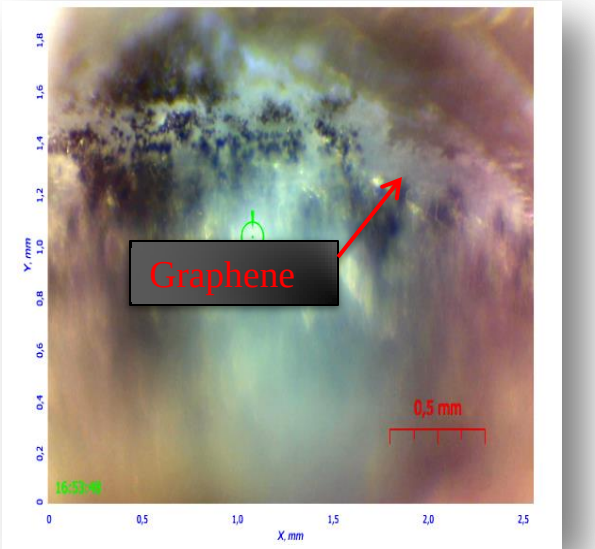
EXFOLIATION IN LIQUID



PICTURES OF THE OBTAINED FILMS

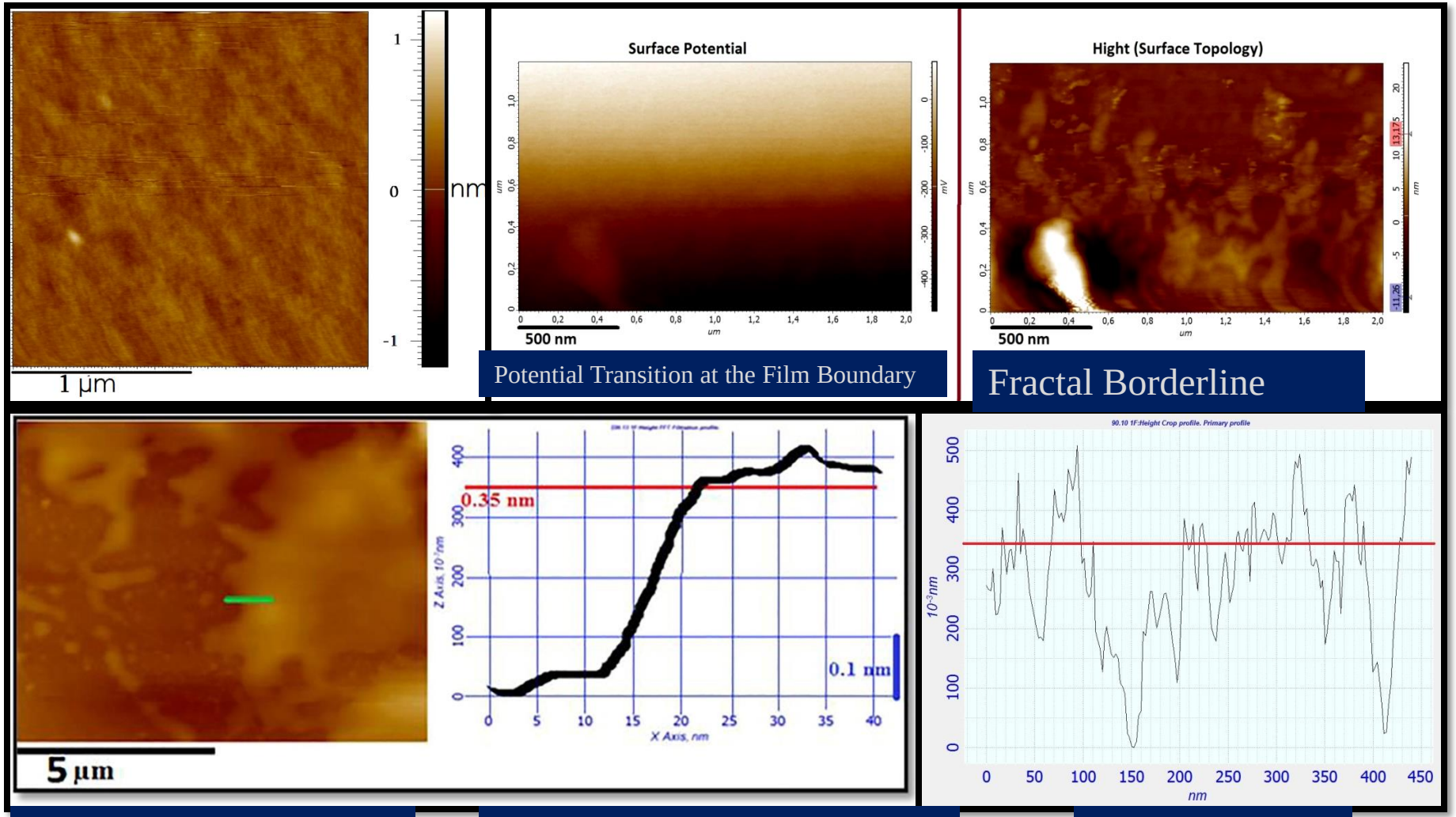
Graphene on liquid surface

Only due to the reflection of light from their surface, graphene layers are noticeable (in both cases).



Graphene on silicon surface, under USB microscope

AFM Study



Potential Transition at the Film Boundary

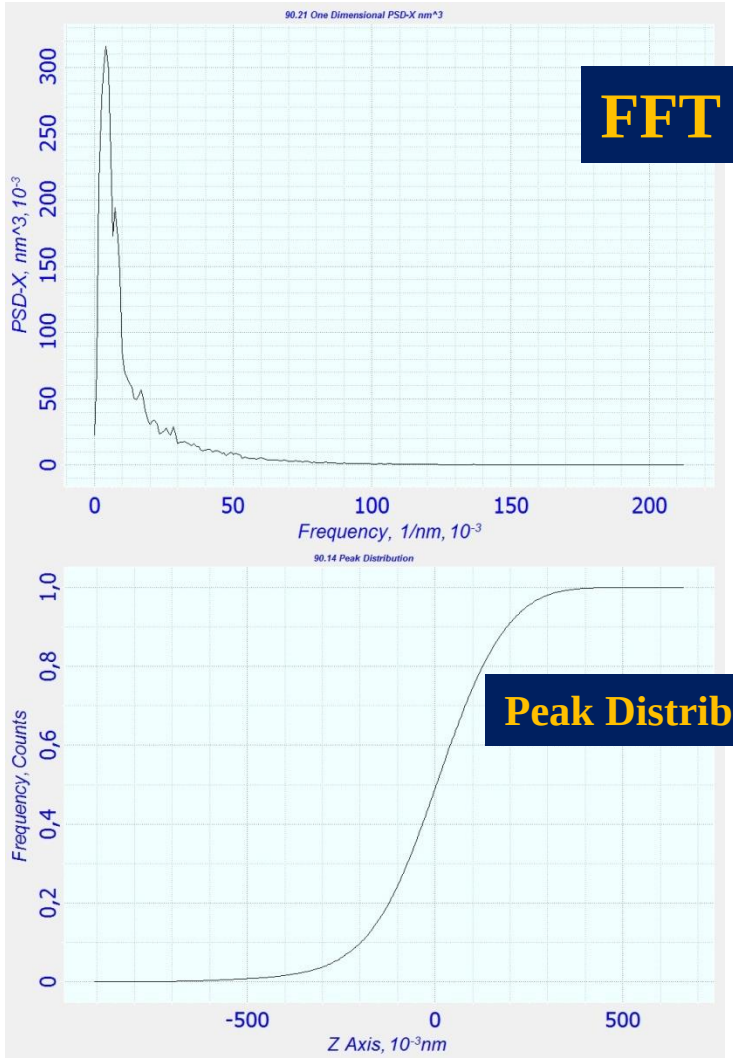
Fractal Borderline

Line Scan Direction

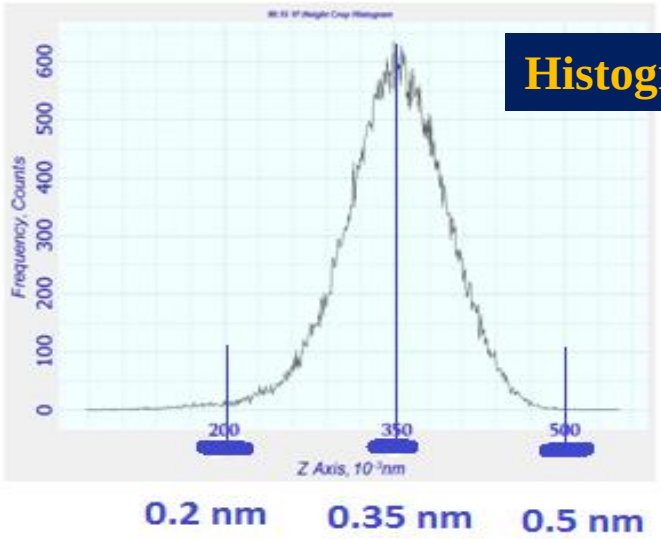
Layer Thickness Estimation

Line Scan

AFM Image Analysis



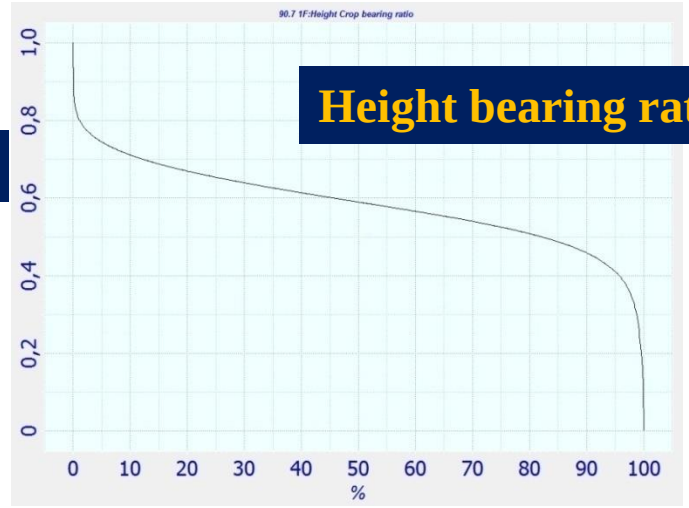
FFT



Histogram

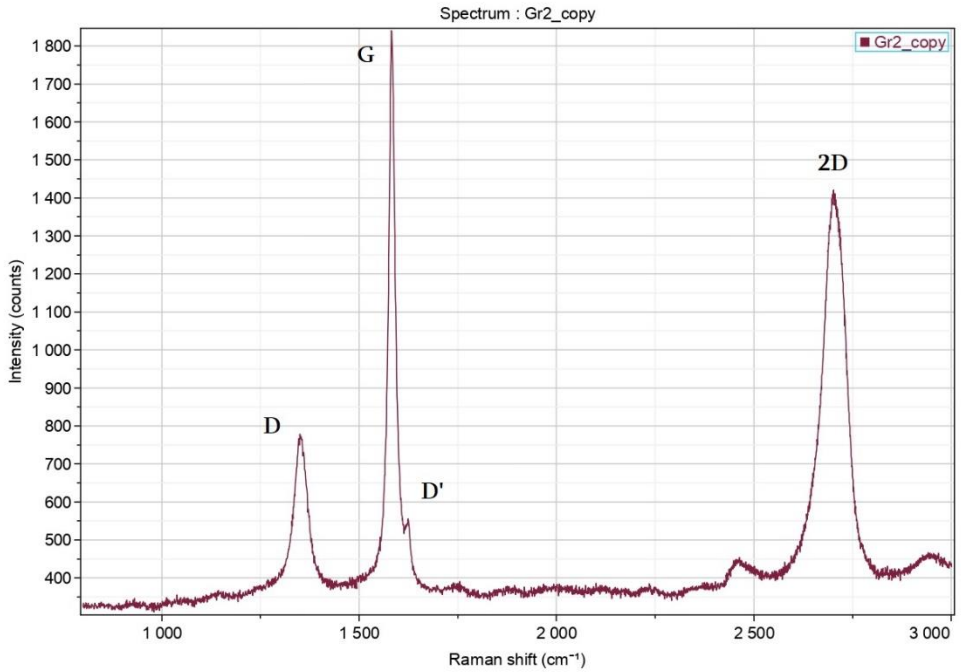
0.2 nm 0.35 nm 0.5 nm

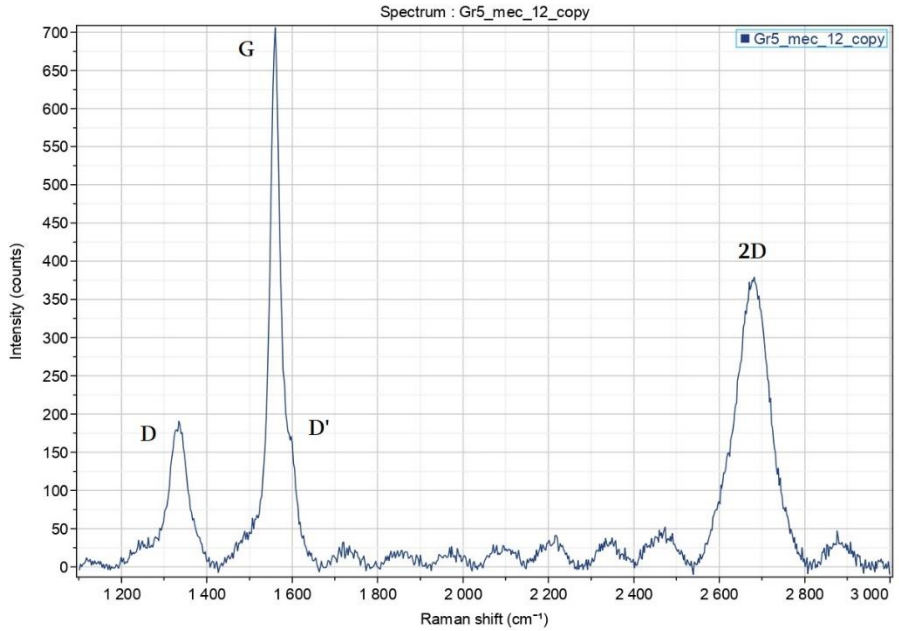
Peak Distribution

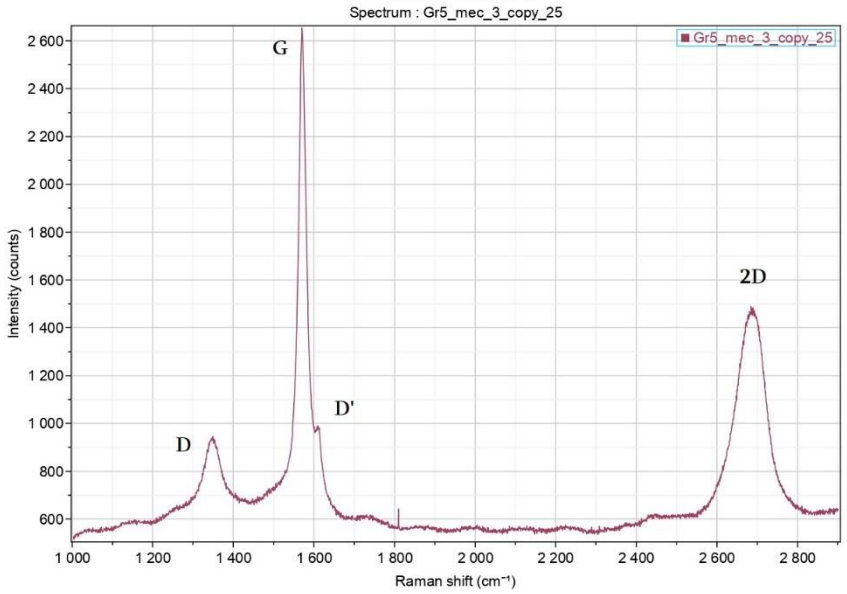


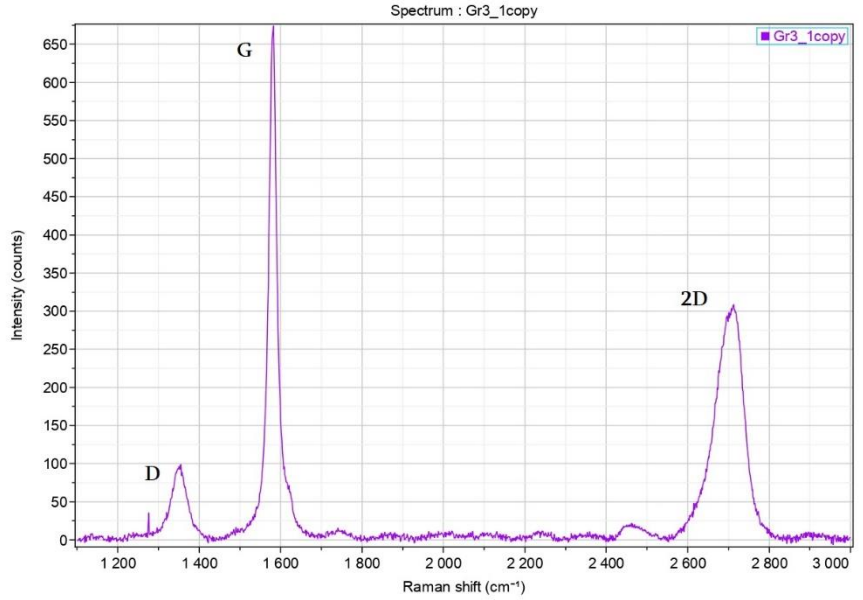
Height bearing ratio

RAMAN SPECTROSCOPY

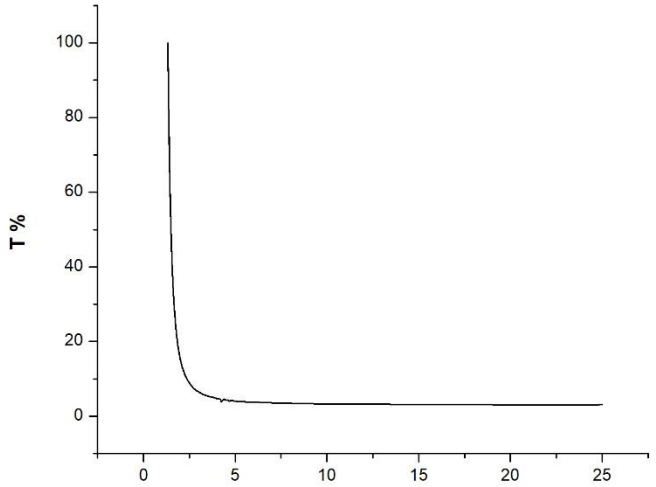


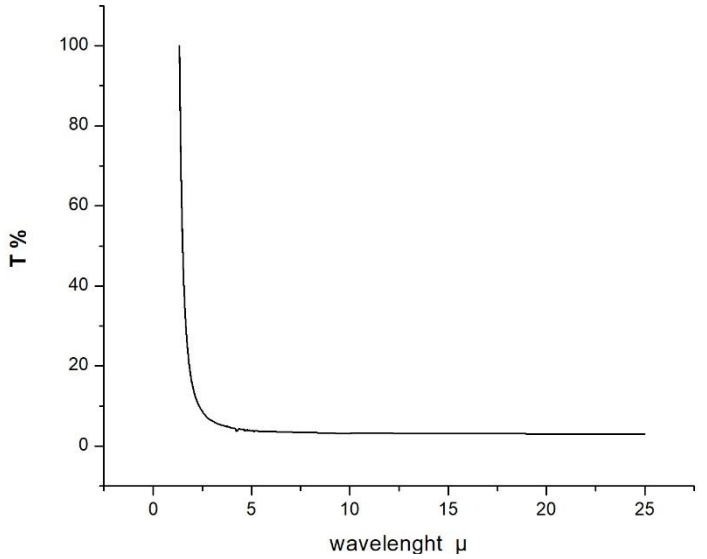


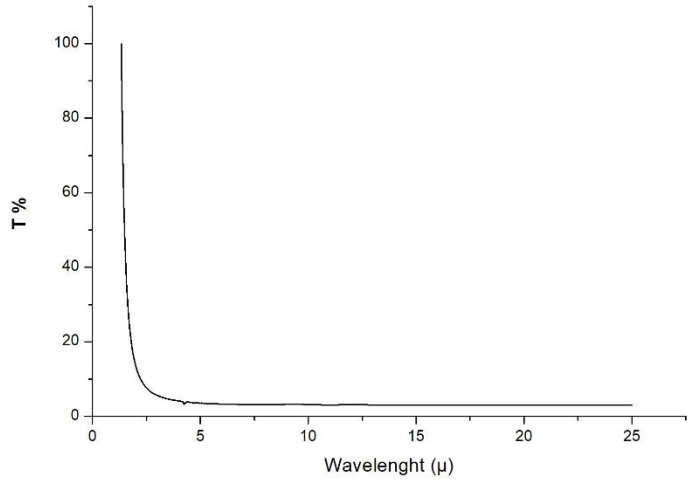


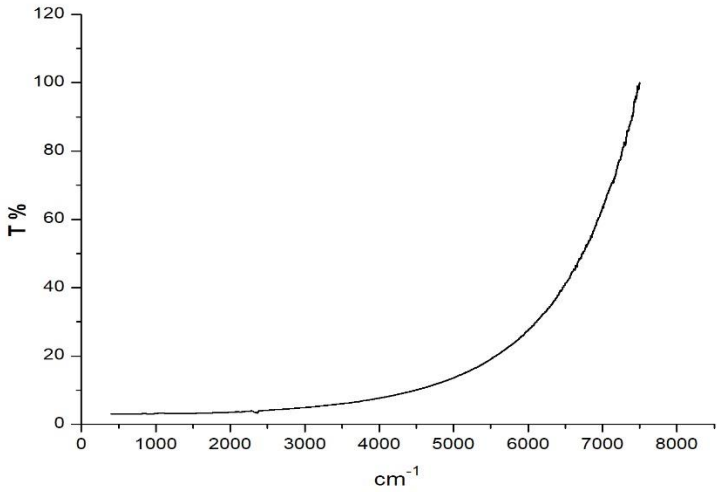


IR TRANSPARENCY









THANK YOU !