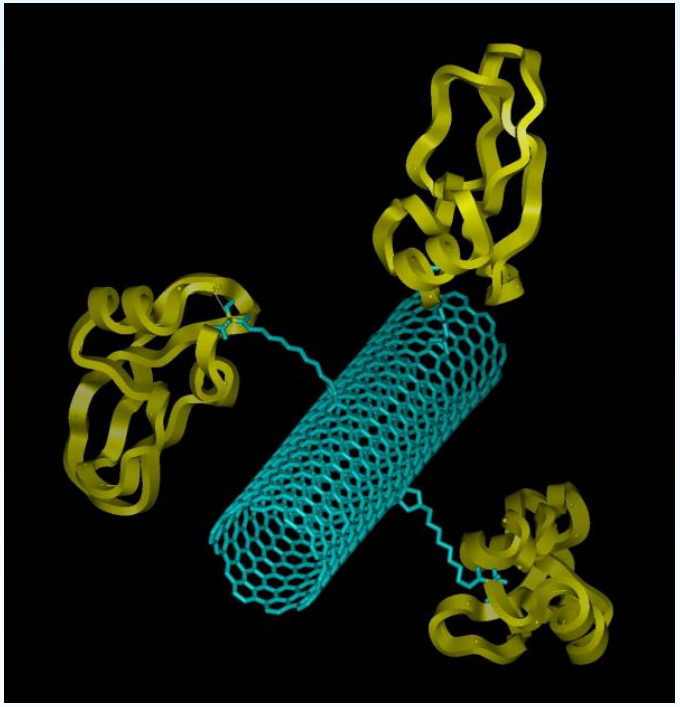
Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Lab of Nanomaterials Synthesis



Dimitrios Tasis

Department of Chemistry

University of Ioannina

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Research interests

-Multifunctional polymer-based composite materials

-Colloidal stability of either carbon-based or inorganic nanomaterials

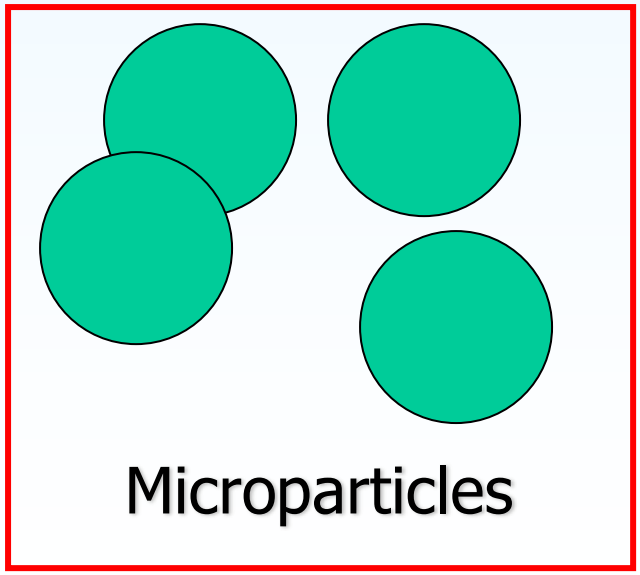
-Chemical functionalization/doping of nanomaterials

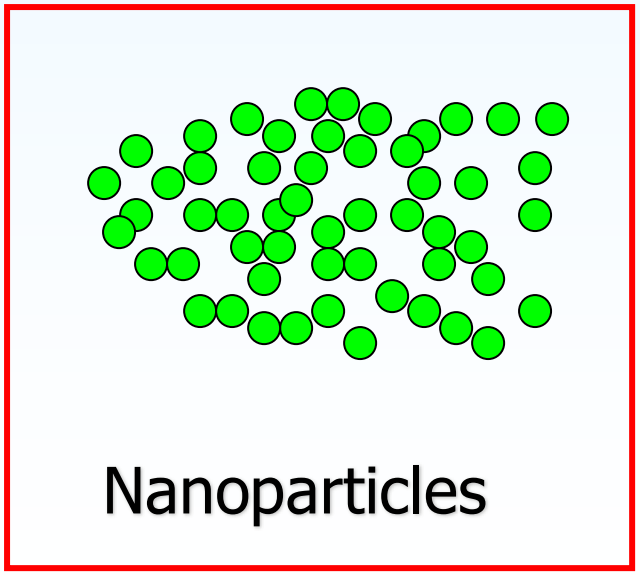
- Nanomaterial assemblies as components in energy conversion applications

Why Nanocomposites?

Size does matter

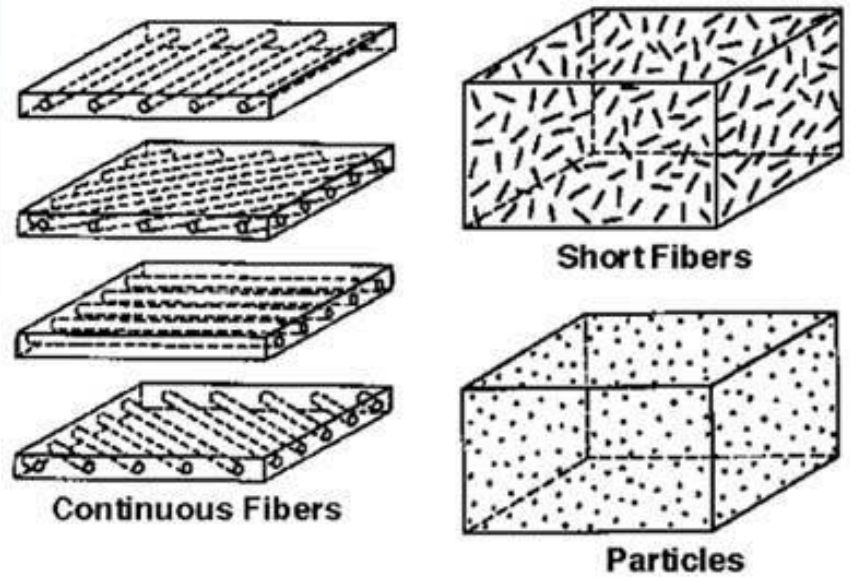
Increased surface area on nanoparticles



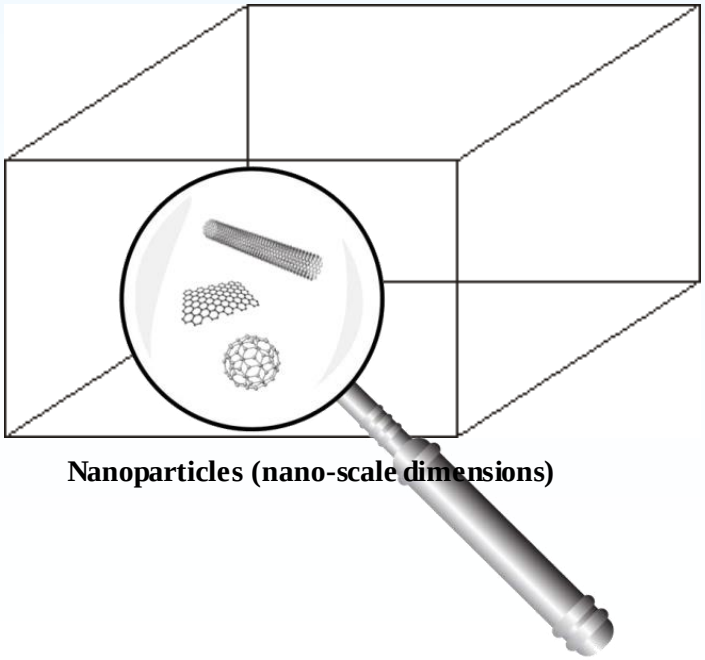


Polymers as matrix for composite materials

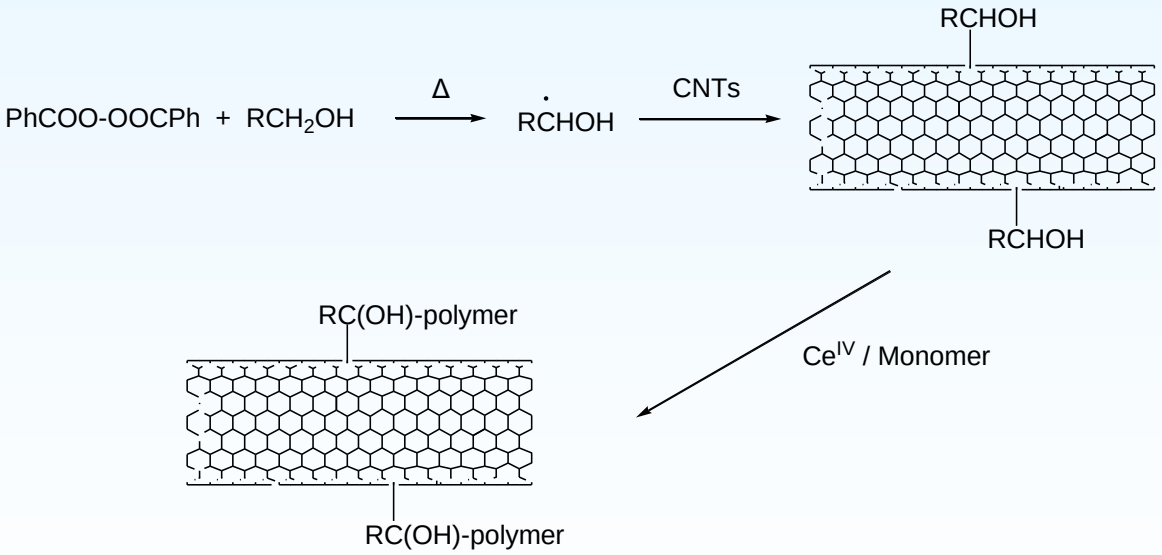
From macro-composites…



…to nano-composites



Polymer grafting onto CNTs by in situ redox radical process



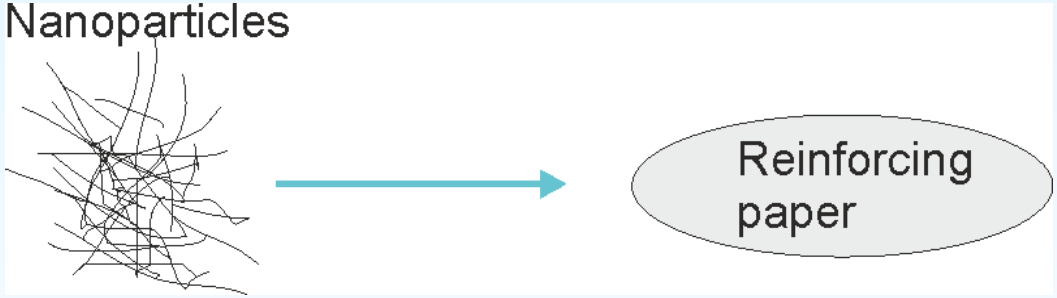
Macromol Rapid Commun 2007

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

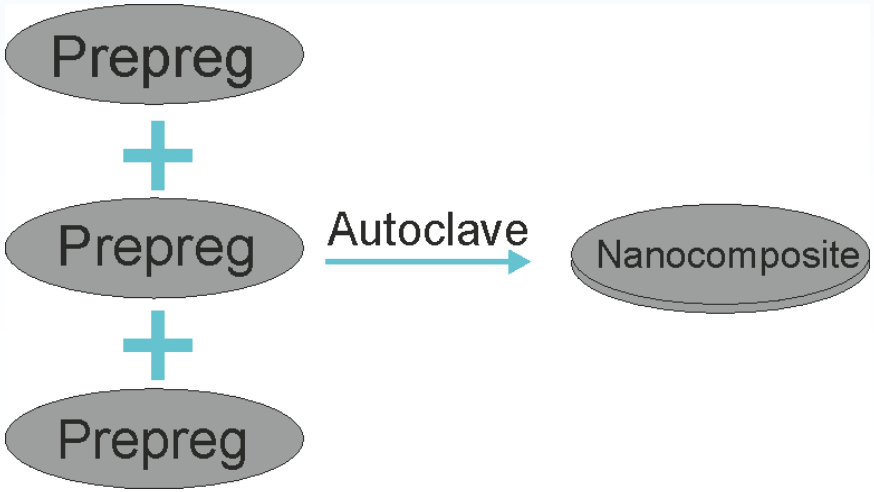
Our approach: The reinforcing paper/prepreg procedure

1. Production of reinforcing paper



2. Production of prepreg

3. Autoclave processing



Production of Reinforcing papers

1. Dispersion of nanoparticles in H_2O by tip sonication

2. Filtration of the suspension under vacuum

3. Drying under hot air

(1)

(2)

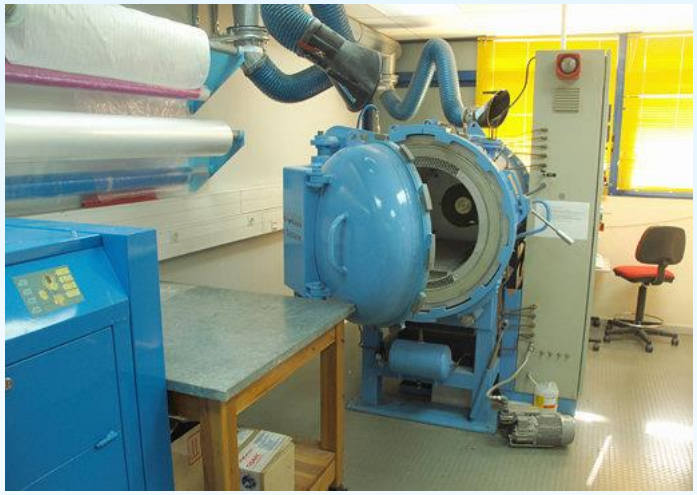
(3)

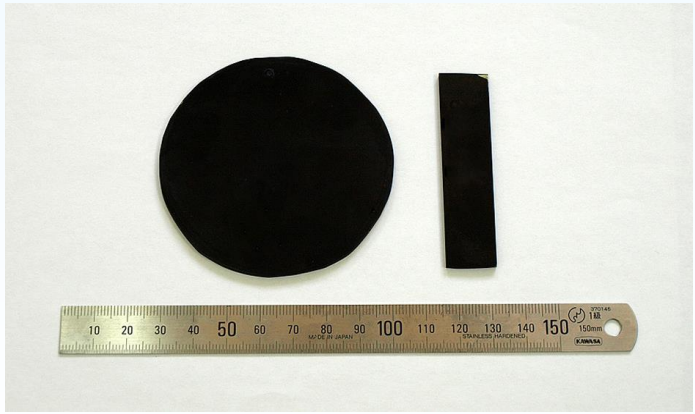
Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Production of nanocomposites

- *Soaking of reinforcing papers into a mixture of epoxy resin*
- *Cooling at refrigerator to form prepregs*
- *Autoclave processing, as in common composites*

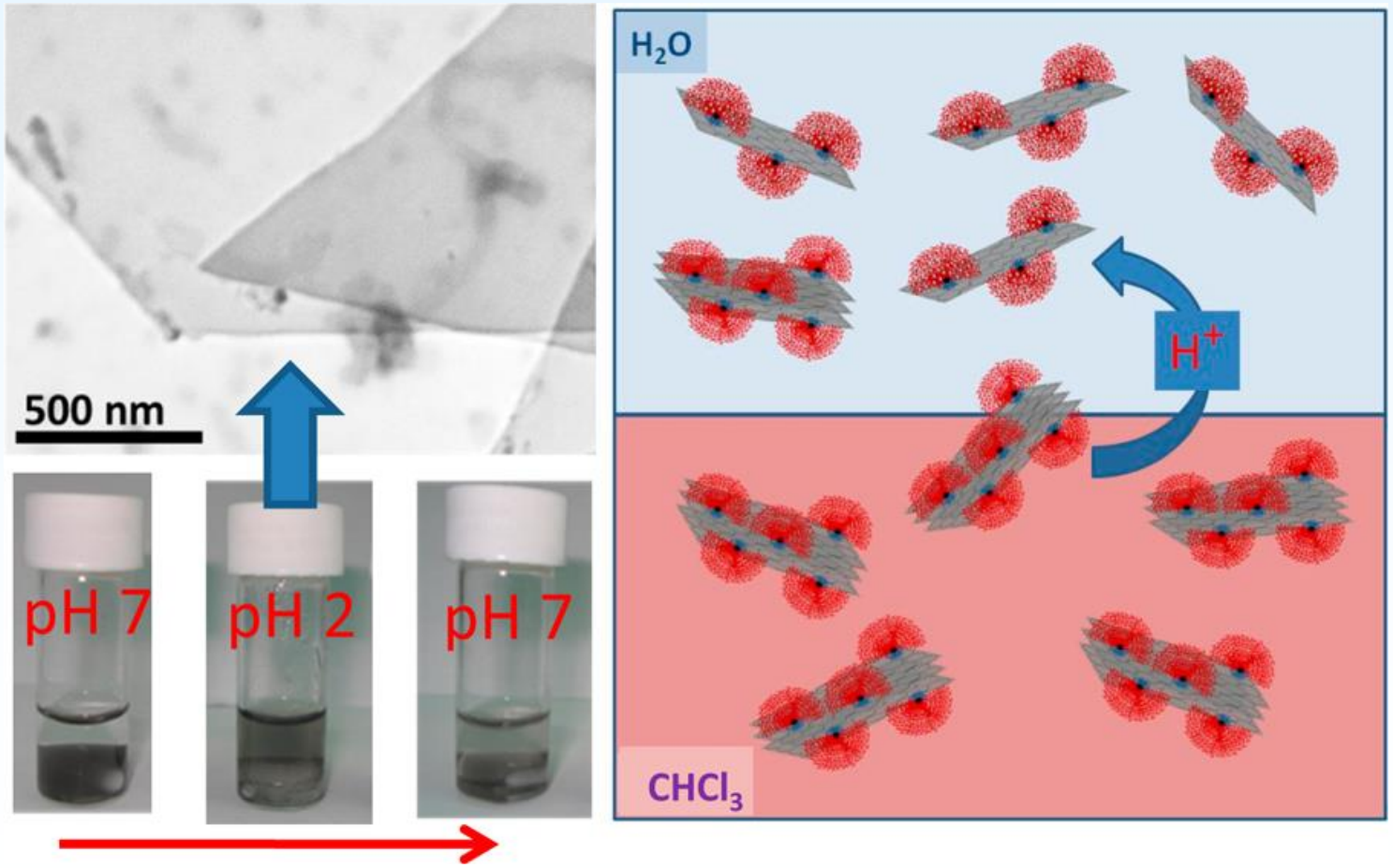




Strength and E values up to 232 ***(82)*** *MPa and 8.4* ***(4.7)*** *GPa, respectively [****flexural tests (tensile tests)****]*

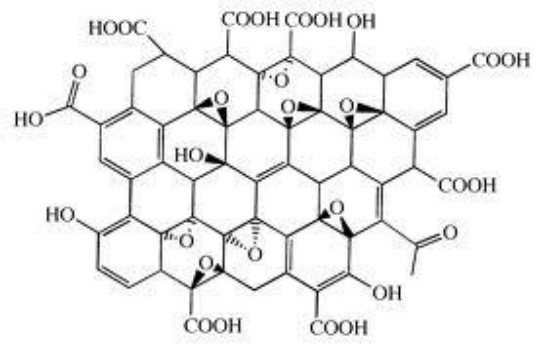
Compos Sci Technol 2013; Chem Engin J 2015; Materials 2020

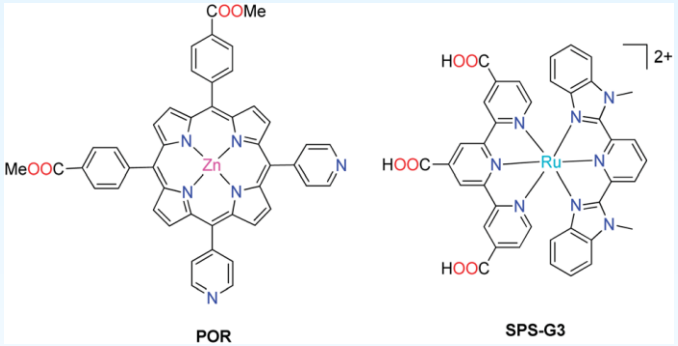
Exfoliation of graphite by noncovalent modification

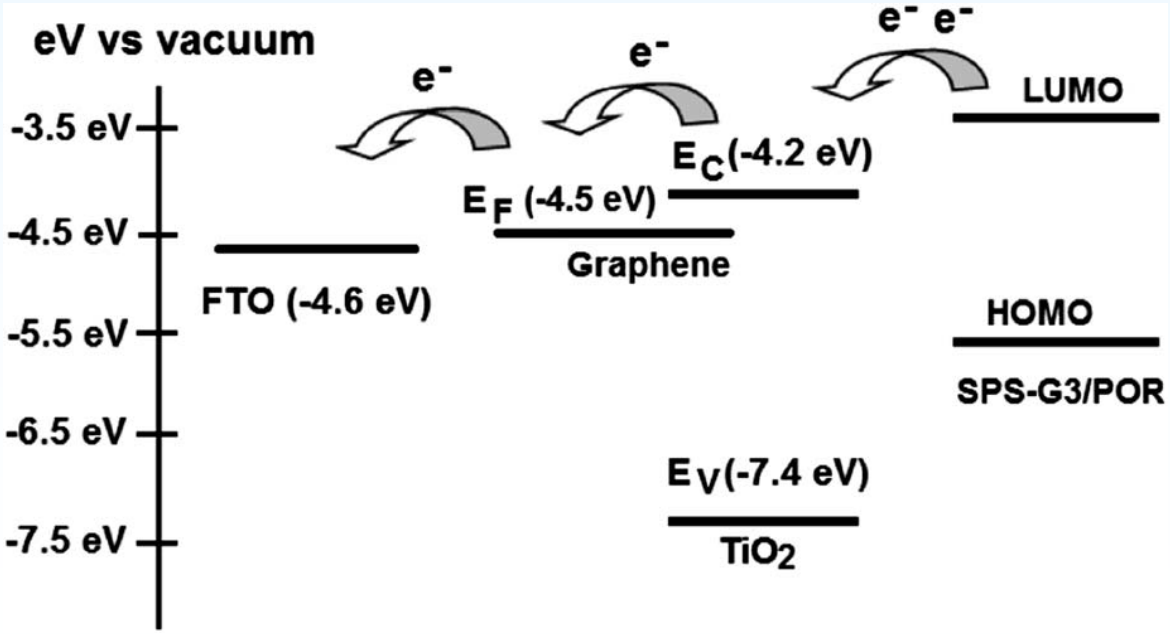


ACS Macro Letters 2014

Development of graphene/TiO_2 photoanodes in DSSCs

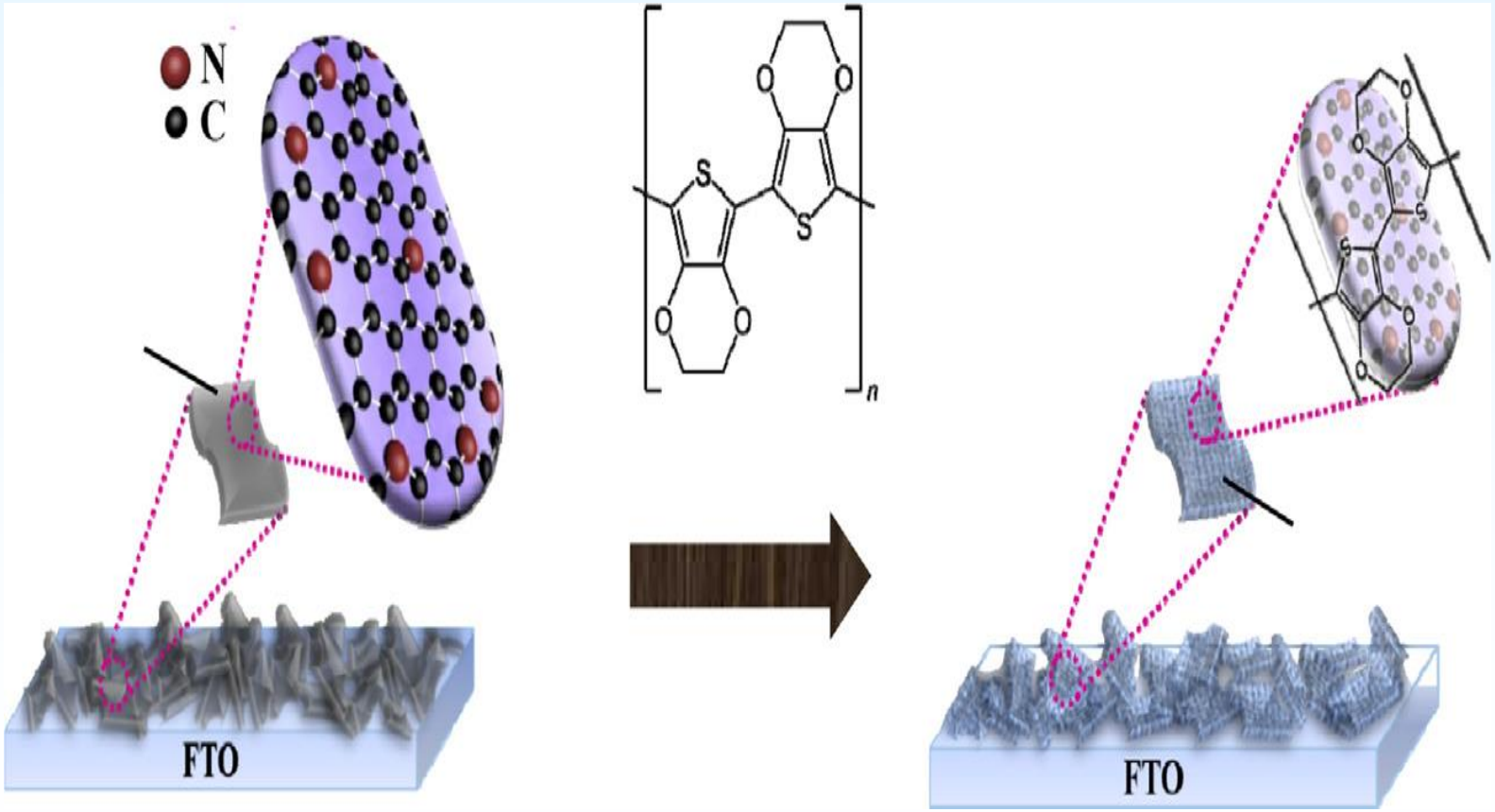






RSC Advances 2013

Development of graphene/PEDOT cathodes in DSSCs

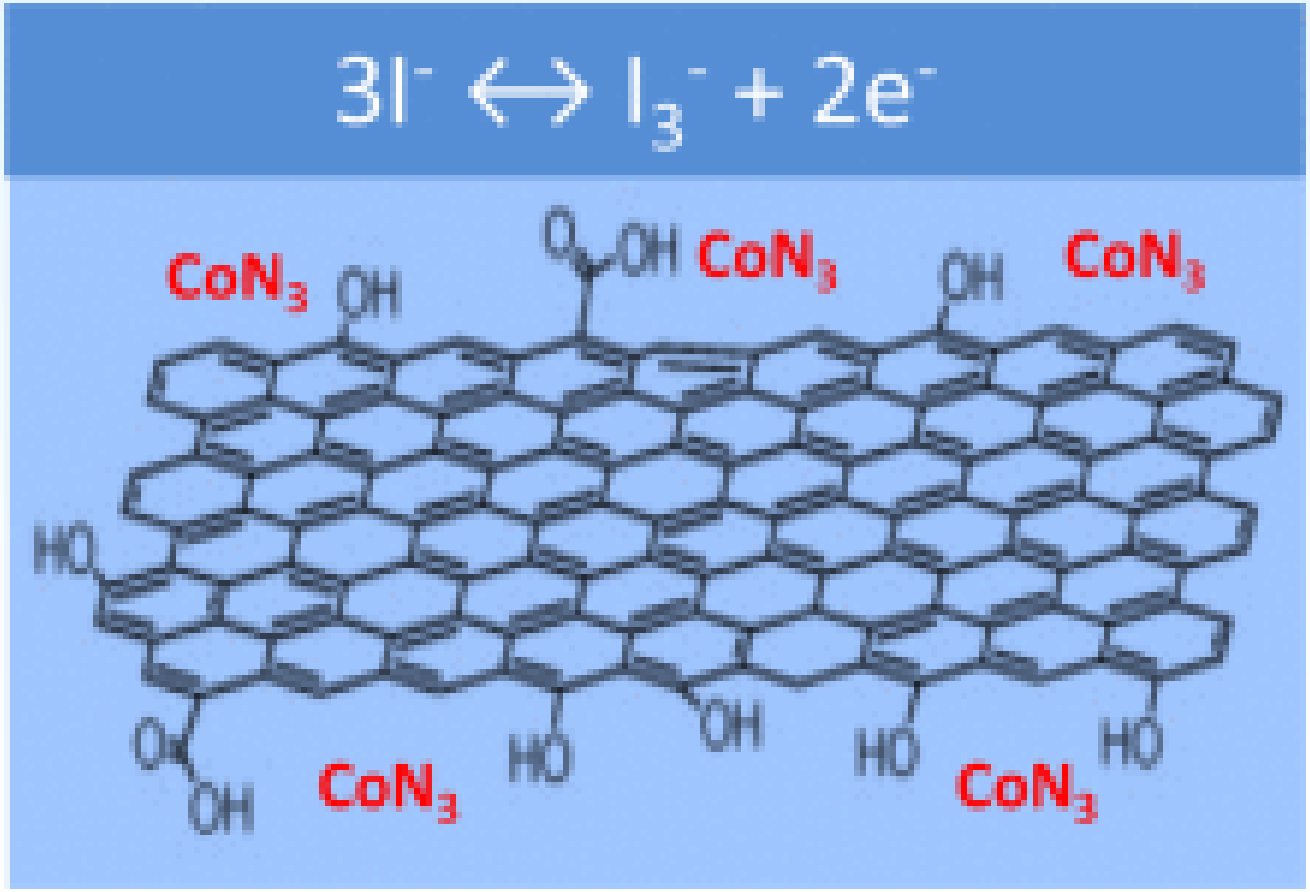


Electrochim Acta 2013; Appl Surf Sci 2017

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

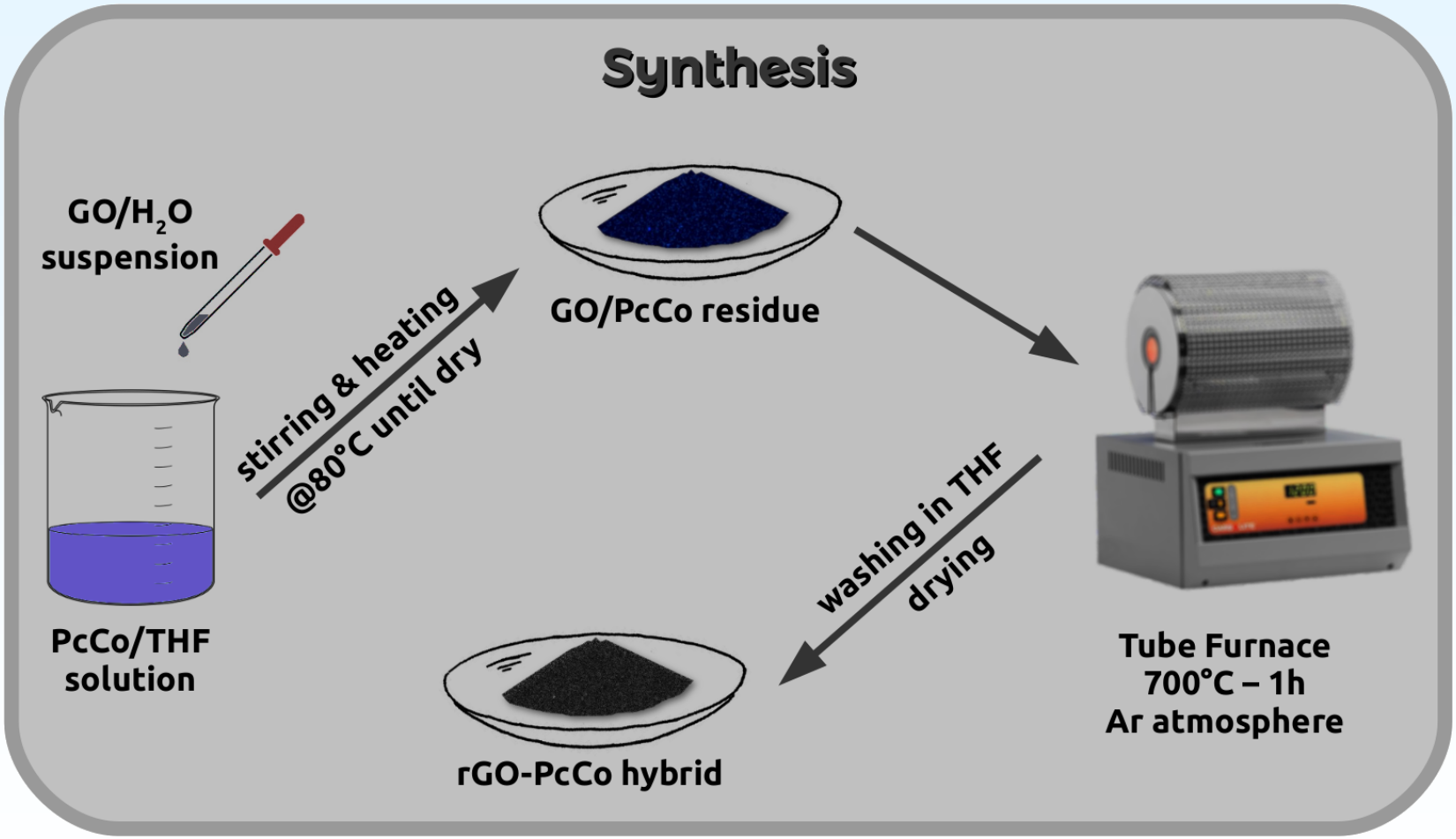
Development of Co-N-doped graphene cathodes in DSSCs



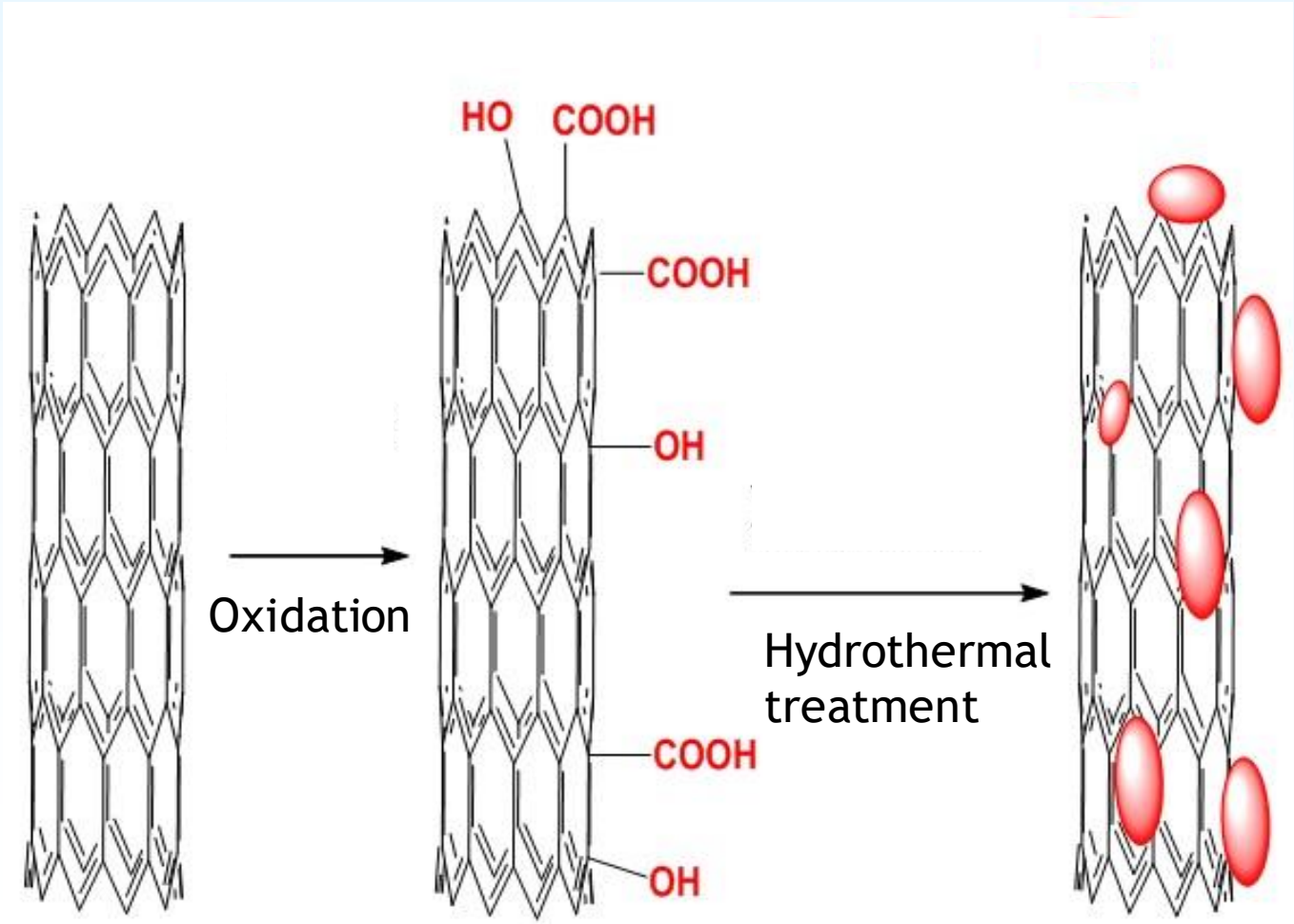
Solar Energy Mater Solar Cells 2016

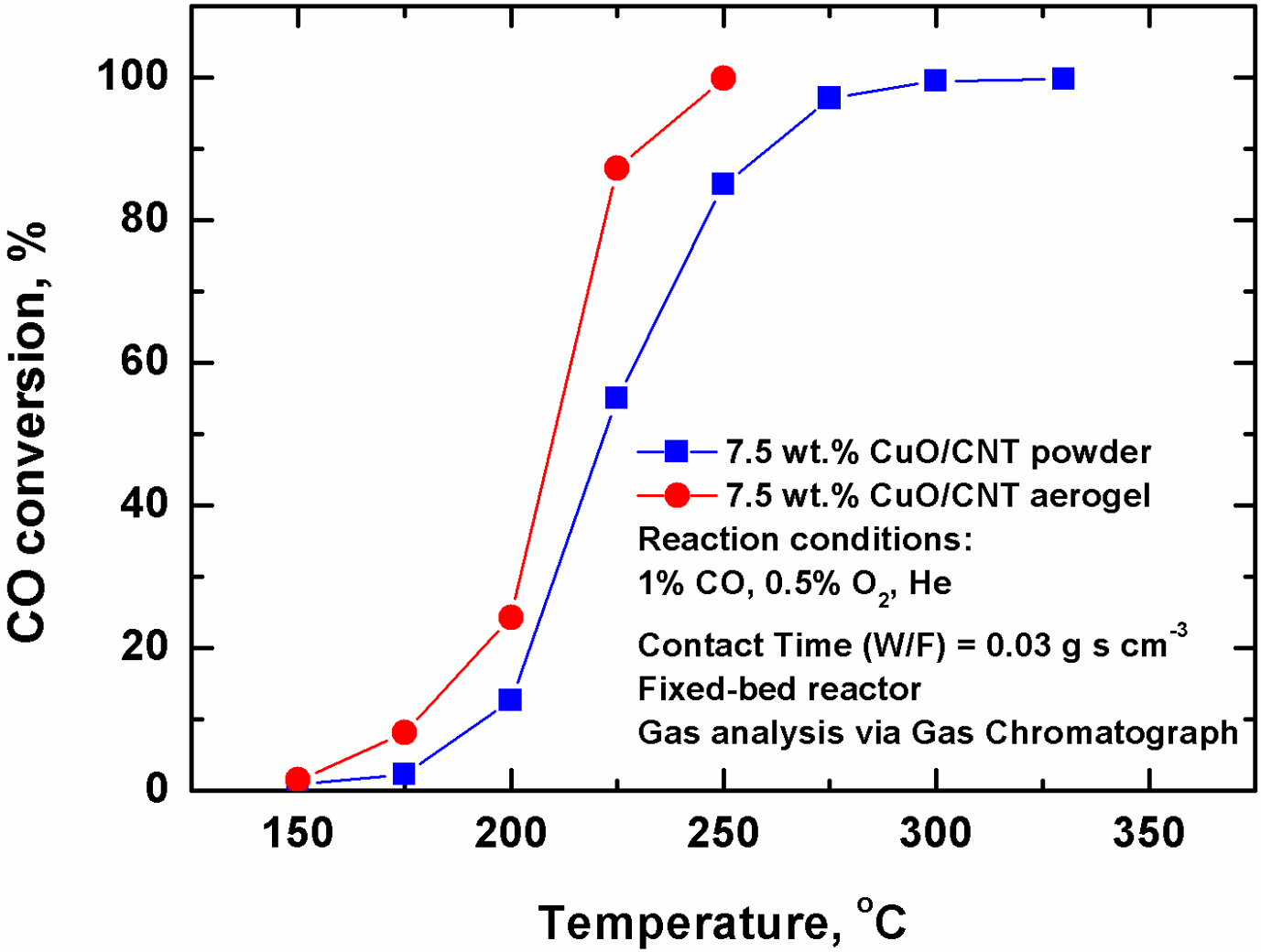
Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ



Hydrothermal synthesis of metal oxide/carbon catalysts

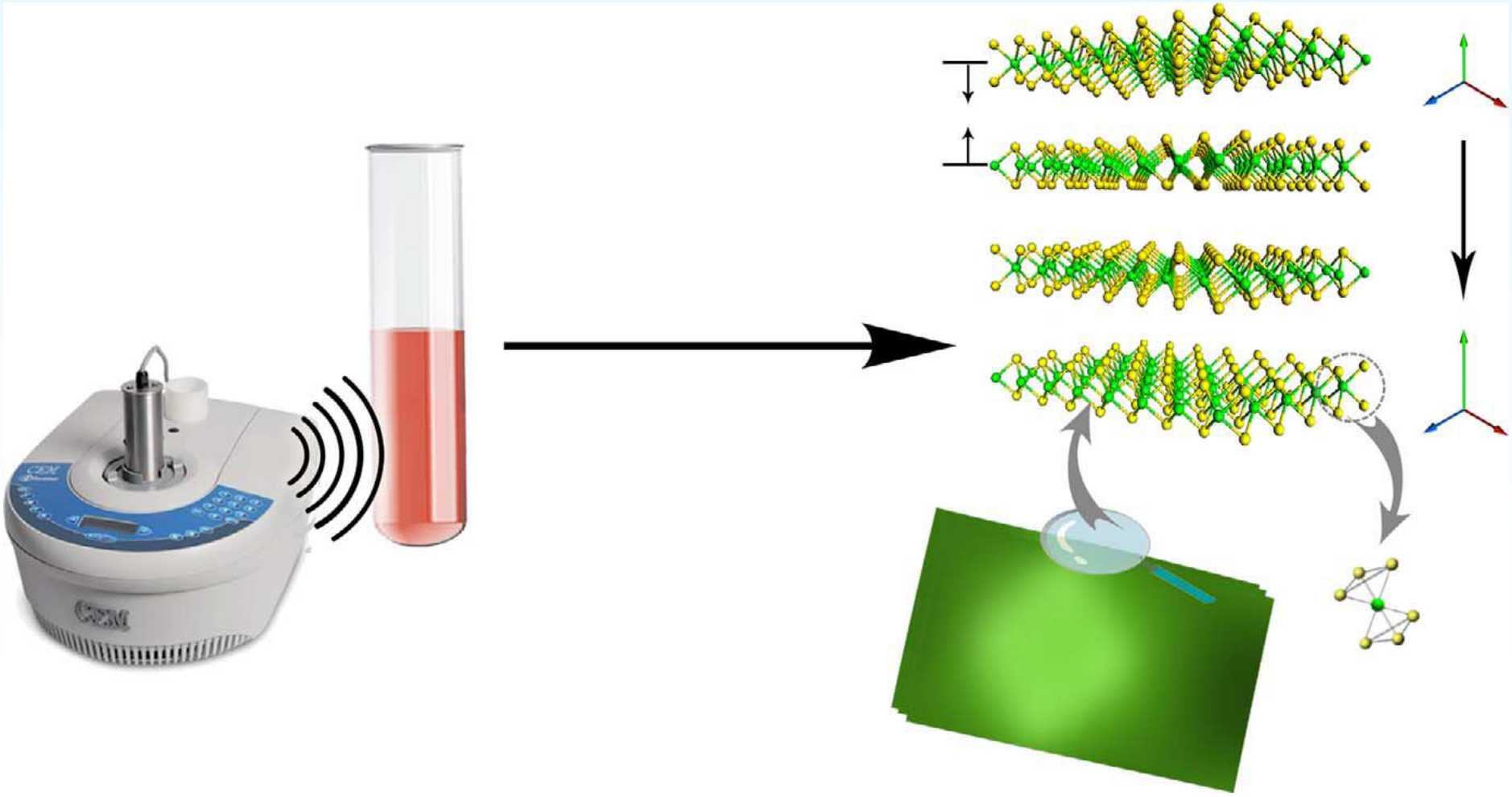



CO conversion, %
100
80
60
40
20
0
150
200
250
300
350
Temperature, °C
7.5 wt.% CuO/CNT powder
7.5 wt.% CuO/CNT aerogel
Reaction conditions:
1% CO, 0.5% O2, He
Contact Time (W/F) = 0.03 g s cm-3
Fixed-bed reactor
Gas analysis via Gas Chromatograph

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Microwave-assisted synthesis of nanostructured materials

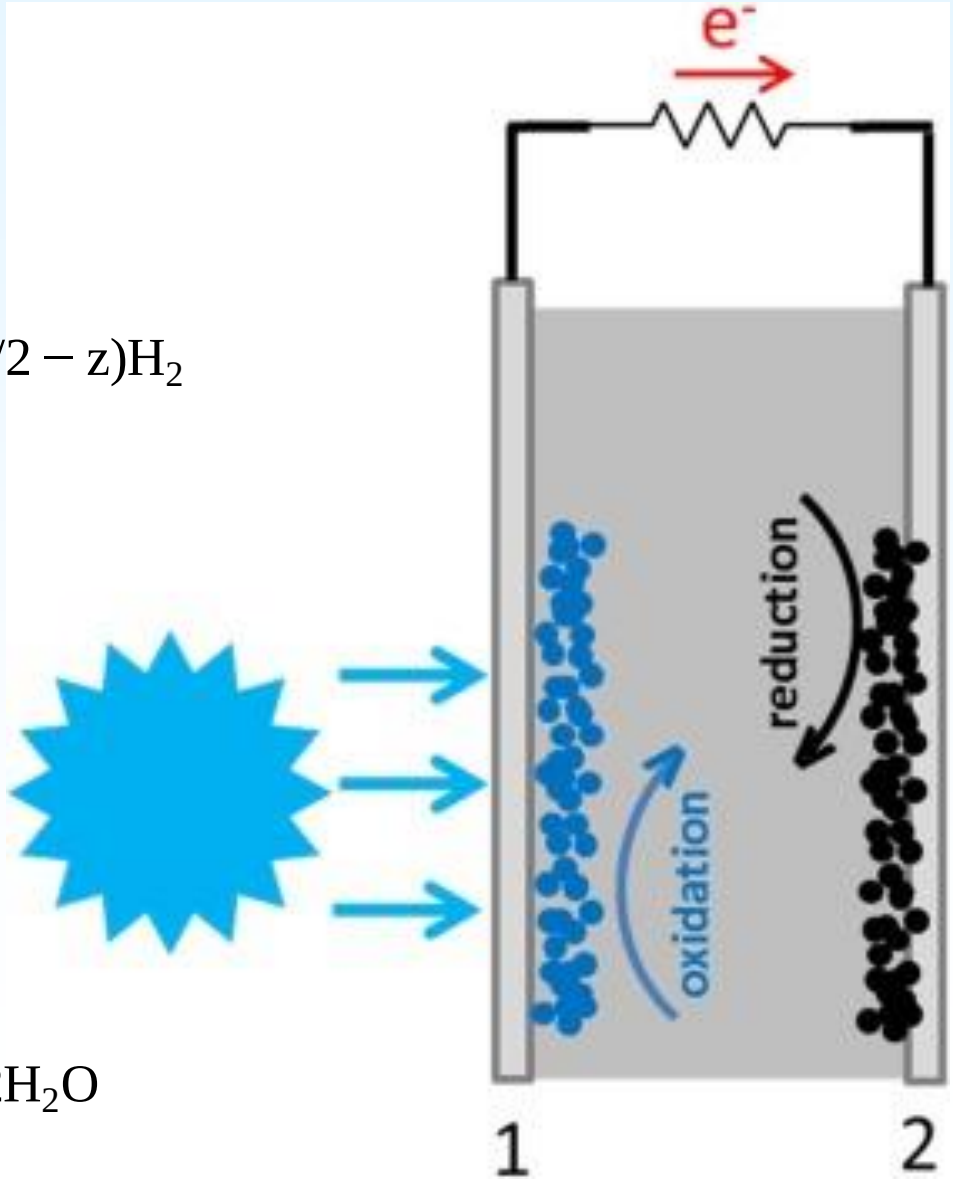


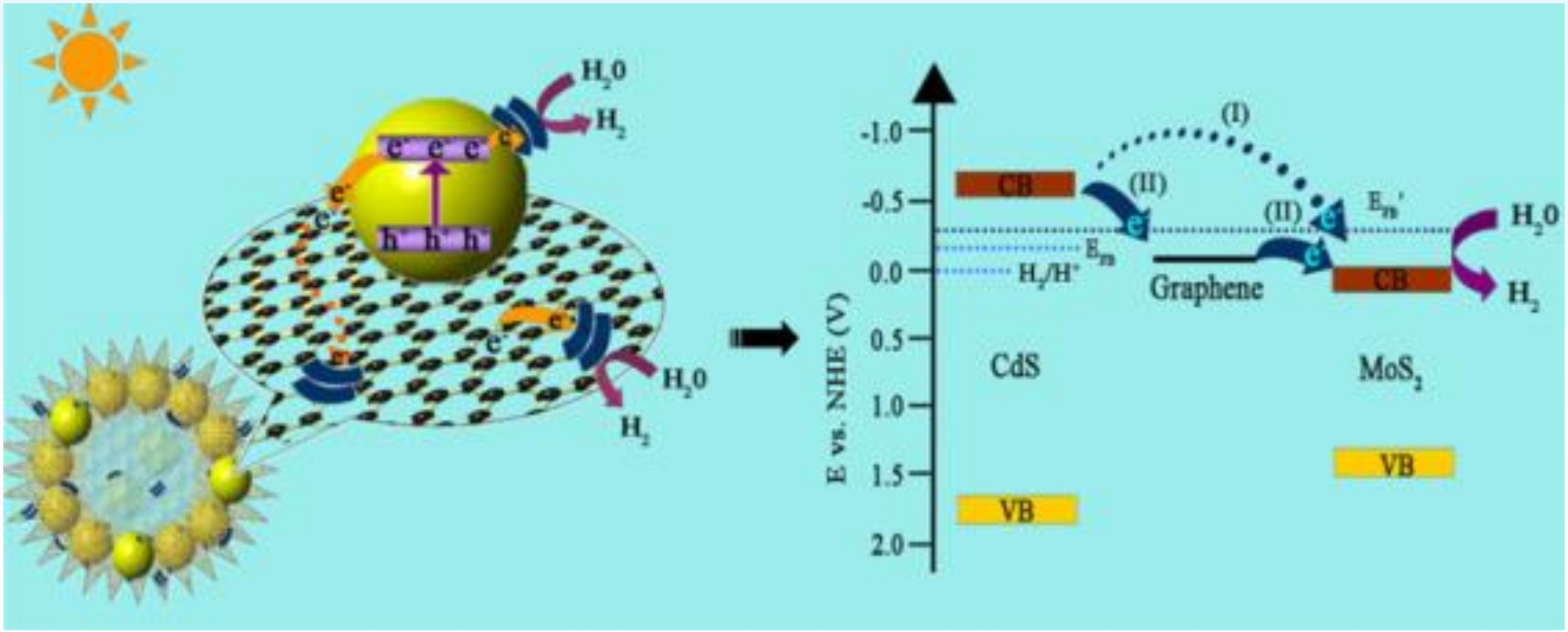
Σε αδρανή ατμόσφαιρα

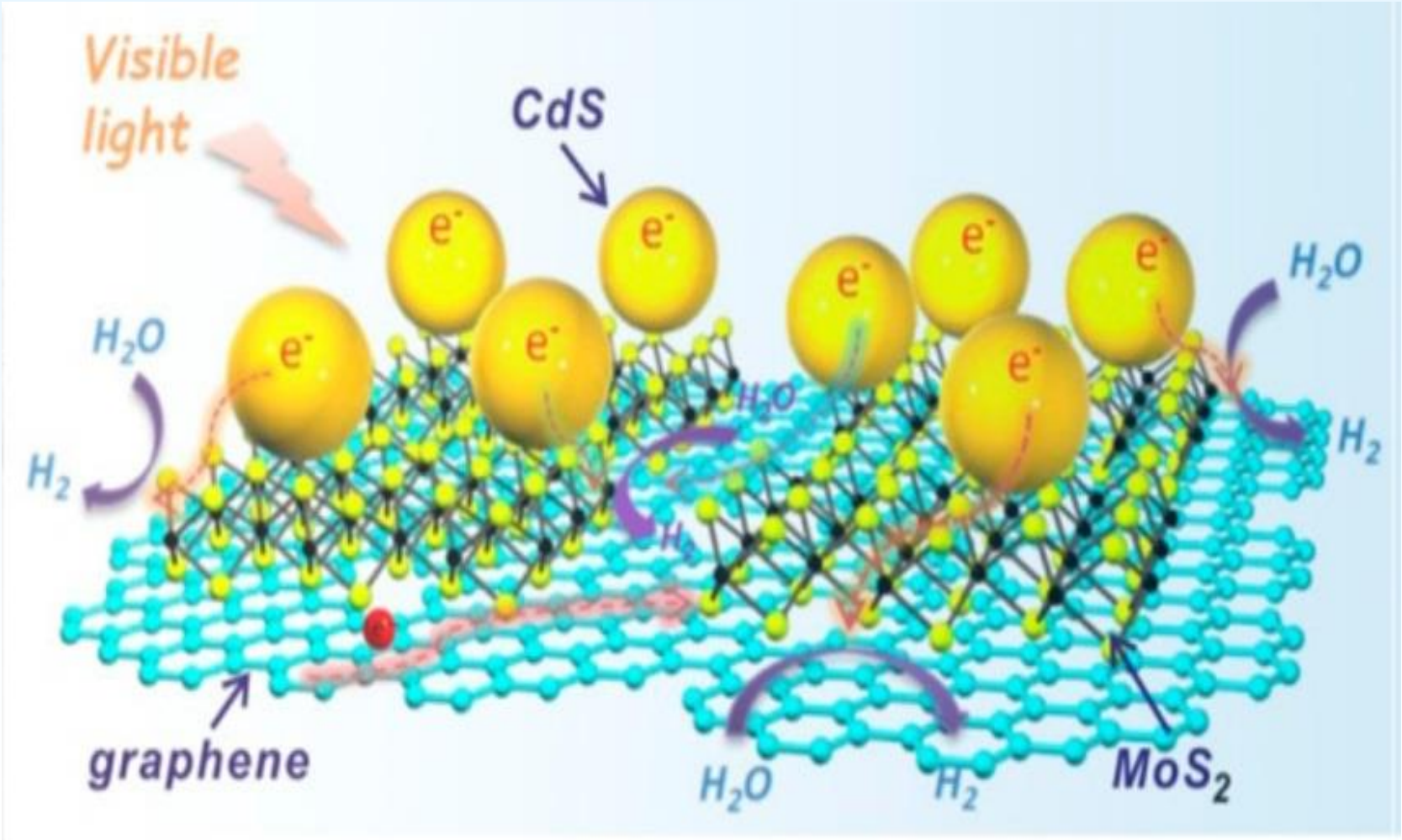
$$C_xH_yO_z + (2x - z)H_2O \rightarrow xCO_2 + (2x + y/2 - z)H_2$$

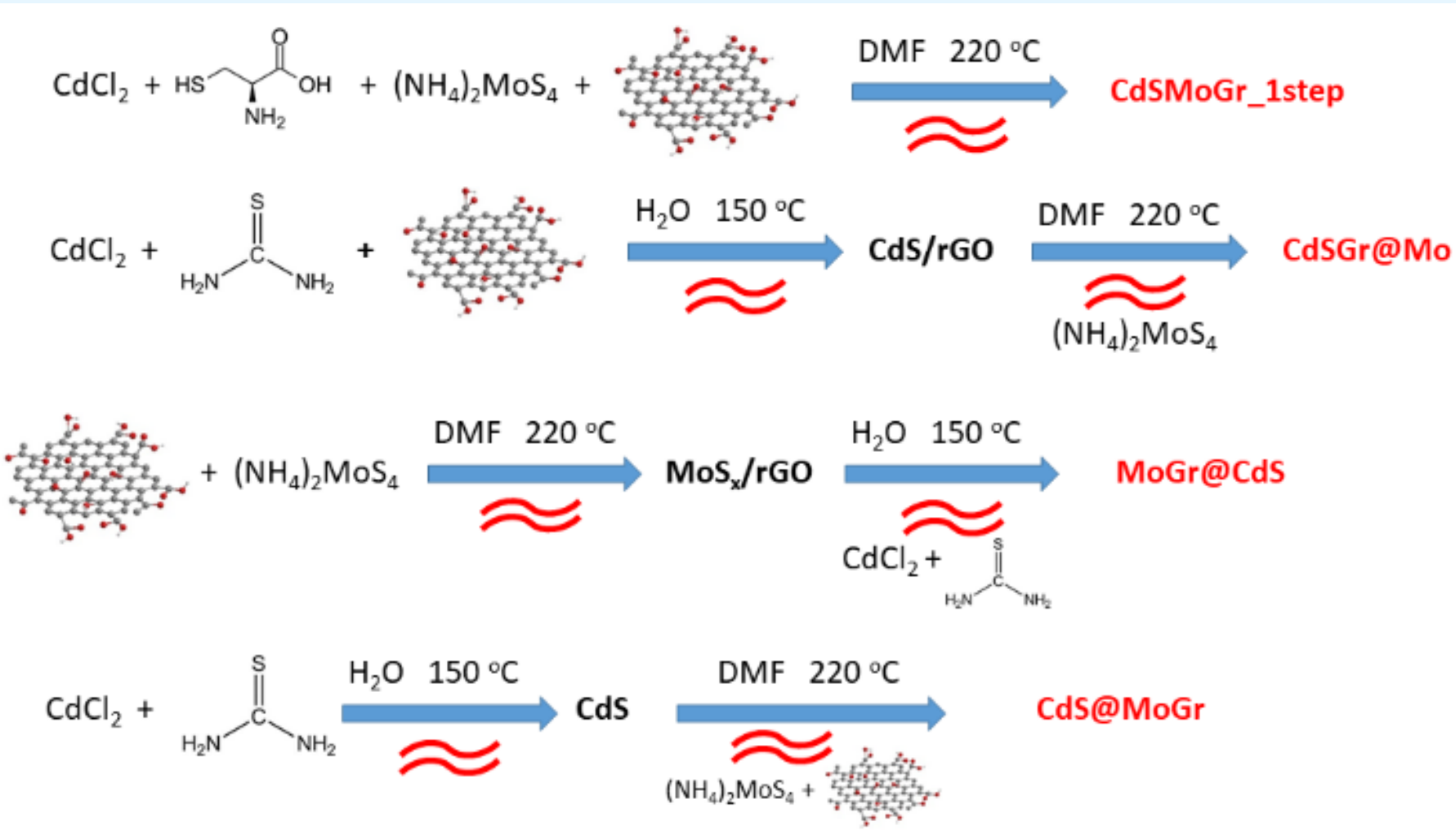
Παρουσία οξυγόνου

$$C_xH_yO_z + (x + y/4 - z/2)O_2 \rightarrow xCO_2 + y/2H_2O$$




H_2O
H_2
e⁻ e⁻ e⁻
h⁺ h⁺ h⁺
H_2O
H_2
E vs. NHE (V)
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
CB
VB
(I)
(II)
(II)
E_{fn}
E_{fn}'
H_2/H^+
Graphene
CdS
MoS_2
CB
VB
H_2O
H_2

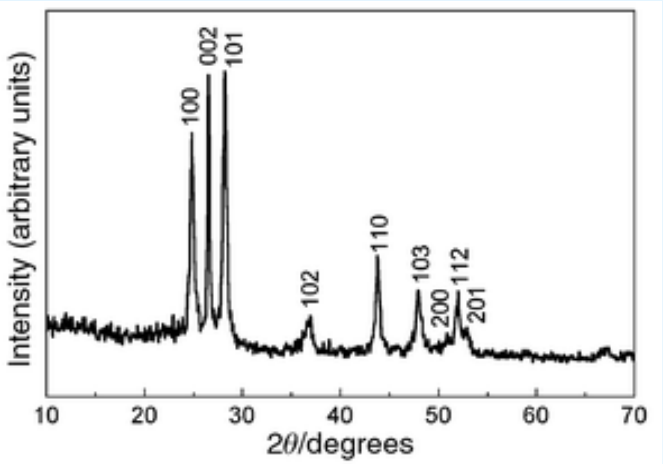

Visible light
CdS
e⁻
H₂O
H₂
graphene
MoS₂

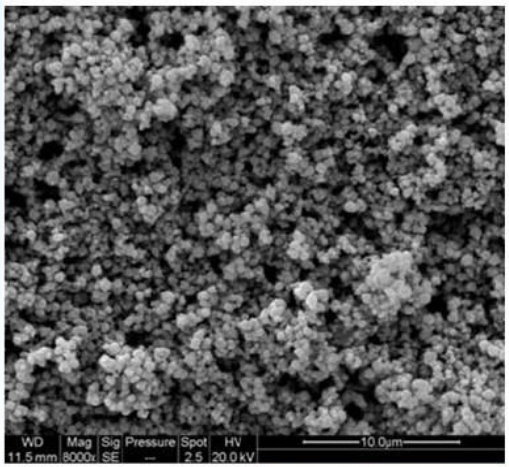


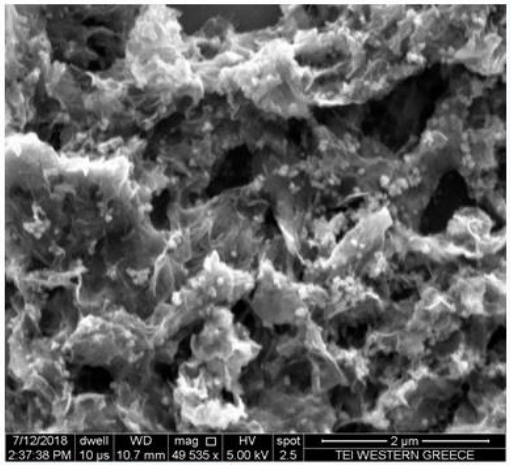
Chem Eur J 2020

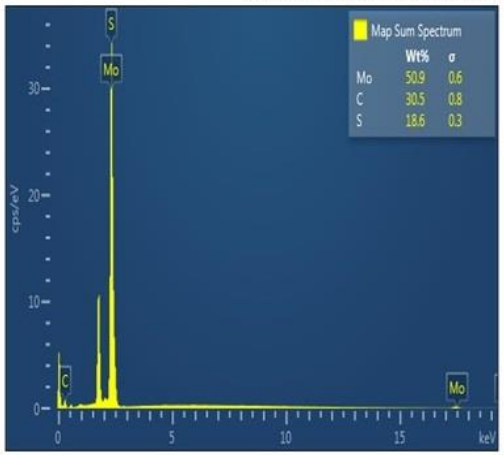
Πανεπιστήμιο Ιωαννίνων

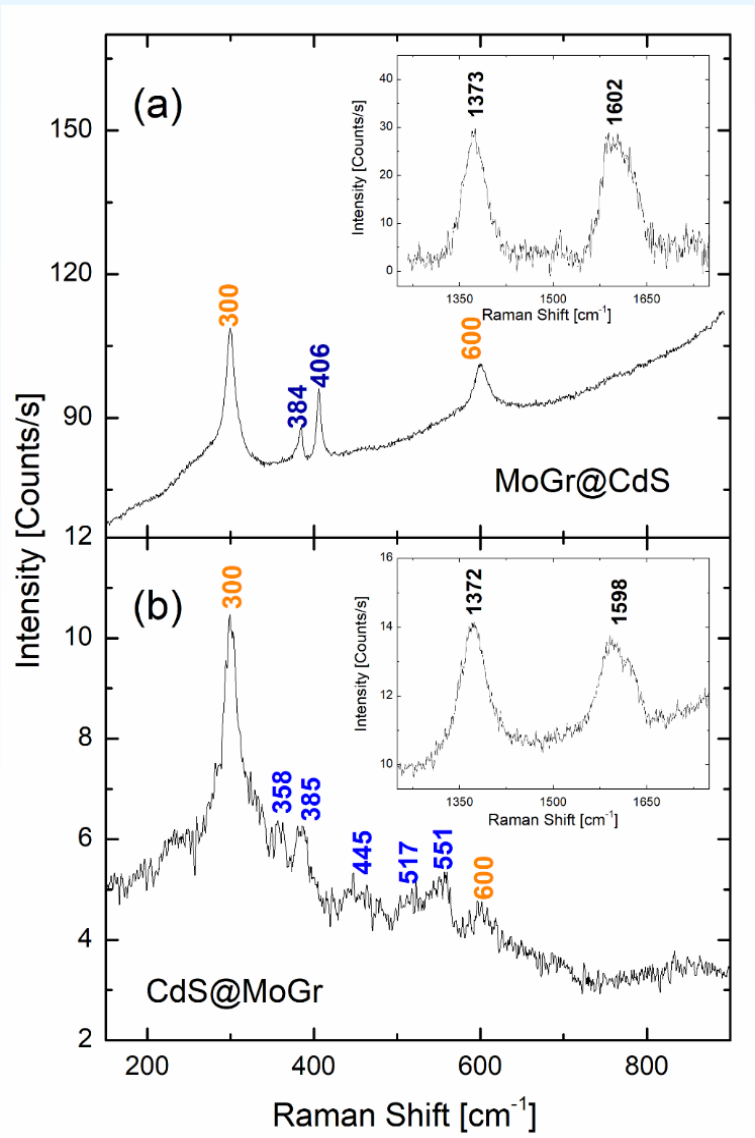
ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

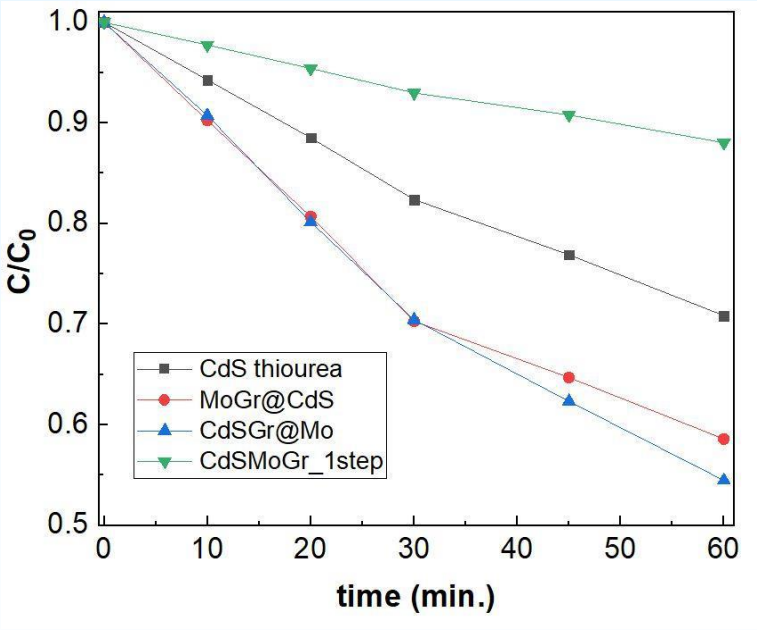












Synthesis of neat CdS nanoparticles by conventional heating was performed within 24 h, whereas in our case, **10 min** was the duration time.

Concerning the synthetic protocols of CdS-based hybrids by conventional heating, only in two cases the duration time was 12h, in total.

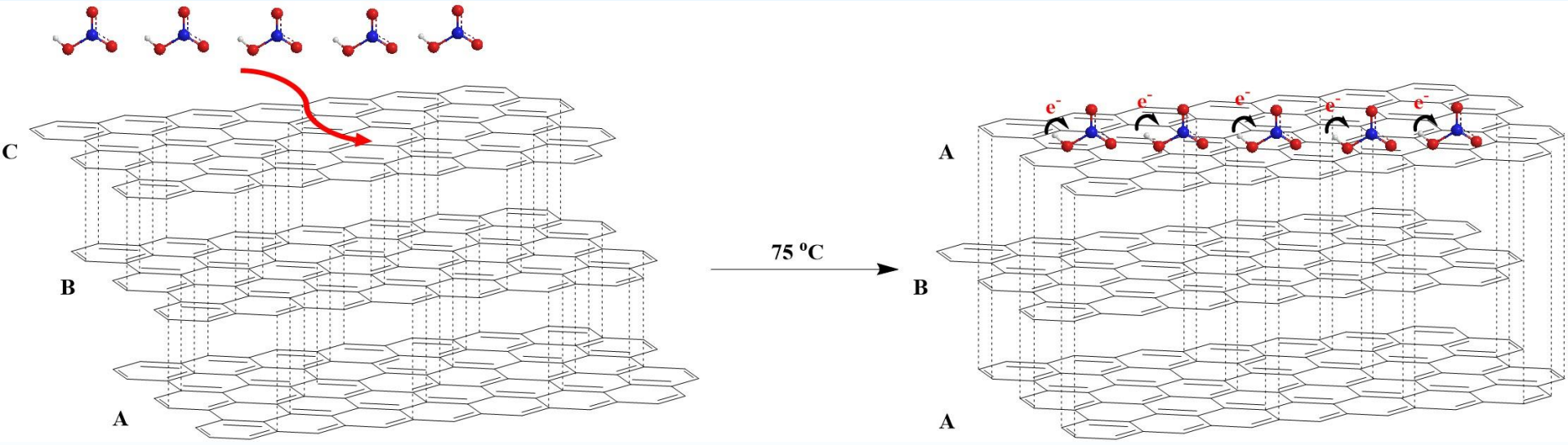
In the remaining examples, the total time ranged between 26 h and 51 h.

In our microwave-assisted process, the total reaction time was **2h10min**.

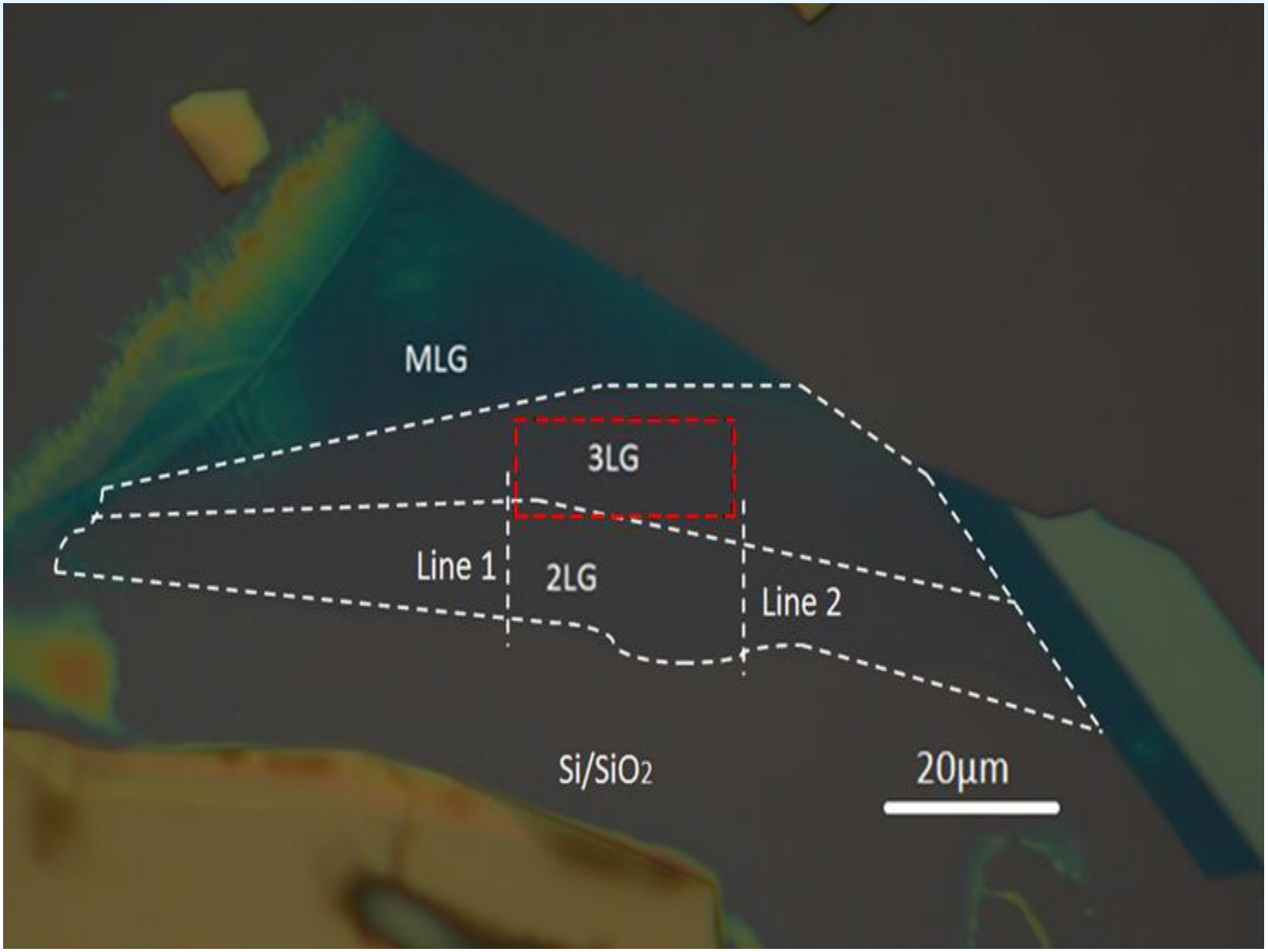
Πανεπιστήμιο Ιωαννίνων

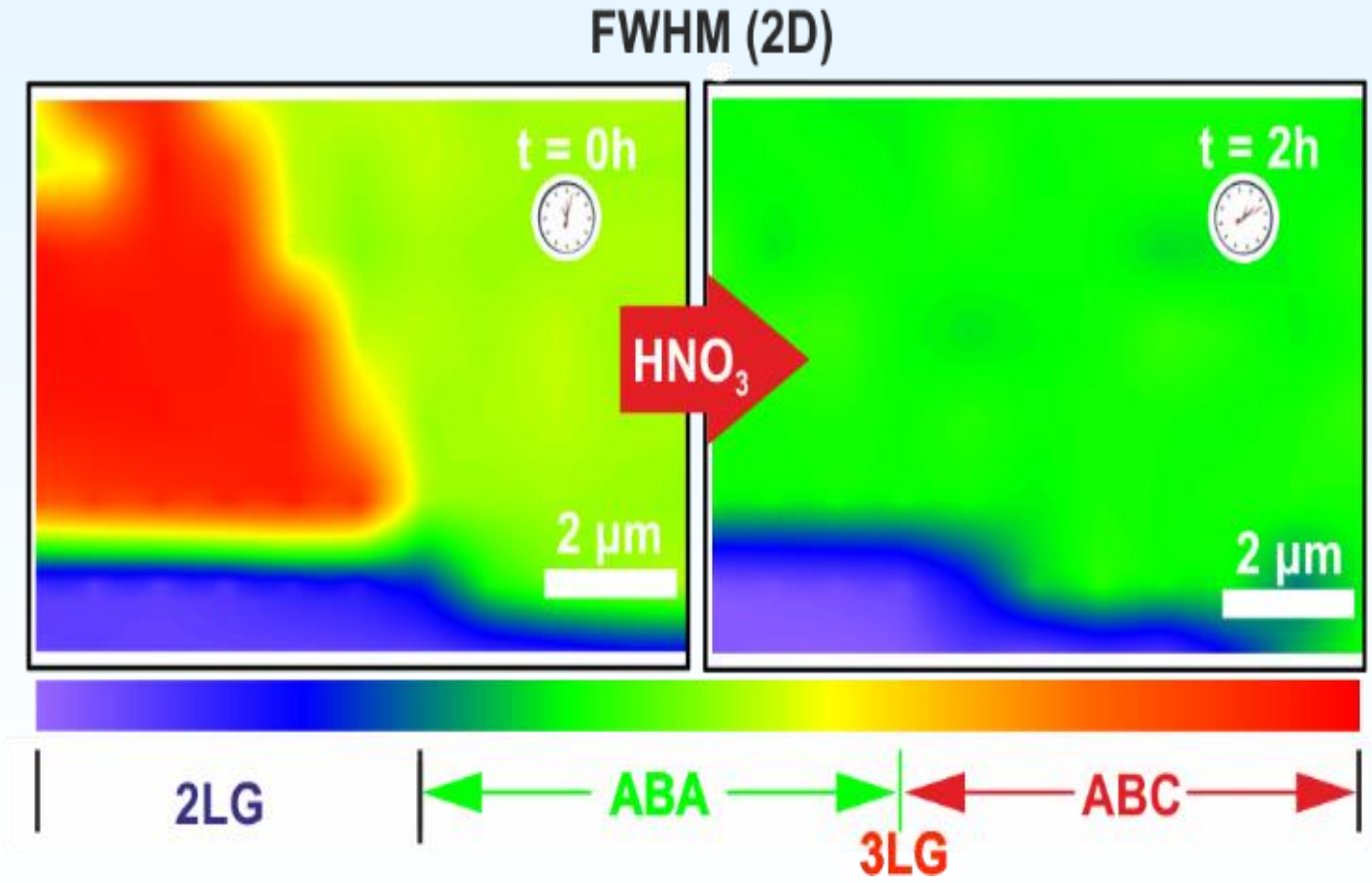
ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Doping of supported graphene by HNO_3 vapors



ACS Appl Nano Mater 2020


MLG
3LG
Line 1
2LG
Line 2
Si/SiO2
20μm


FWHM (2D)
t = 0h
t = 2h
HNO3
2 μm
2 μm
2LG
ABA
ABC
3LG

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Collaborators

- **K. Papagelis**

(*Dep. of Physics, AUTH)*

- **C. Galiotis**

(*Dep. of Chemical Engineering, UPATRAS)*

- **G. D. Sharma**

(*Dep. Of Physics, LNMIIT, India)*

- **P. Lianos** *(Prof. Emeritus)* – **C. Tsitsilianis** *(Prof. Emeritus)*

(*Dep. of Chemical Engineering, UPATRAS)*

- **I. Konstantinou**

(Dep. of Chemistry, UOI)

- **S. Yannopoulos - L. Sygellou**

(FORTH-ICEHT, Patras)

Πανεπιστήμιο Ιωαννίνων

ΙΝΣΤΙΤΟΥΤΟ
ΕΠΙΣΤΗΜΗΣ ΥΛΙΚΩΝ
ΚΑΙ ΥΠΟΛΟΓΙΣΜΩΝ

Ευχαριστώ για την προσοχή σας