COMMON SENSE

MARINE SENSORS - MARINE MONITORING

pH and pCO2 NANOSENSOR

Partner FTM-UCIM

FINAL DISSEMINATION EVENT
BARCELONA, 26 – JANUARY - 2017

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MARINE SENSORS - MARINE MONITORING

About me

- <u>Speaker: Prof. Anita Grozdanov,</u>
  Faculty of Techonology and Metallurgy,
  University Ss Cyril and Methodius in Skopje

- Expertise Area: Polymer Nanocomposites and Nanosensors

- Why CS ?
- CS research task contribute to the improvement of my skills for Design and Development of Nanosensors based on Polymer Nanocomposites
  To make wider the network of coworkers.

Role on CS: *Coordinator of the Macedonian research team*

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 614155.

Origin

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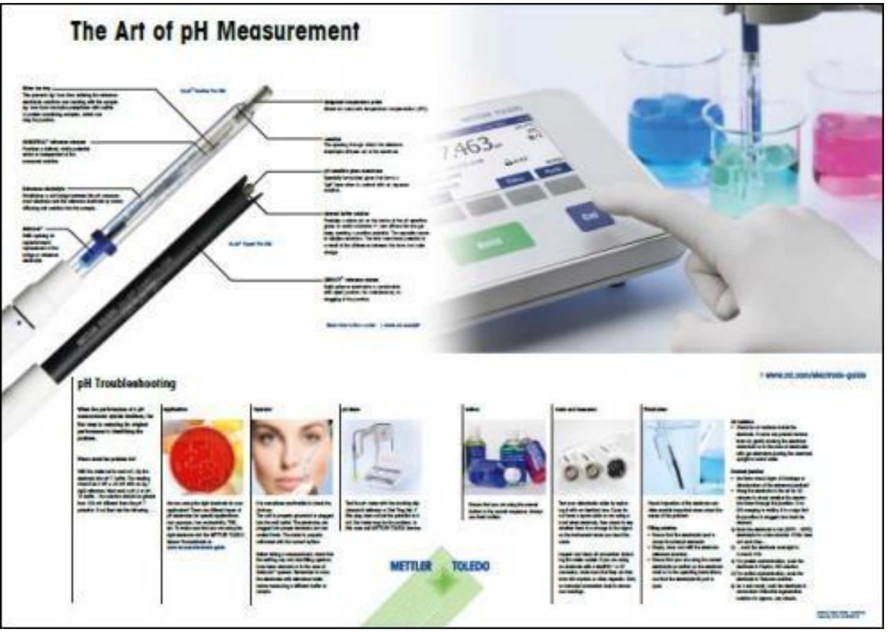
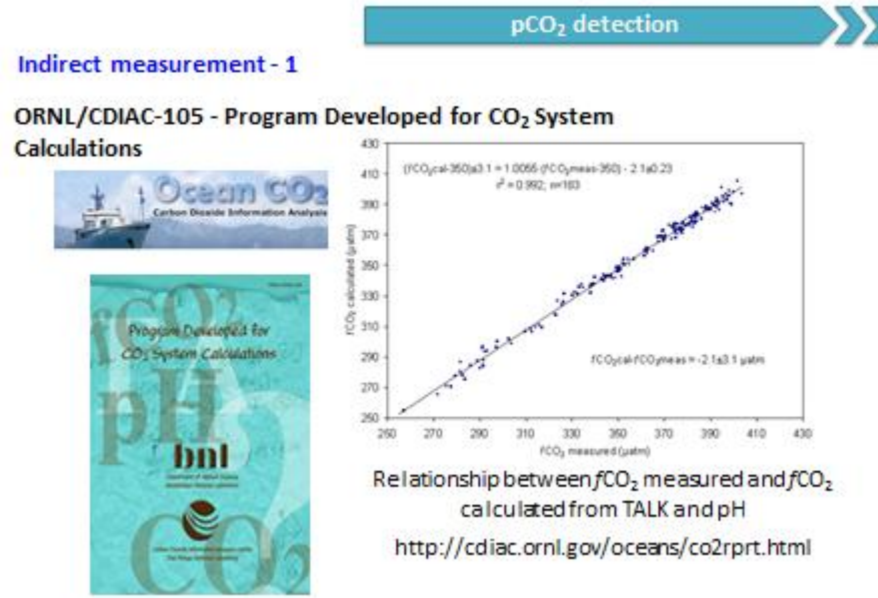
- State of the art at initial sta





- Needs identification!
- Low cost sensor
- 3 S nanosensor
- (Senstivity, Stability, Selectivity)

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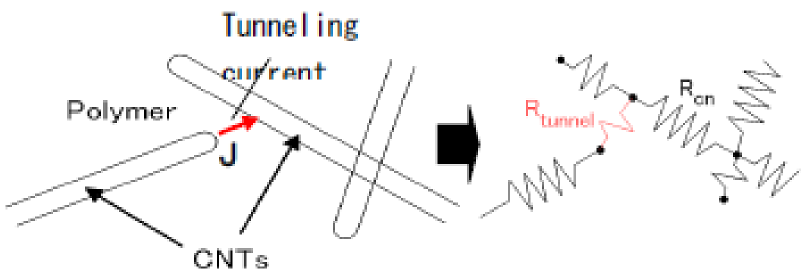
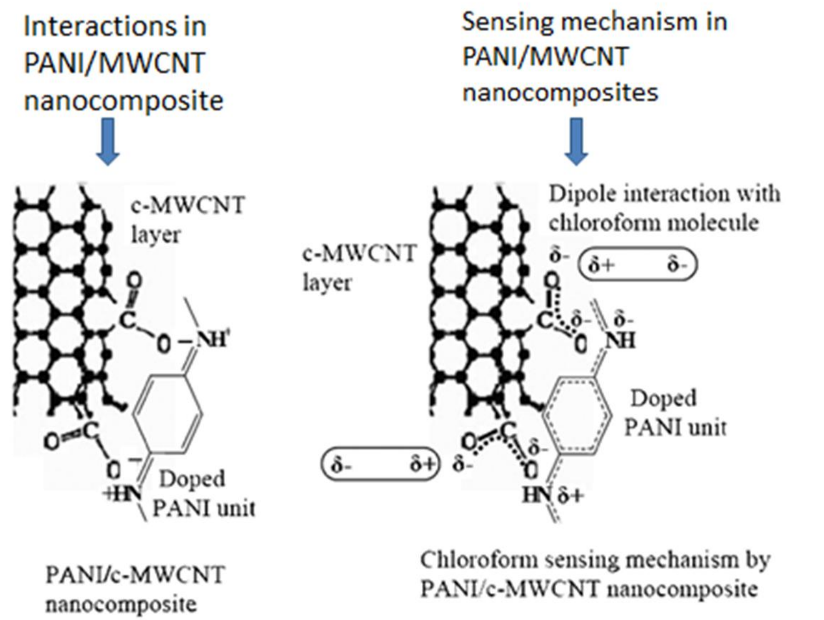
Objectives

Good sensors needs:

"3 S nanosensor (Senstivity, Stability, Selectivity) "





- Using the synergy effect of conductive polymer matrix – Polyaniline and conductive filler –CNT & G, resistivity and sensitivity should be increased and improved.

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Technical contribution

- Based on electronic properties of carbon nanotubes are:
  - metallic or
  - semiconducting → f (diameter, chirality of graphitic rings)

- The unique properties of carbon nanotubes have led to their use as:
  - sensors,
  - actuators,
  - field-emitting flat panel displays,
  - energy, and gas storages.

- Greater adsorptive capacity
  due to larger surface-area-to-volume ratio→ high sensitivity

CNTsurface area ~1587 m^2/g

- CNT-based sensors detect:
  - the nature of gases
  - their concentrations

"based on change in electrical properties induced by charge transfer with the gas molecules (e.g., O2, H2, CO2) or in mass due to physical adsorption"

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- Plan implementation
-

Technical contribution

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http://graphene.mk

Experiment	Percent of nanostructure	Film or electrolyte	Time
KG-1 P	1	Film	40
KG-2 P	1	E	40
KG-3 P	2	Film	40
KG-4 P	2	E	40
KG-5 P	3	Film	40
KG-6 P	3	E	40
KG-7 P	1	Film	60
KG-8 P	1	E	60
KG-9 P	2	Film	60
KG-10 P	2	E	60
KG-11 P	3	Film	60
KG-12 P	3	E	60

Experiment	Percent of nanostructure	Film or electrolyte	Time
KC-1 P	1	Film	40
KC-2 P	1	E	40
KC-3 P	2	Film	40
KC-4 P	2	E	40
KC-5 P	3	Film	40
KC-6 P	3	E	40
KC-7 P	1	Film	60
KC-8 P	1	E	60
KC-9 P	2	Film	60
KC-10 P	2	E	60
KC-11 P	3	Film	60
KC-12 P	3	E	60

This project has received f
Programme for research, t
under grant agreement No

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- Plan implementation

Technical contribution

Transversals sensors

COMMON SENSE

FTM-UKIM Task: NanoSensors for autonomous pH & pCO_2 measurements

For pH sensor, nano-composite film, based on Polyaniline, Graphene (G) and multi-walled carbon nanotubes (MWCNTs) was developed using two types of deposition:

- G & MWCNT Deposited on Electrode (Film)
- G & MWCNT Dispersed in Electrolyte

***Phase 1:* Preparation and characterization of nanocomposite films**

NC Systems:
pH: PANI/G
pCO2: PANI/MWCNTPVDF/G

***Phase 2:* Preparation of Screen Printed Electrode**

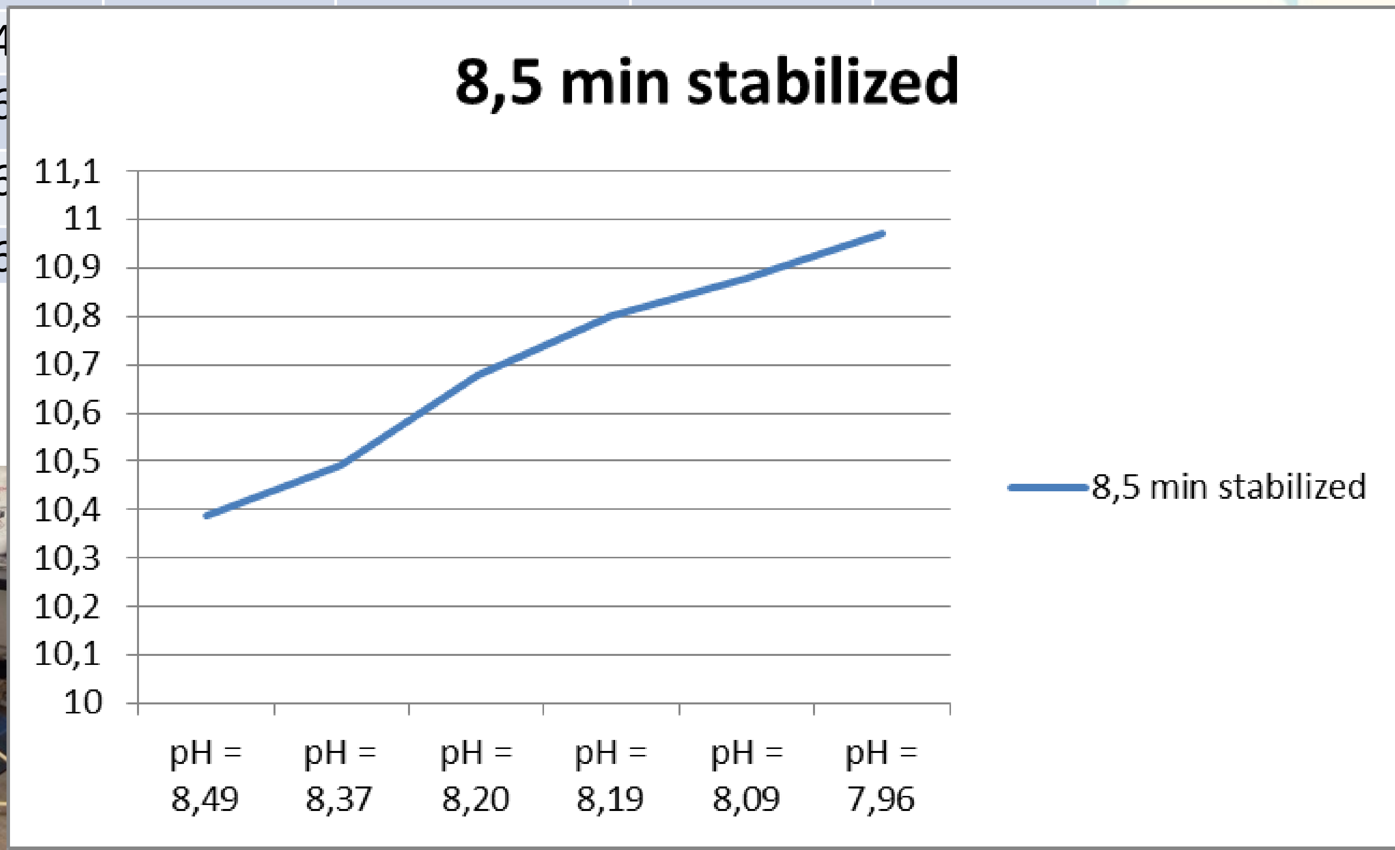
NC sensor as a tablet

***Phase 3:* Field Testing**

This project h...
Programme f...
under grant a...

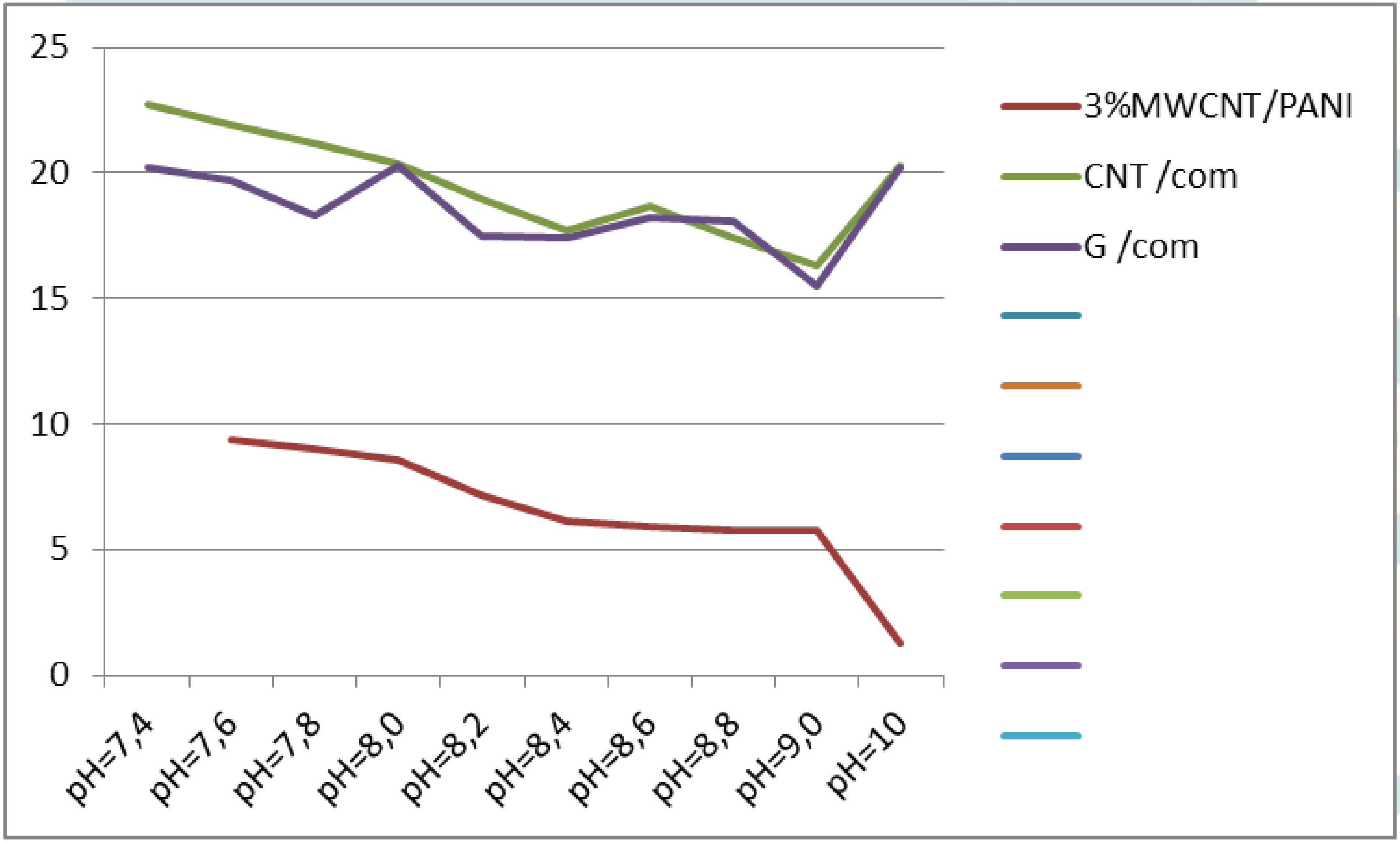
Table 3. Validation test of SPE-MWCNT nanosensors in simulated sea water (changing pH ; controlling pH and R)

Sample: 3wt% MWCNT/PANI	T=20,3°C		R [MΩ]		
	1 min	2 min	4 min	5 min	8,5 min stabilized
pH = 8,49	8,49	9,53	10,32	10,380	10,386
pH = 8,37	8,28	9,32	10,49	10,494	10,494
pH = 8,20	10,4	[illegible]	[illegible]	[illegible]	[illegible]
pH = 8,19	10,6	[illegible]	[illegible]	[illegible]	[illegible]
pH = 8,09	10,6	[illegible]	[illegible]	[illegible]	[illegible]
pH = 7,96	10,6	[illegible]	[illegible]	[illegible]	[illegible]



Electrical conductivity after treatment of the SPE-G and SPE-MWCNT nanosensors at pH range : 7,4 to 9,0 (~ pH of the sea water)

RESULTS



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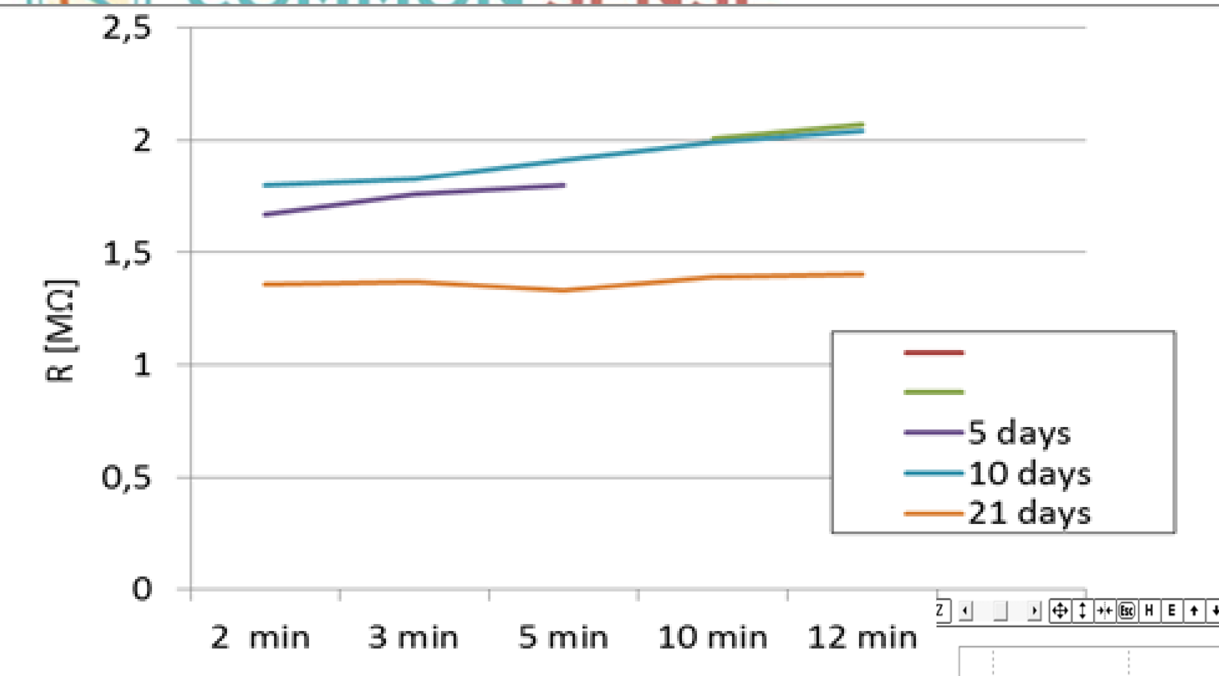
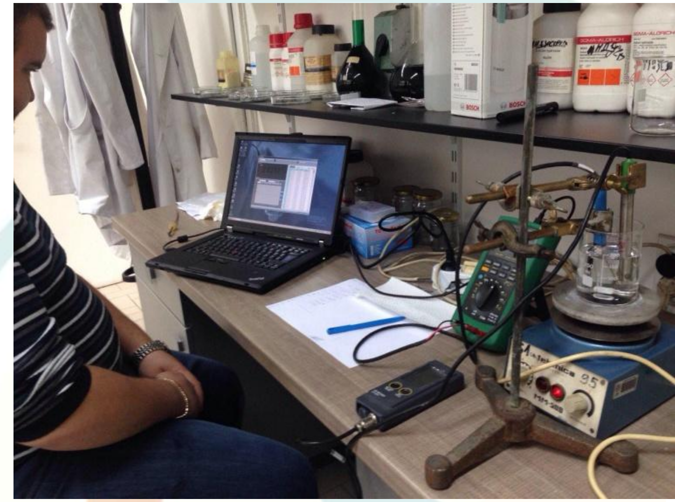
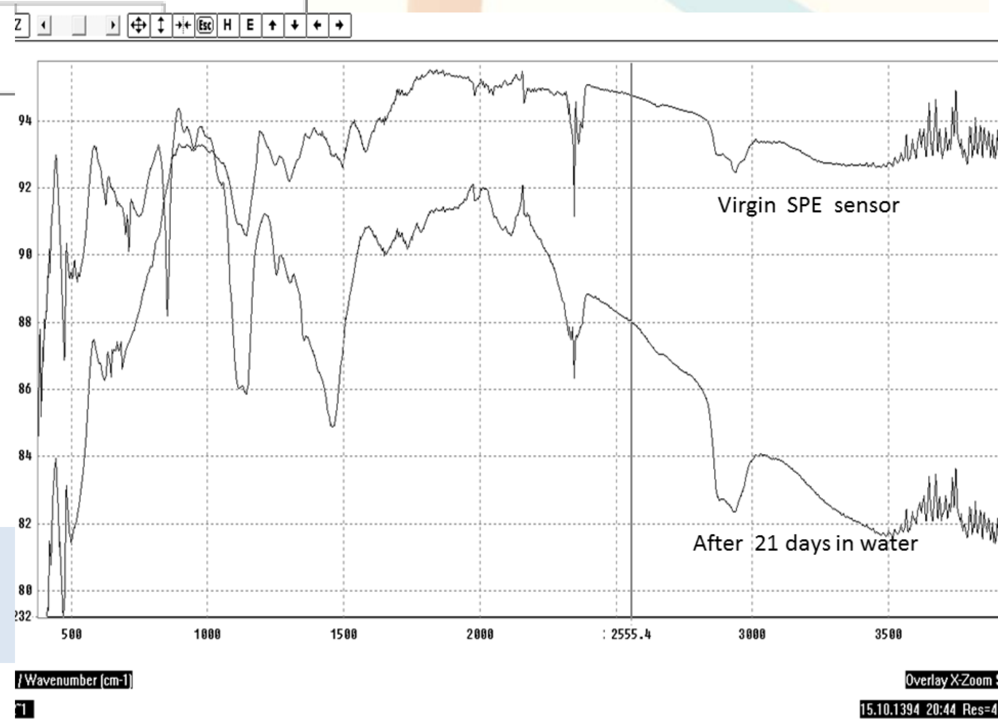
Achieved results vs Initial







tability of SPE-MWCNT nanosensors in
ea water at pH =8,4 (Lucrino, It)

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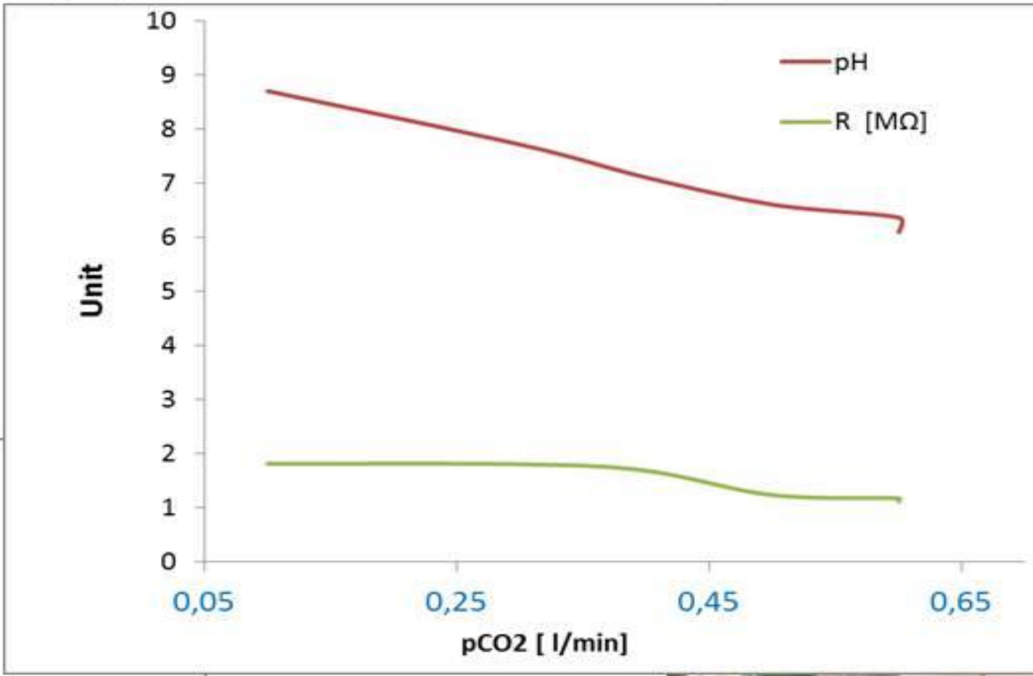
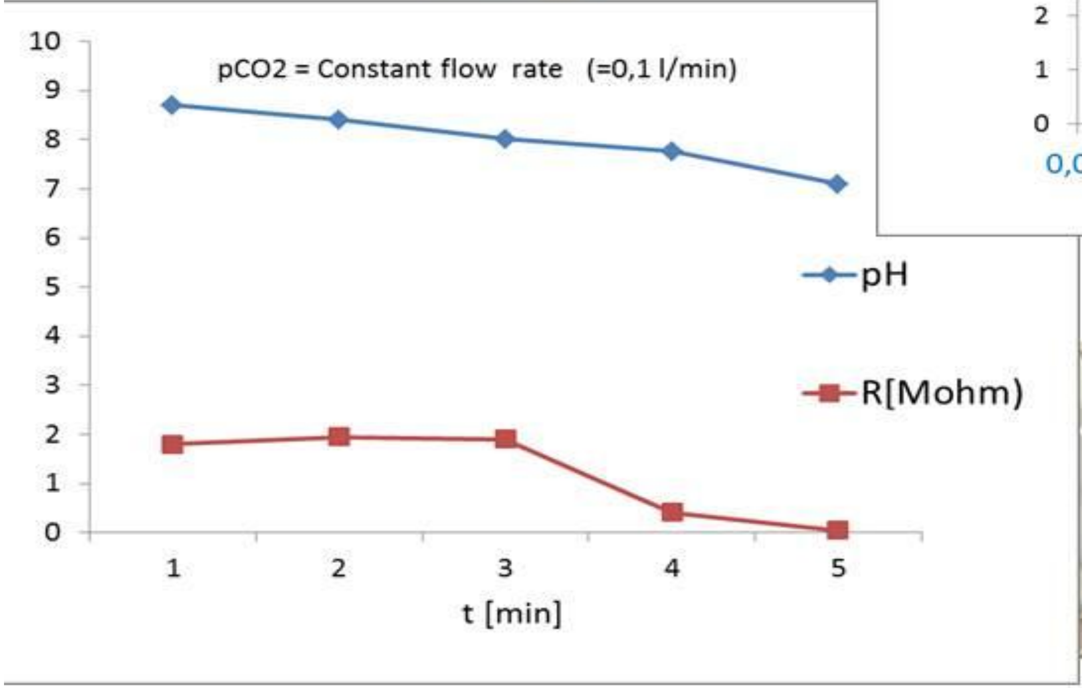
Achieved results vs Initial

2016 June, pCO2 testing (in simulated sea water)

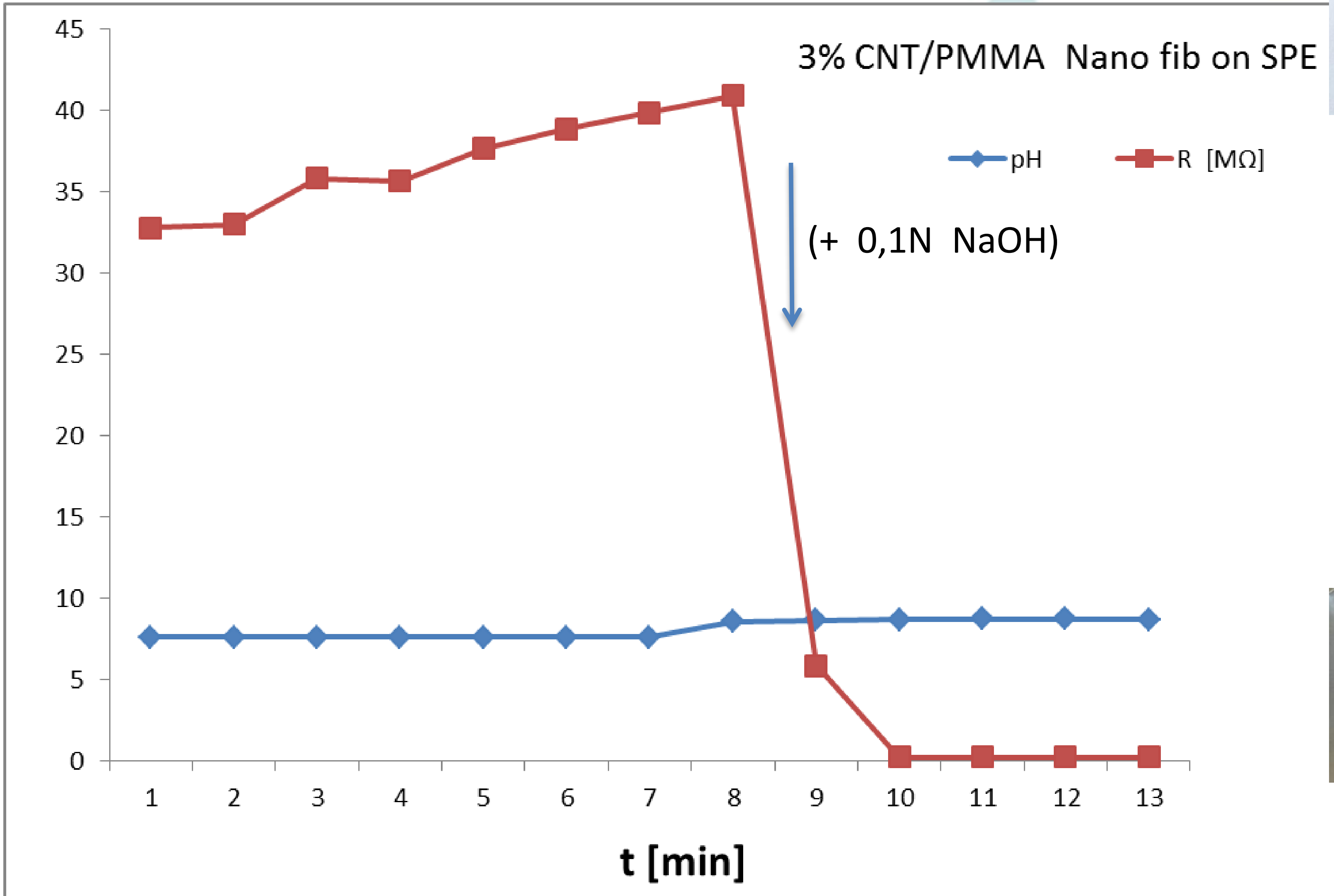




Testing (Conductivity measurements) of SPE-Nano fiber 3% MWCNT/PMMA nanosensors in Lucrino-sea water (changing pH ; controlling pH and R)

Achieved RESULTS

(2016 June ; pH testing in Sea-Lucrino water)



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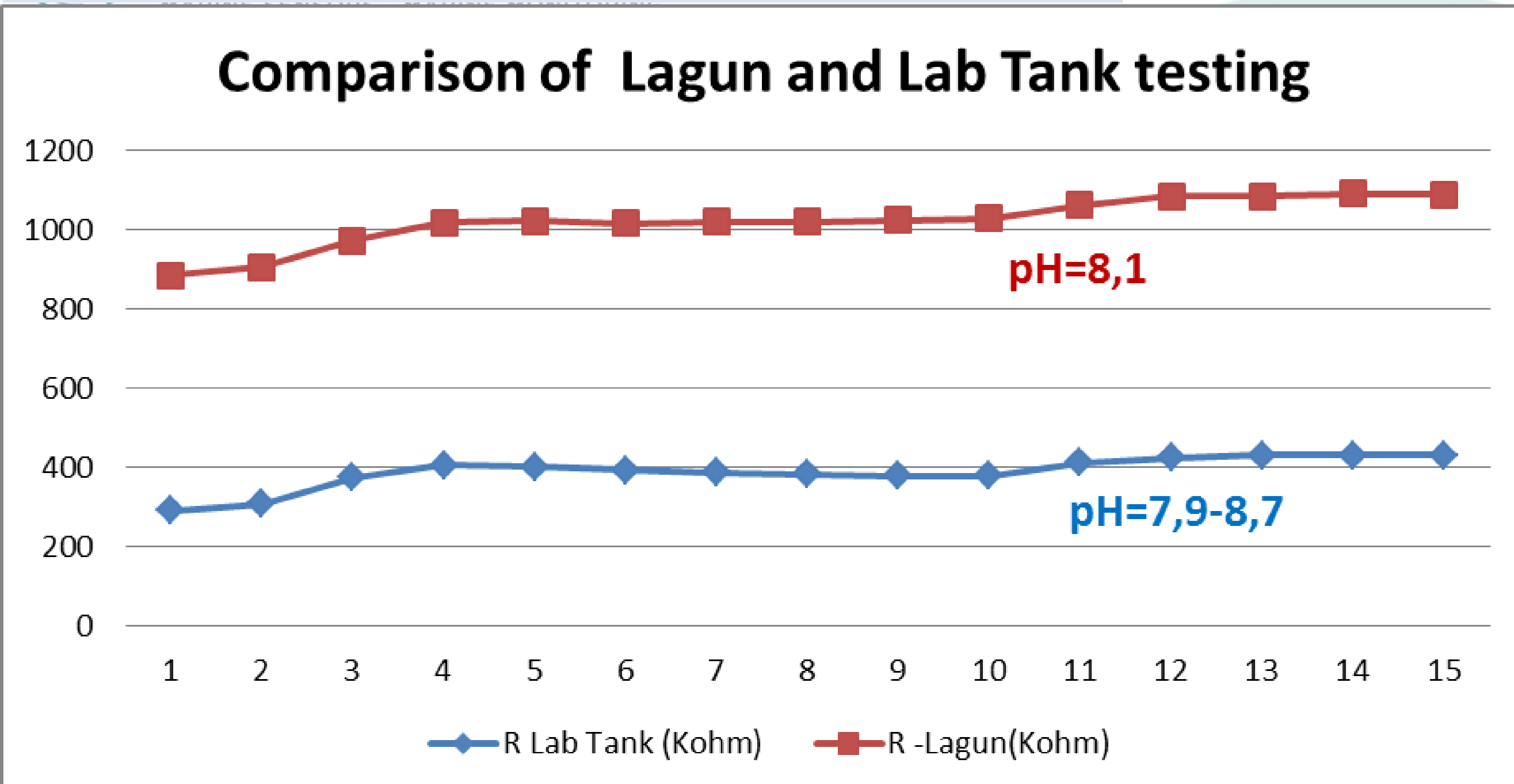
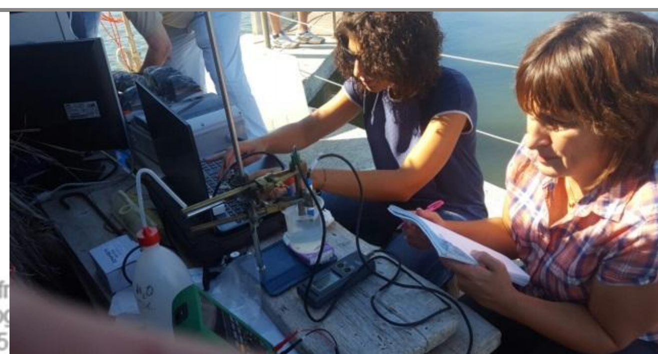
ORISTANO LAGUNA TESTING
For SPE of 3% G/PANI Nanocomposite





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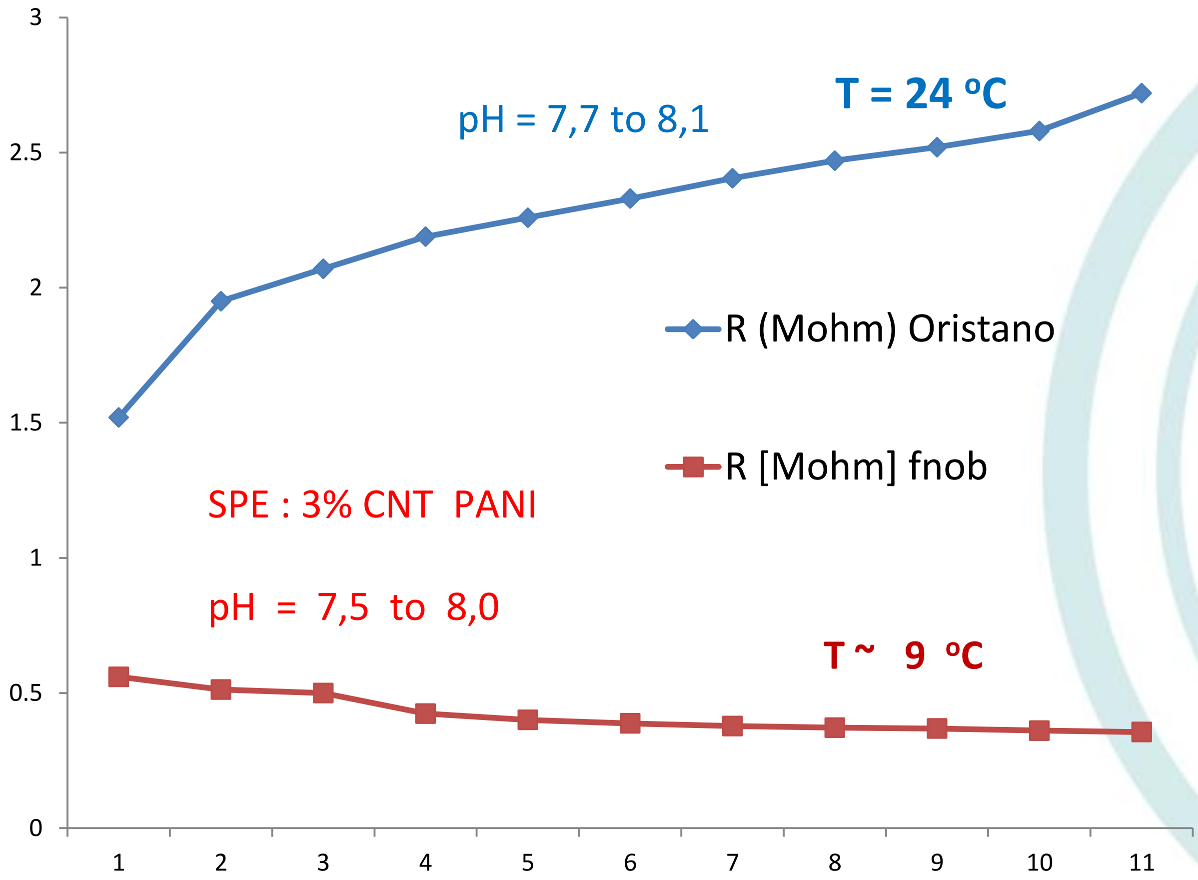
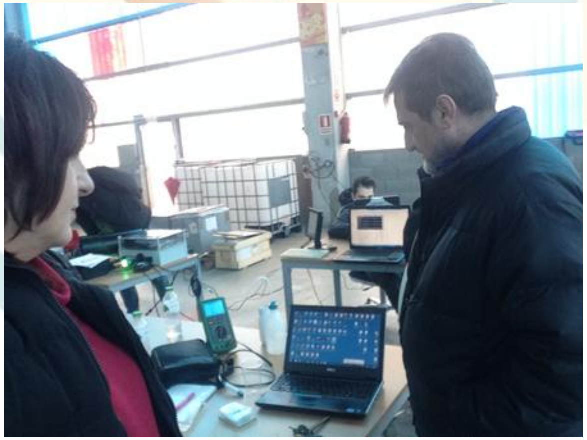
Technical description



Testing in FNOB, 25.01.2017



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Results

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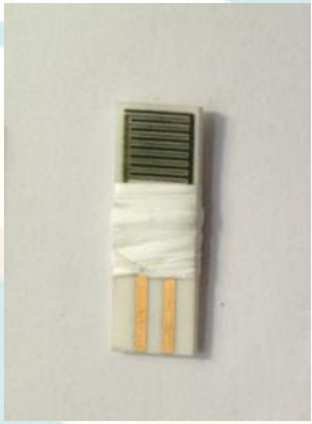

Highlights of developed technology and TRL

- ✓ New nanocomposite based pH and pCO_2 sensor
- ✓ Detection based on resistivity changes
- ✓ Remarkable smaller dimensions
- ✓ Overpassed mechanical fragility
- ✓ Cost effective
- ✓ Easy operation
- ✓ Fast recovery (15 min) of the SPE nanocomposite sensor
- ✓ Utilises an a electronic measuring that combine several measurement functions in one

- TRL : 5

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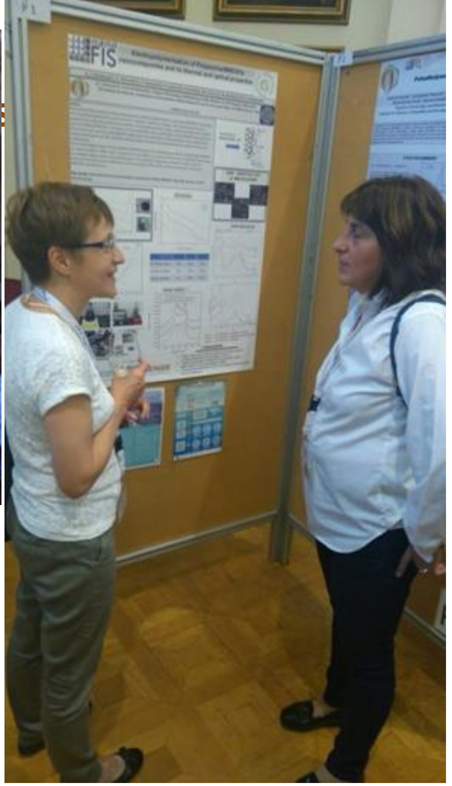

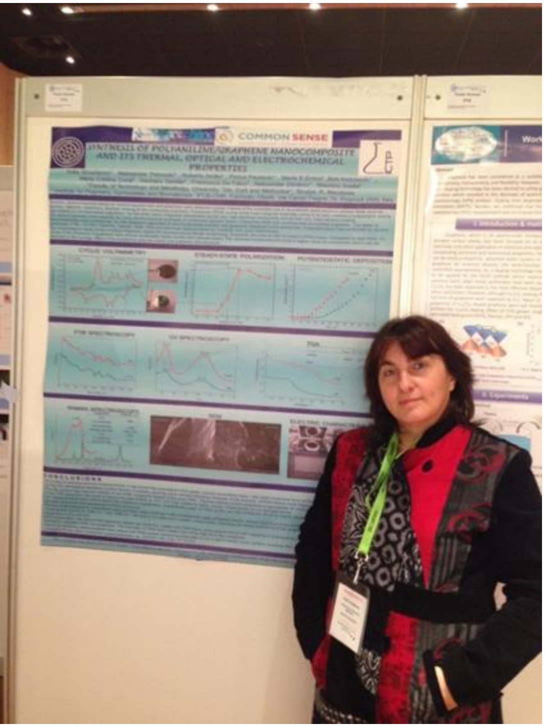

Promotion of COMMON SENSE

Presentations in

1. **Nano & Material Conferences**

2. **Trinity Hall, Cambridge ,**
   15 December 2015

3. **DG Research and Innovation Officers**
   E.C.- Mr. Kostas Gilos, Head of Unit
   Ms. - Tania Friederichs, Policy Officer

EXPLOITATION

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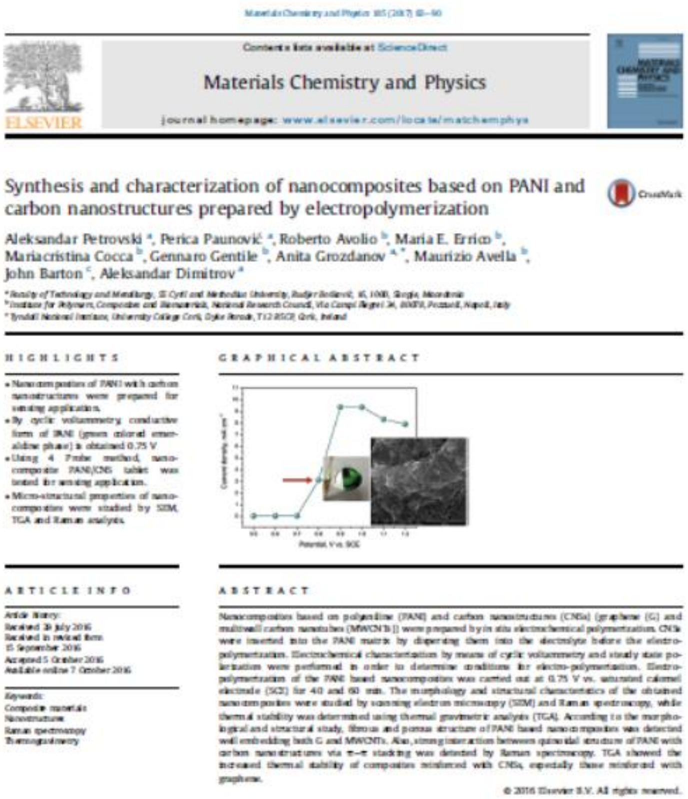

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journal homepage: www.elsevier.com/locate/matchemphys

Synthesis and characterization of nanocomposites based on PANI and carbon nanostructures prepared by electropolymerization

Aleksandar Petrovski [a], Perica Paunović [a], Roberto Avolio [b], Maria E. Errico [b], Mariacristina Cocca [b], Gennaro Gentile [b], Anita Grozdanov [a,*], Maurizio Avella [b], John Barton [c], Aleksandar Dimitrov [a]

HIGHLIGHTS

- Nanocomposites of PANI with carbon nanostructures were prepared for sensing application.
- By cyclic voltammetry, conductive form of PANI (green colored emeraldine phase) is obtained 0.75 V.
- Using 4 Probe method, nanocomposite PANI/CNS tablet was tested for sensing application.
- Micro-structural properties of nanocomposites were studied by SEM, TGA and Raman analysis.

GRAPHICAL ABSTRACT

ARTICLE INFO

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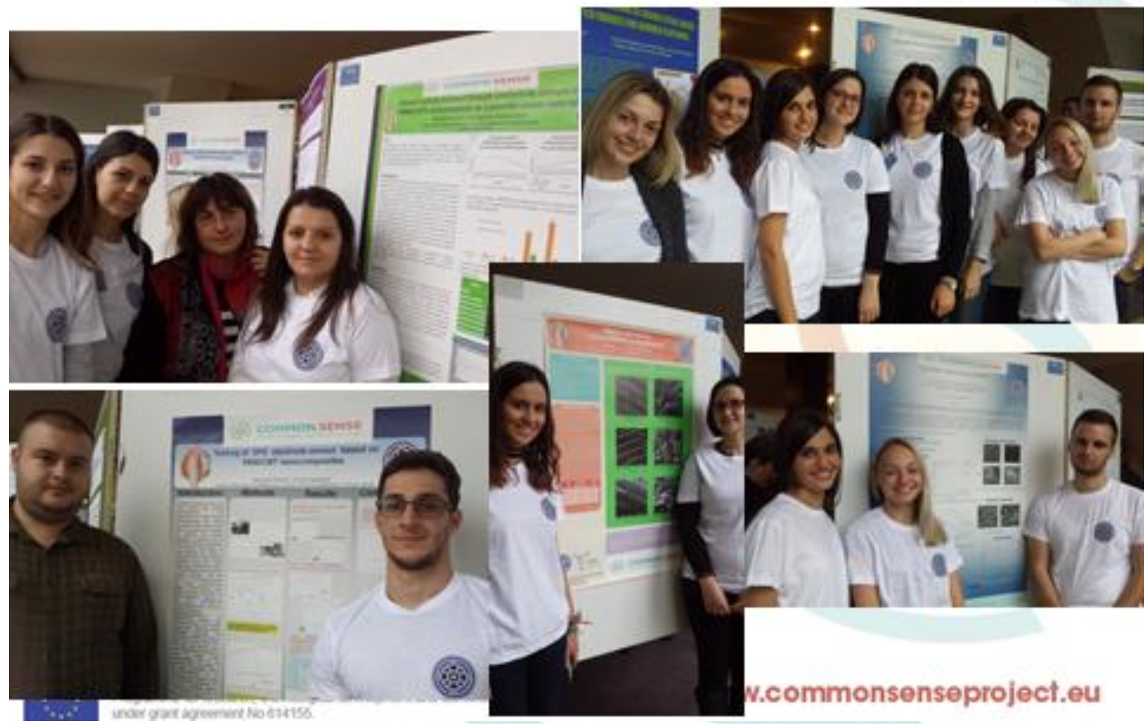
ABSTRACT

Nanocomposites based on polyaniline (PANI) and carbon nanostructures (CNSs) (graphene (G) and multiwall carbon nanotubes (MWCNTs)) were prepared by in situ electrochemical polymerization. CNSs were inserted into the PANI matrix by dispersing them into the electrolyte before the electropolymerization. Electrochemical characterization by means of cyclic voltammetry and steady state polarization were performed in order to determine conditions for electro-polymerization. Electropolymerization of the PANI based nanocomposites was carried out at 0.75 V vs. saturated calomel electrode (SCE) for 40 and 60 min. The morphology and structural characteristics of the obtained nanocomposites were studied by scanning electron microscopy (SEM) and Raman spectroscopy, while thermal stability was determined using thermal gravimetric analysis (TGA). According to the morphological and structural study, fibrous and porous structure of PANI based nanocomposites was detected well embedding both G and MWCNTs. Also, strong interaction between quinoidal structure of PANI with carbon nanostructures via π–π stacking was detected by Raman spectroscopy. TGA showed the increased thermal stability of composites reinforced with CNSs, especially those reinforced with graphene.

KNOWLEDGE TRANSFER
– STUDENT'S CONGRESS 05.11.2016 Belgrade

Status M40
Description of technical activities



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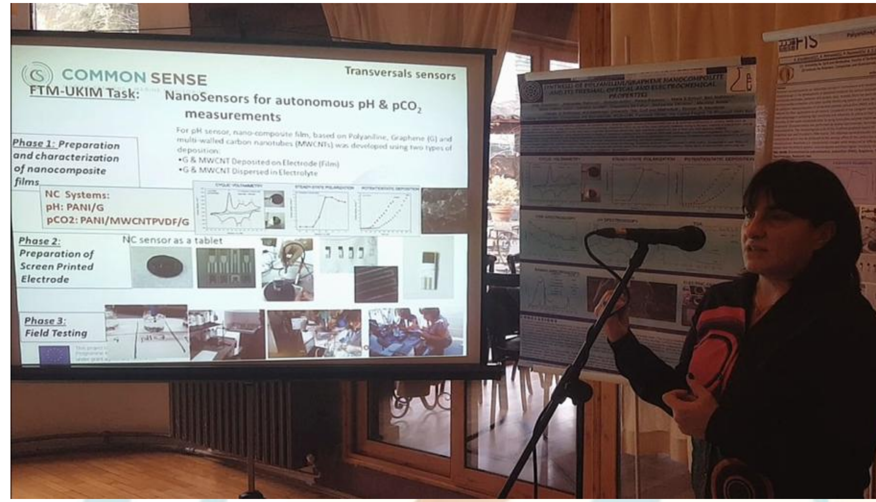
1st . Public Dissemination Event



Guests: Min of EDU&SCI, SMEs, Rectorate, IPR-Low Office, Colleagues, Technical faculties
14 Decembar 2016

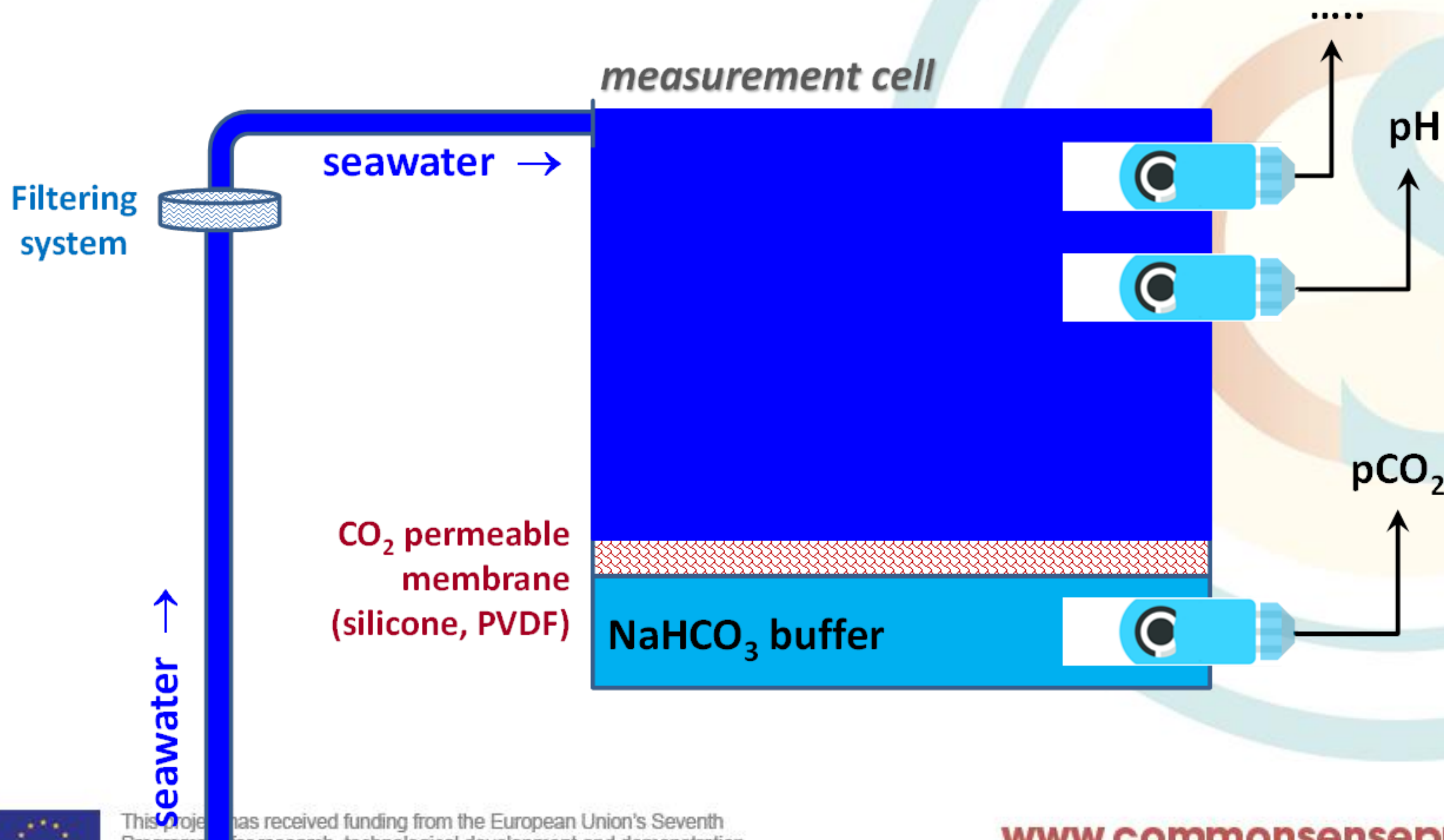
2nd . Public Dissemination Event

✓ **With SME, Companies and ENV-Ministry in February, 2017**

This project has received funding from the European Union's Seventh

EXPLOITATION

FURTHER WORK



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Thank you for your Attention

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