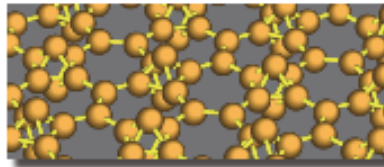


# Research Innovation and Technology Center for New Materials (RITecC)



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## Outline:

- Short presentation of NIMP
- RITecC: Why and What
- Highlights Nanotechnology in RITecC

## ➤ **Short presentation of National Institute of Materials Physics**

- ❑ the largest institute in Romania devoted to research and development in the field of solid state physics and advanced materials.
- ❑ a center of excellence for research and high-level education
- ❑ a frame for interdisciplinary research in materials science.

### Research area

#### **Solid state physics:**

**Nano-objects, Surfaces & Interfaces, Electronic Correlations, radiation interactions**

#### **Nanostructures and functional materials**

- ❑ **energy applications:** generation, conversion, transport and storage; materials and composites for fusion and fission
- ❑ **information technology:** high frequency electronics, optoelectronics, ferroics and multiferroics, magnetic.
- ❑ **medicine & environment:** bio-compatible –functional –mimetic materials sensors and catalysts

NIMP has a new research infrastructure acquired in the last 10 years with state of the art equipment for:

- ❑ materials synthesis and processing
- ❑ structural, optical and physical properties characterization

➤ **RI TecC: Why and What**

**NIMP = tradition + good level expertise + new equipment**

**Solid state physics :**

**basic research covering most of the modern/current high interest topics**

**→ create, analyse, understand, improve material design & properties**

- Dimensional effects in nano-entities and quantum layers**
- Surfaces and interfaces in structures**
- Electronic correlations and interactions**
- Microstructure dynamics (including modeling)**

**→ Solid ground for applications → yet few applications made it to the market**

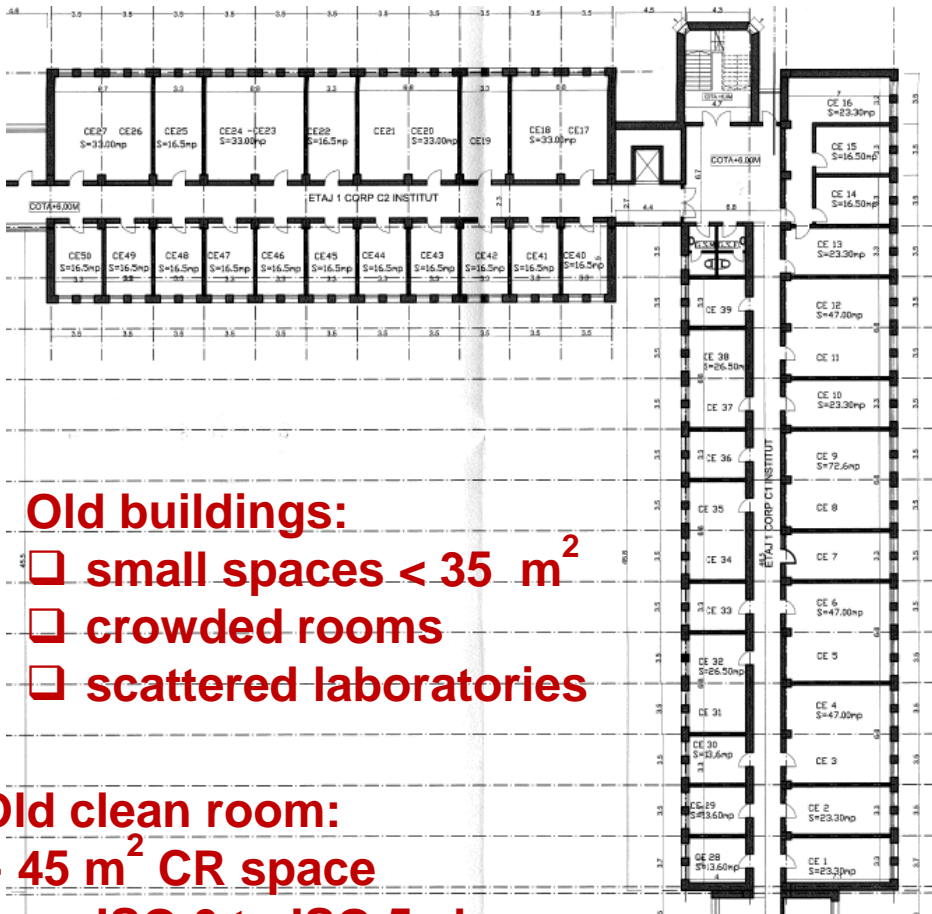
**Why: we have many good bricks, but no house. What can be done ?**

**1<sup>st</sup> step: build the house, create an infrastructure dedicated to applications:**



**3 Directions :**

- New high tech materials and applications**
- New materials & applications to improve life**
- New materials and applications for extreme conditions**



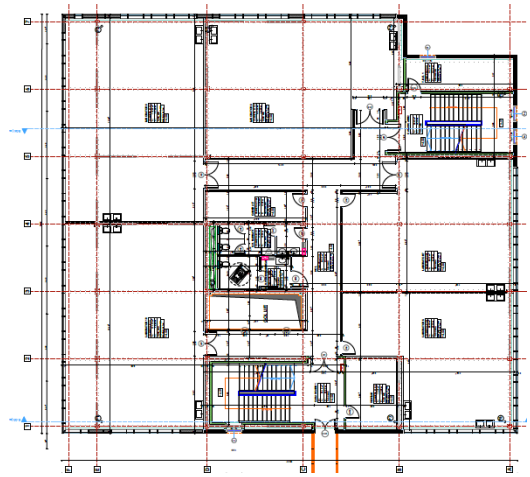
**Old buildings:**

- ❑ small spaces < 35 m<sup>2</sup>
- ❑ crowded rooms
- ❑ scattered laboratories

**Old clean room:**

~ 45 m<sup>2</sup> CR space  
from ISO 6 to ISO 5 class

**NOW → Bio-related applications**



**New building:**

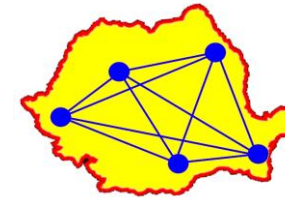
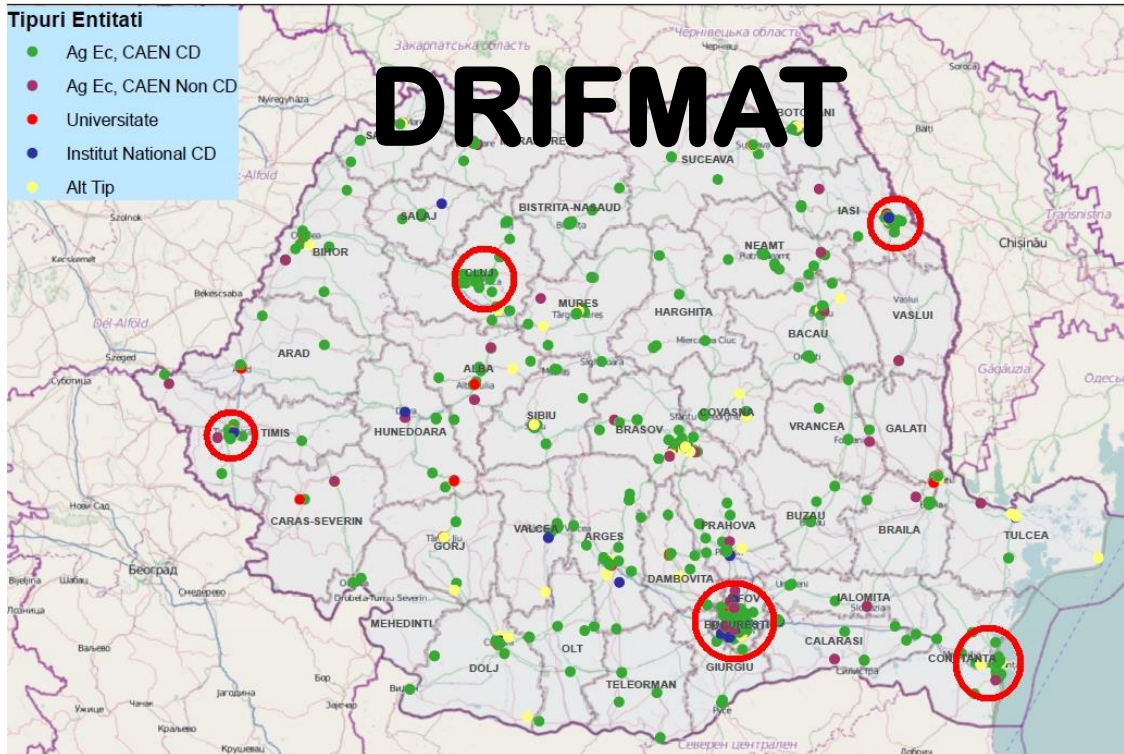
- ~ 2500 m<sup>2</sup> lab. space
- ❑ large rooms 80-160 m<sup>2</sup>
- ❑ better organized

**New & large clean room**

~ 230 m<sup>2</sup> CR space  
from ISO 7 to ISO 5 class

We are now much better prepared, but can we respond quickly enough to complex challenges?

2<sup>nd</sup> step: increase cohesion, use synergetic resources, focus efforts



Distributed Research Infrastructure for Future MATerials

**A R&D cluster:**  
 based on a core of 9 top research institutes and universities  
 and  
 SMEs focused on processing and development of new materials and technologies

[www.infim.ro](http://www.infim.ro), <https://erris.gov.ro>

## RITecC Infrastructure:

- 1) production: **SPS, MWS, HPS + MA, UFC**, deposition, **sg.crystals**, chemistry
- 2) Thin films: evap./dep., PLD, MBE +in situ characterization, CVDs, MAPLE
- 3) Structural: TEM, **2 HRTEM\***, **SEM**/EBS/EDX, **XRD**, AFM/PFM, **XRF, PSA**
- 4) Optical:UV-VIS-NIR ellipsometry, NSF, FL, TLD, Raman, FTIR, SNOM, PLM
- 5) **Surface**: LEED, RHEED, AES, QMS, STM, STS, SARPES, XPS, UPS, XPD, ARUPS, MEIS, LEEM-PEEM, SPM
- 6) Physical properties: PPMS, MPMS-SQUID, VSM, MOKE, LFA, TG/DTA, DSC, various electrical/dielectrical properties measurement systems, **EPR\***, **Moessbauer**, dilatometry, **mechanical properties**
- 7) Support: 2 mechanical workshops with CNC machines, glassware lab, chemistry labs., calculations&analysis clusters.

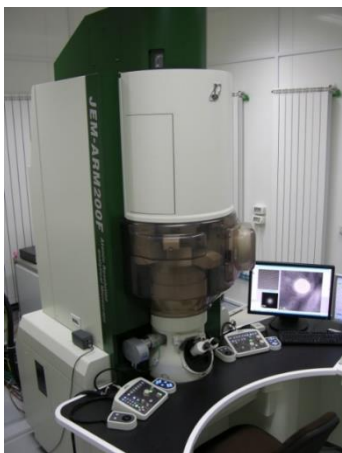
**Legend:** underlined equipment: unique at national level

**green**: including new (2018 or later) equipment

**\* red star**: included also in CERIC (Central European Research Infrastructure Consortium)



➤ Highlights Nanotechnology in RITecC: top HRTEM equipment



### JEM ARM200F

Working modes:

CTEM, HRTEM, STEM BF, STEM HAADF, SAED, nano-ED, CBED, EDS, EELS, EFTEM, EELS-SI;

- TEM resolution: **0.19 nm**;
- STEM-HAADF resolution: **0.08 nm**;
- EELS – energy resolution **0.7 eV** ➔ **compositional mapping**

### JEM 2100

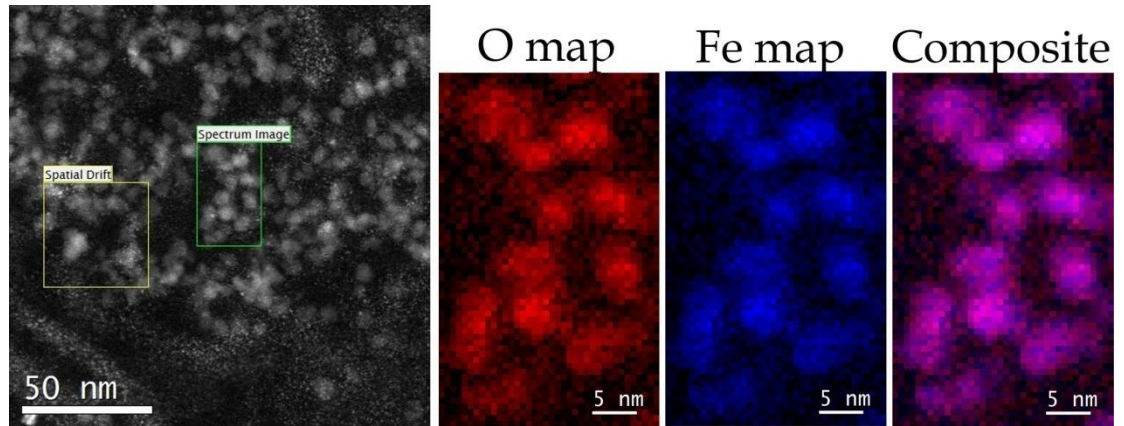
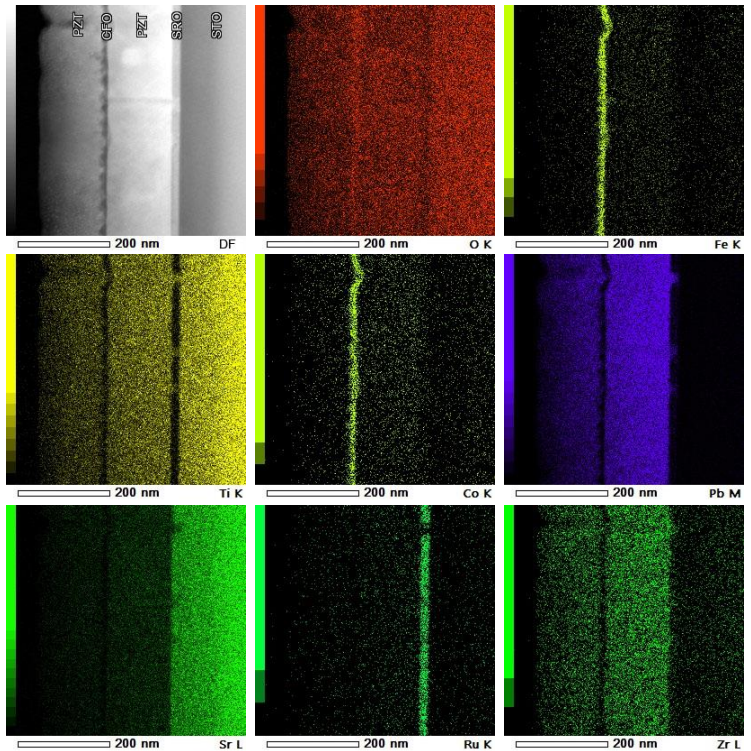
Working modes:

CTEM, HRTEM, STEM BF, STEM ADF, STEM HAADF, SAED, nano-ED, CBED, EDS;

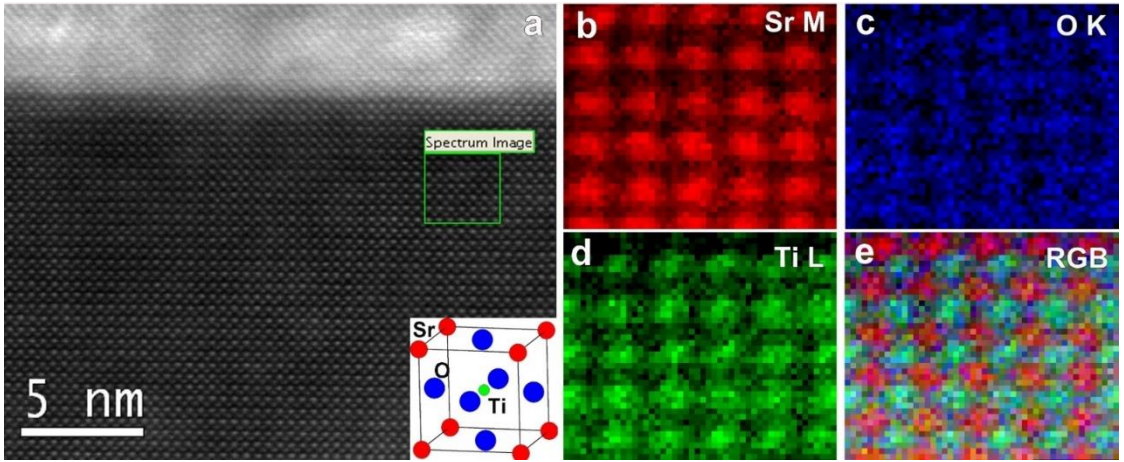
- TEM resolution: **0.19 nm**;
- STEM-HAADF resolution: **1 nm**;
- electron tomography**
- in situ* experiments up to ~ 900 °C**
- precession Electron Diffraction ➔ **structural mapping**



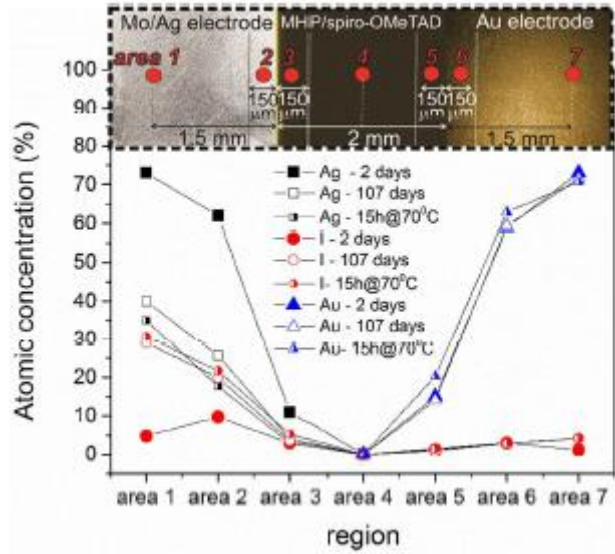
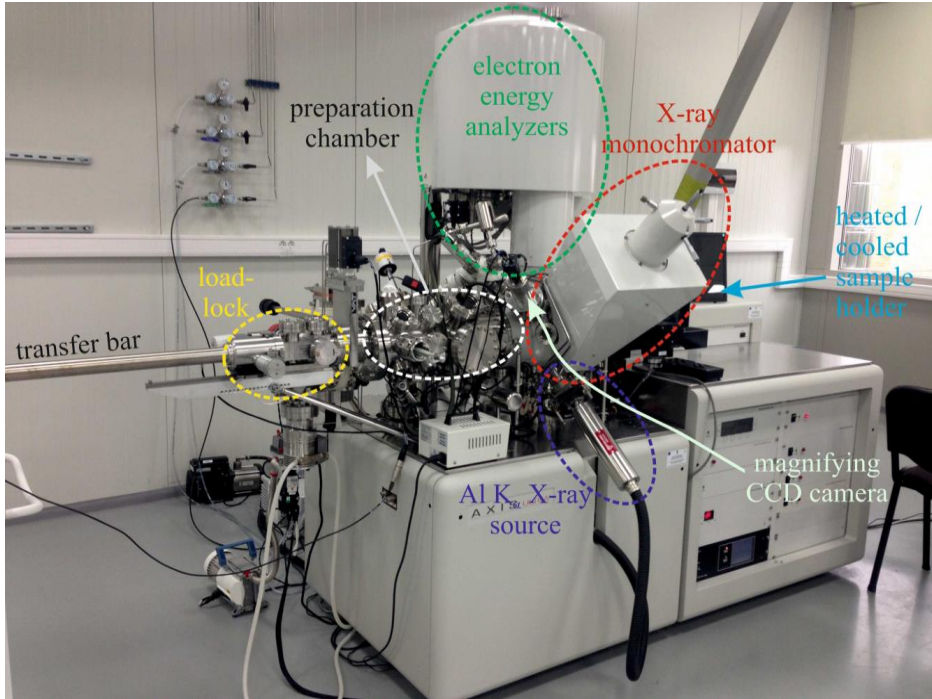
➤ **atomic level resolution results on organic and inorganic specimens**



Ex: Iron oxide nanoparticles in mouse spleen



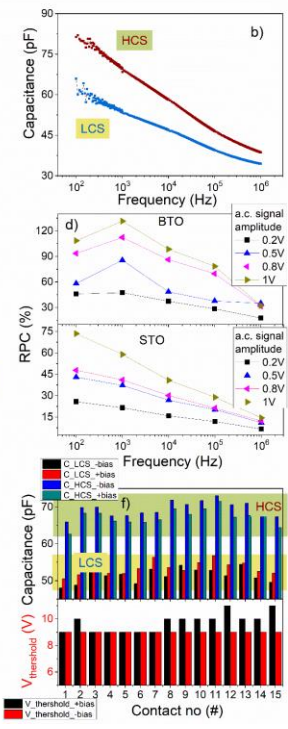
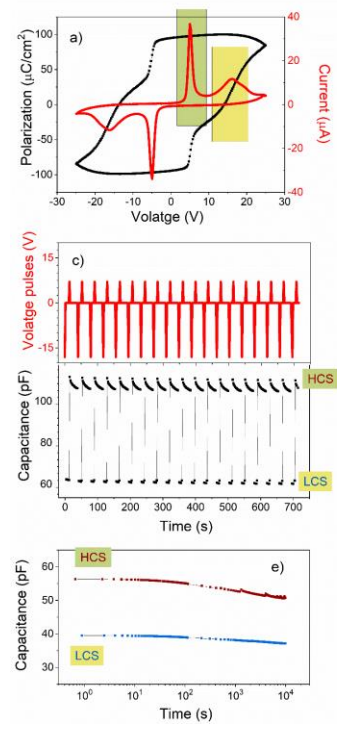
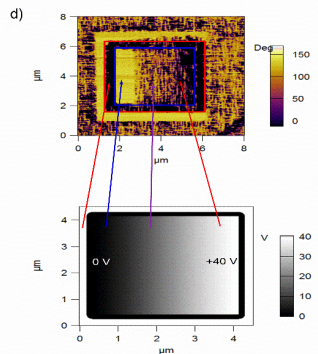
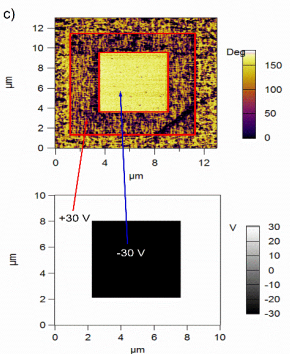
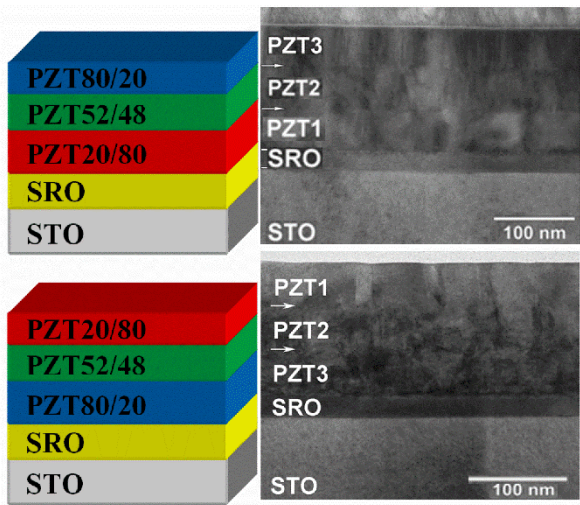
# XPS + spatial resolution 2 mm + *in situ* reaction cell (1000 °C, 4 bar)



Iodine Migration and Degradation of Perovskite Solar Cells Enhanced by Metallic Electrodes

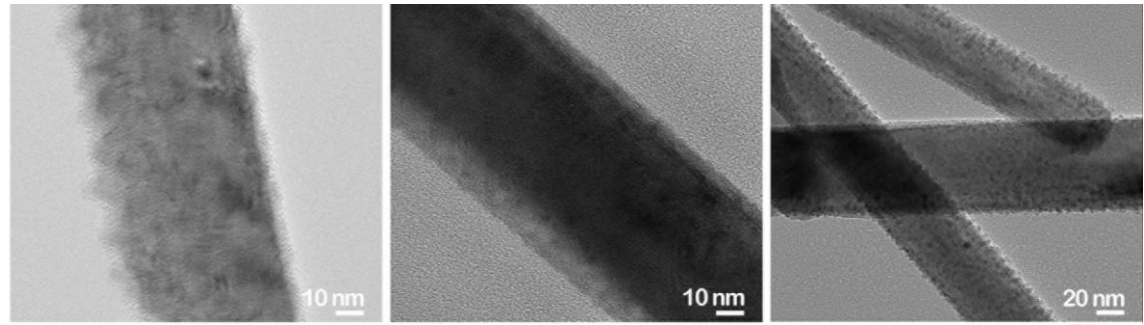
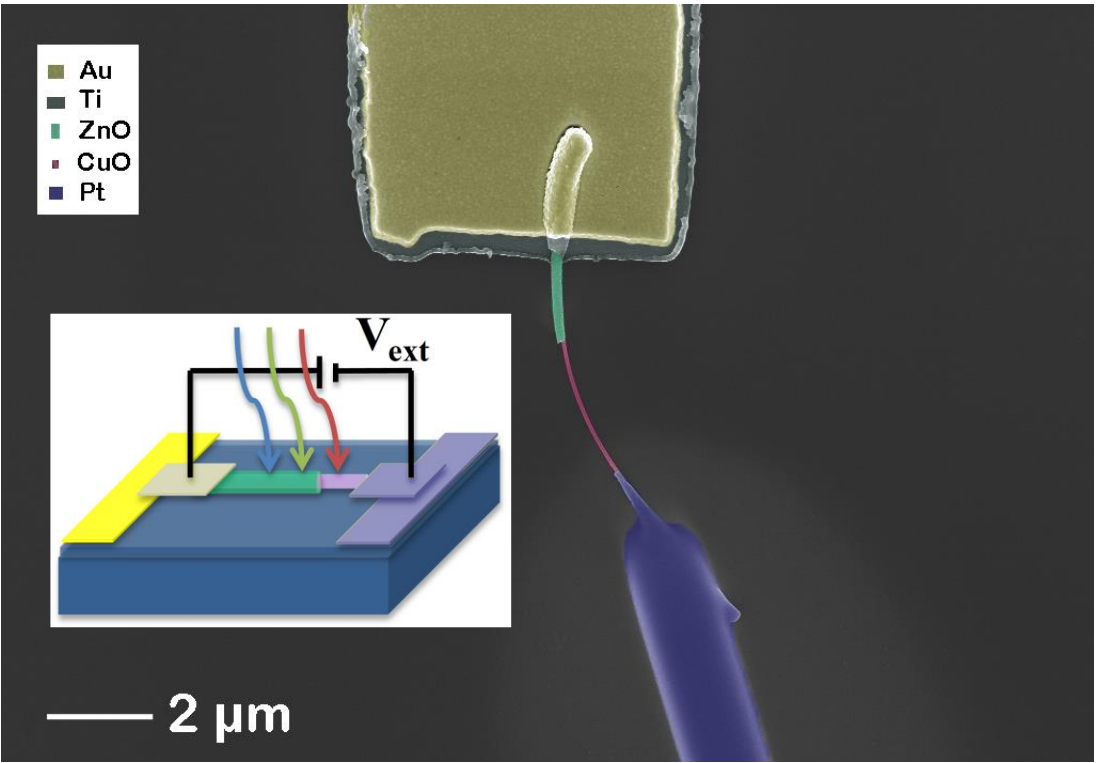
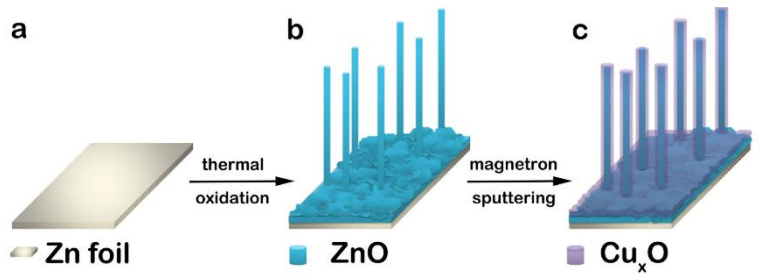
Beșleagă et al., *J. Phys. Chem. Lett.* 2016, 7(24) 5168

# Thin Films and Heterostructures for Electronic Devices (non-volatile memories, field effect transistors, etc.) and Sensors

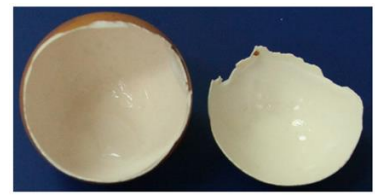


**Multi-layers for multiple states memories;  
 capacitive memories; memcomputing  
 (memristors and memcapacitors)**

# CuO-ZnO core-shell nanowires



# Converting eggshell membrane (ESM) from a bio-waste into a source for synthesis of new value-added materials using bio-inspired pathways



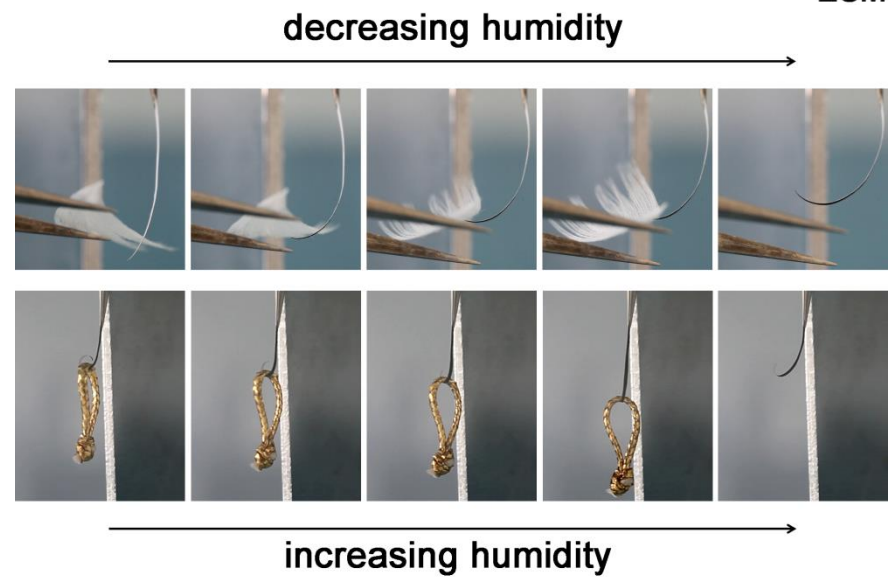
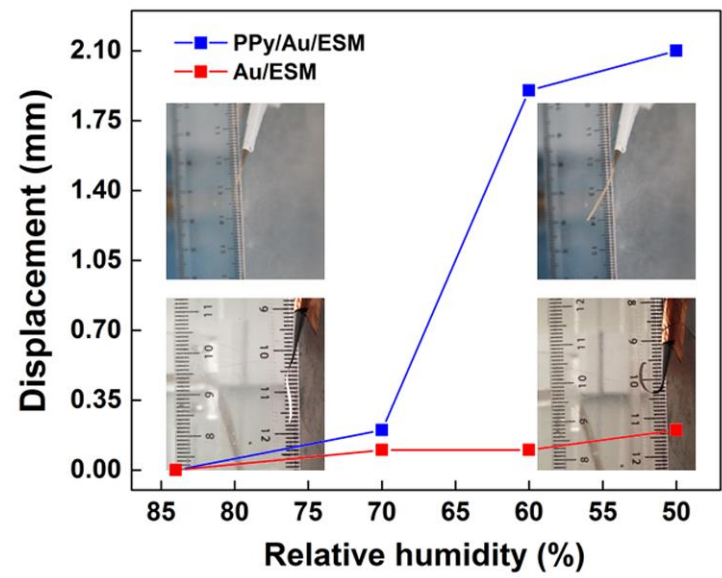
eggshells

high occurrence  
 →  
 environmentally friendly

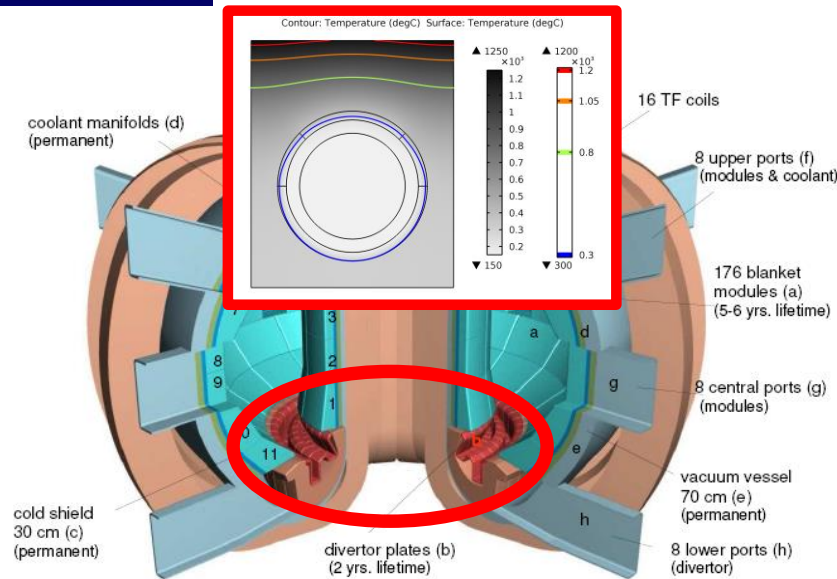
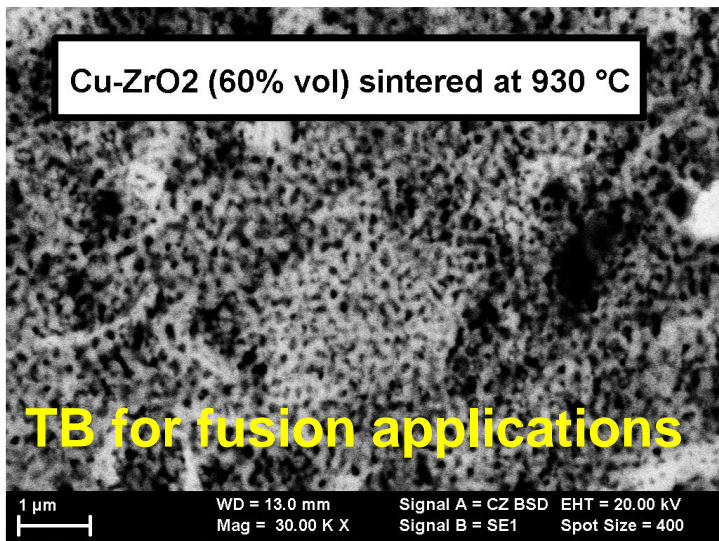


ESM

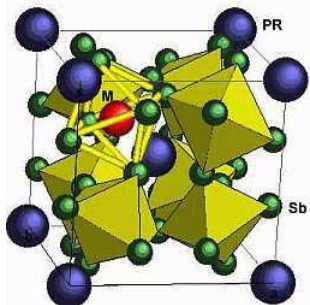
## Application: humidity-triggered actuators



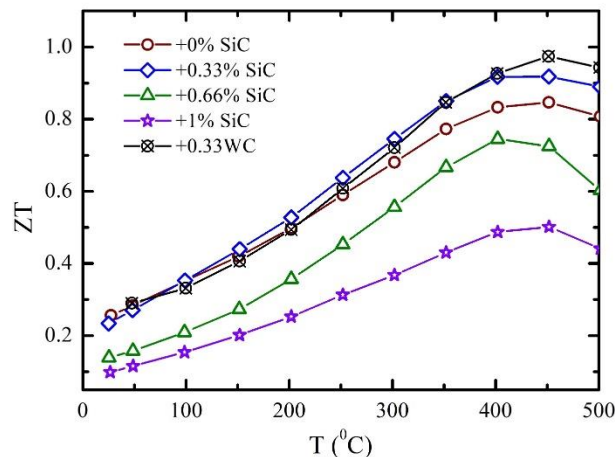
## Bulk nano-structured materials



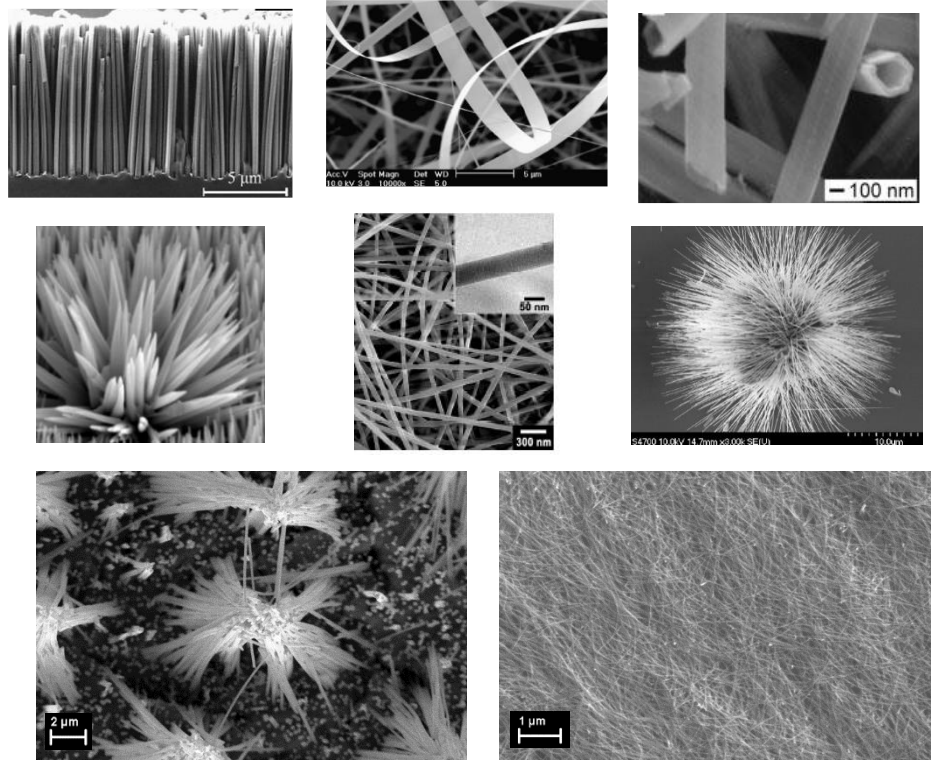
## TE composites with filled skutterudites



Processing time:  
 20+ days → 3 days  
 No TT → nm



**Spectacular look – lots of preparation methods: wet, physical, chemical, top down or bottom up**



**1-D Nanostructures**



*Thank you for your attention !*