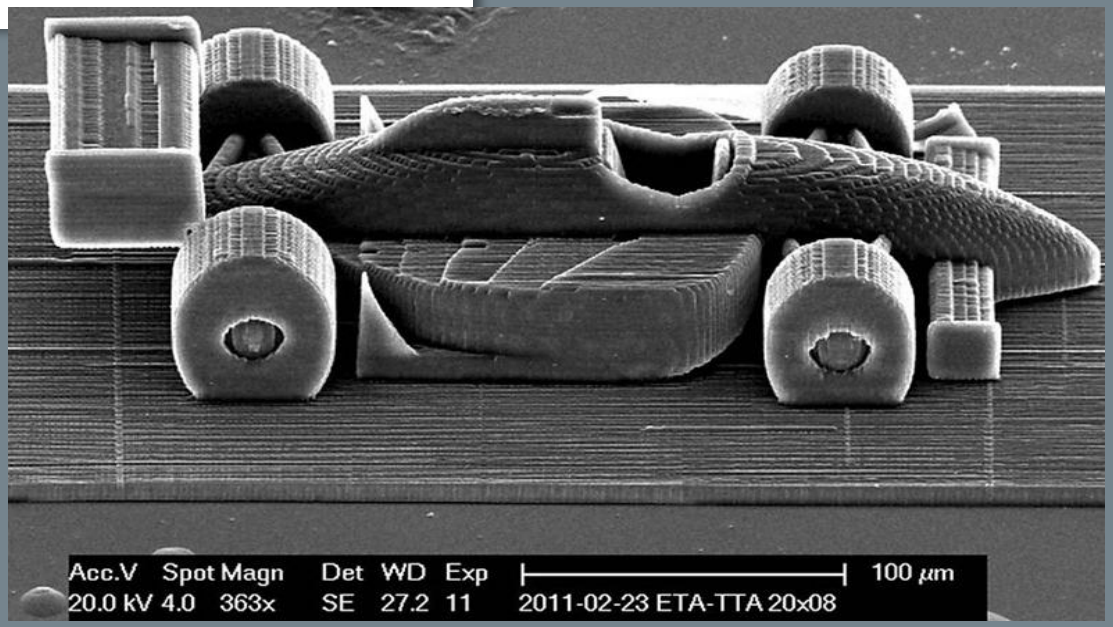
UNIVERSITY OF PATRAS

Department Of Chemical Engineering

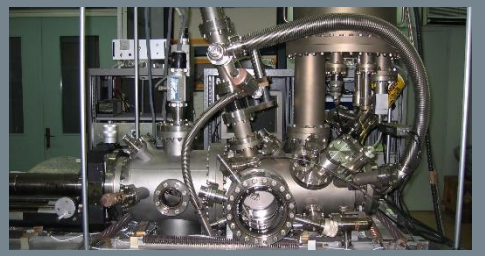
ChemEngUP

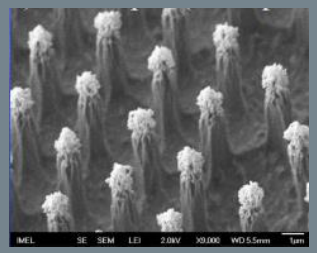


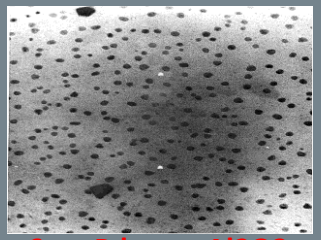
Surface, Interface and Thin Film Science and Technology

E. Amanatides, S. Kennou, D. Kouzoudis, S. Ladas, D. Mataras

General description of the Research Area







6nm Pd on α-Al2O3

Condensed Matter

Bulk materials
Solid State
Physics

Molecular Physics

HV & UHV technology

Surface Modification

Heteroge-neous catalysis

Surface and Interface Physics

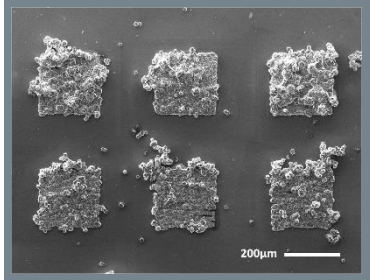
Real surfaces
Thin Films
Nanotechnology

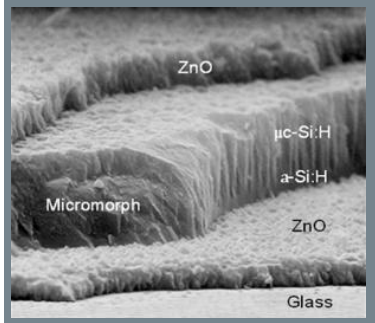
Computer calculations

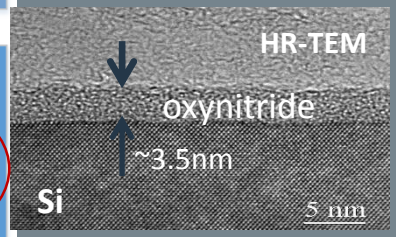
Particle beam optics

Semicondu-ctors and devices

Nano-analysis tools







Oxynitride properties by XPS:
N/Si ratio: 0.54 Thickness ~ 3.2 nm

Research Groups

PLASMA TECHNOLOGY LABORATORY

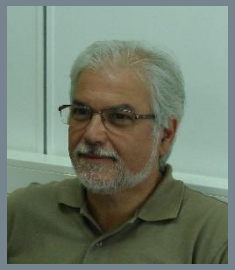
Prof. Dimitrios Mataras
PECVD of semiconductors, surface modification

www.plasmatech.gr

Assist. Prof. E. Amanatides
PECVD, thin films characterization

SURFACE SCIENCE LABORATORY

Prof. Stella Kennou
Experimental Surface Physics



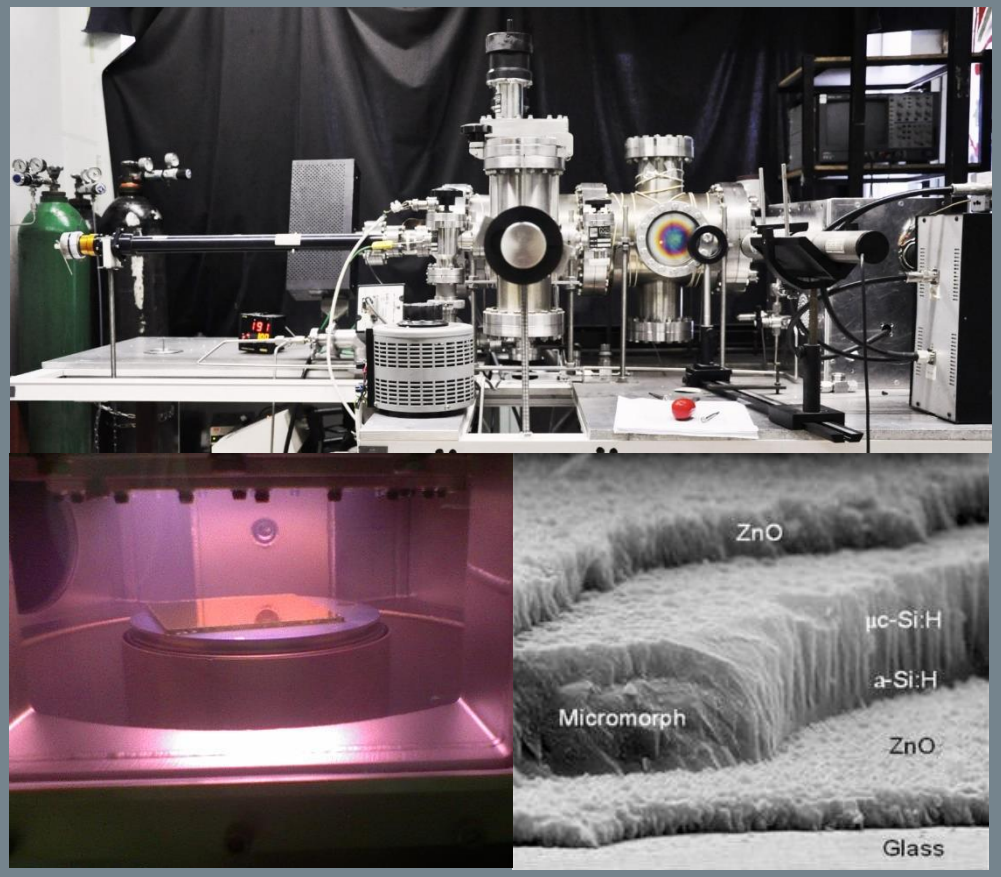
http://athena4.chemeng.upatras.gr/

Prof. Spyros Ladas
Surface Science

ELECTRON BEAM LITHOGRAPHY LABORATORY

Assist. Prof. Dimitrios Kouzoudis
Magnetoelastic materials, sensors, zeolites

http://www.des.upatras.gr/physics/kouzoudis/ourgroup/home.htm



Plasma Technology Laboratory

Plasma Enhanced Chemical Vapor Deposition of Thin Films and Surface Modification

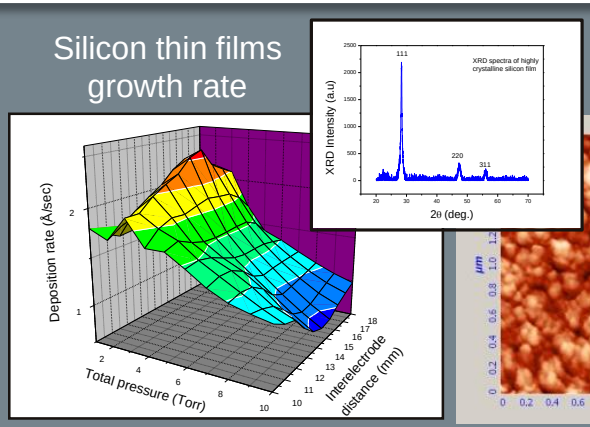
Research Activities

- Plasma Enhanced Chemical Vapor Deposition of hydrogenated silicon for thin film photovoltaics. Increase of film growth rate and improve materials quality

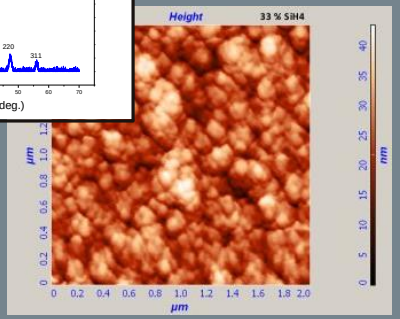
- Atmospheric and low pressure plasma treatment and grafting of polymers and metals for antimicrobial surfaces and biomedical devices

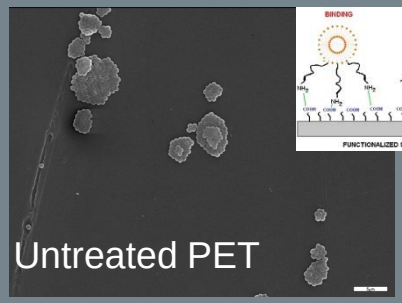
- Thin Films and surfaces physicochemical characterization (SPM, XRD, Raman, IR and UV/Vis spectroscopies

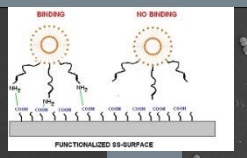
Silicon thin films growth rate

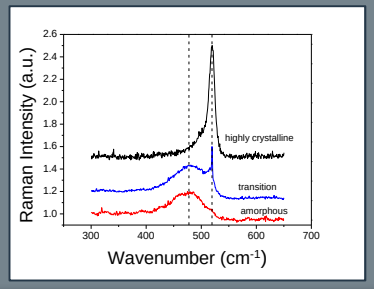


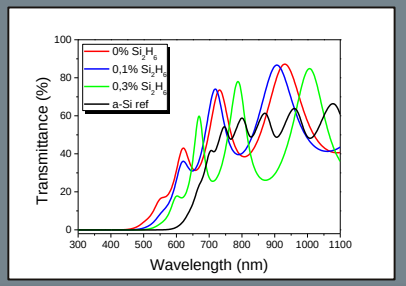
and structure











Researchers

- 1 Professor, 1 Assistant Professor, 1 Lecturer, 5 PhD Student, 6 diploma thesis students

D. Mataras, Prof.

E. Amanatides
Assist. Prof

N. Spiliopoulos
Lect.(Physics Dept.)

E. Farsari, PhD
Thin Films
PECVD, AFM

V. Vrakatselli, PhD
Superhydrophilic Thin Films, Surface modification

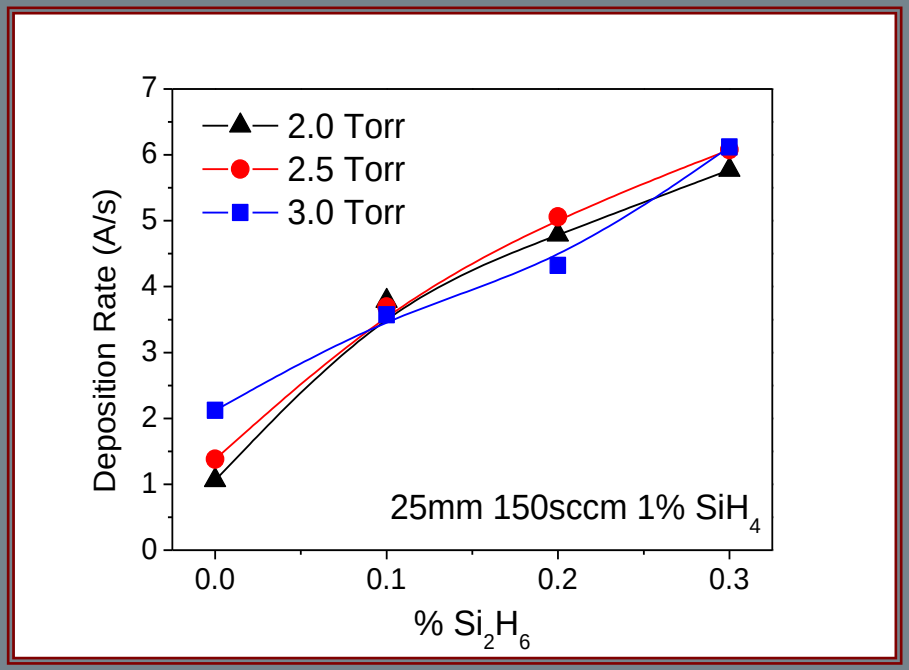
P. Dimitrakellis, PhD
PECVD silicon
New Plasma Sources

J. Alexiou, PhD
PECVD silicon
Optoelectronic properties

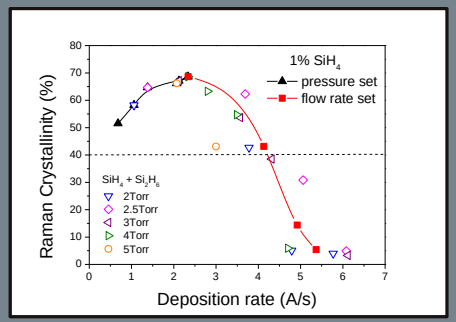
G. Tsigaras, PhD
Plasma Diagnostics and modelling

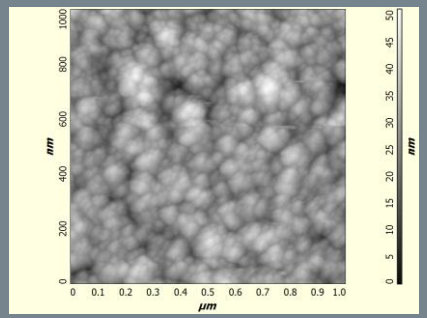
Research Activity: PECVD of Si:H thin films

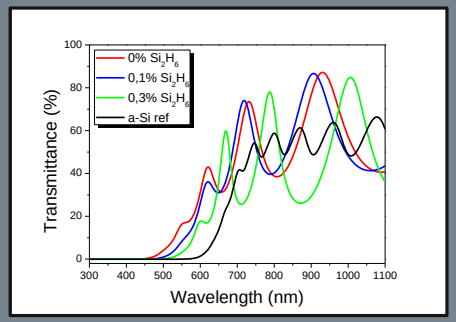
Patent: Application No./Patent No. 12306522.9-1508, 2012 Title: Microcrystalline Silicon Thin Film PECVD using hydrogen and Silane Mixtures, European Patent Office 5.12.12, V. Lahootun, A. Madec, E. Amanatides, D. Mataras, AIR LIQUIDE - UNIVERSITY OF PATRAS

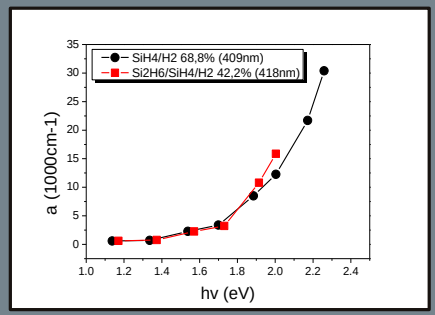


Catalytic effect of small disilane addition on film growth rate of microcrystalline silicon thin films







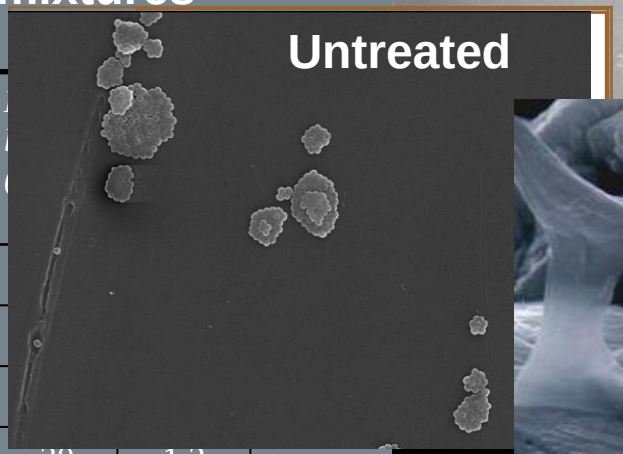


Materials quality is preserved even if the growth rate is 5 to 6 times higher!

Research Activity: Antimicrobial Surfaces

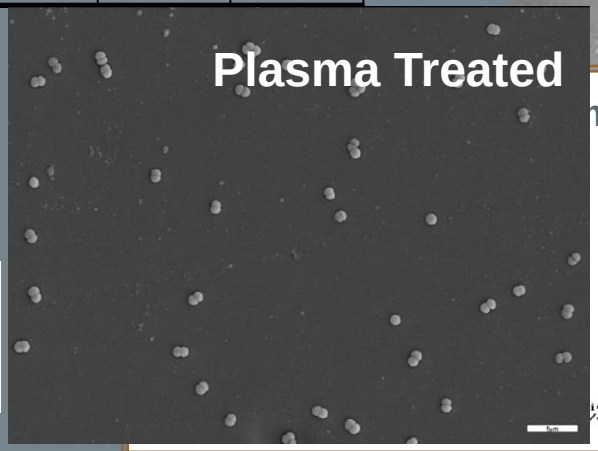
PET treatment from various O2/He mixtures

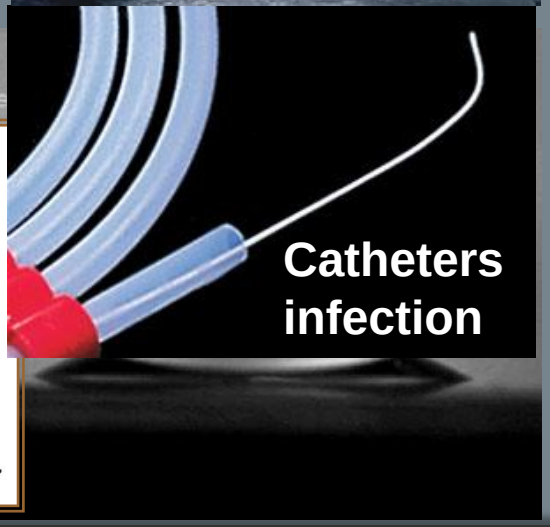
Sample name	*He flow rate (sccm)*	*O_2 flow rate (sccm)*	*Pressure (Torr)*	*RF voltage V_{RF} (Volt)*		
PET5	20	0	0.25	305		
PET6	18	2	0.25	306		
PET7	16	4	0.25	278		
PET8	10	10	0.25	242	-30	1.2
PET9	0	20	0.25	200	-30	1.2
PET10	20	0	0.5	300	-30	2.0

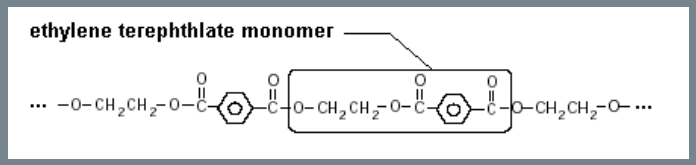


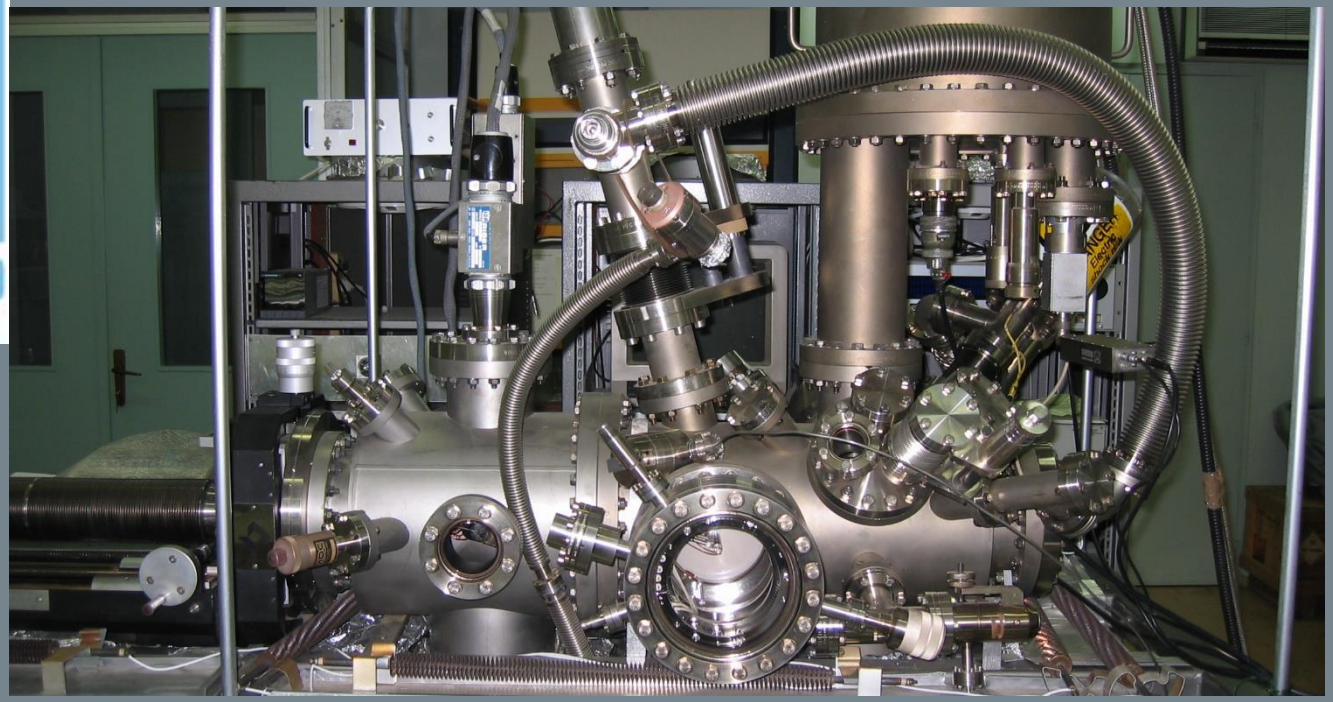
Incr h

Reduction of bacteria adhesion with plasma treatment





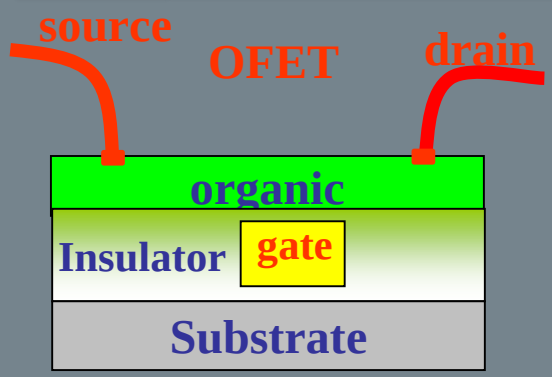




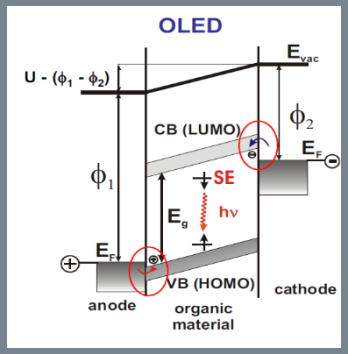
SURFACE SCIENCE LABORATORY

S. Kennou, S. Ladas

SSL Research Activities

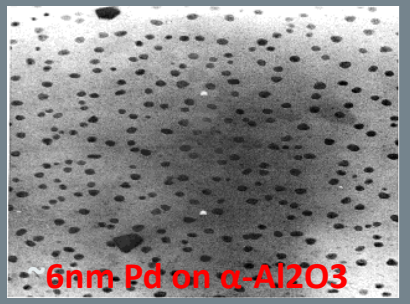


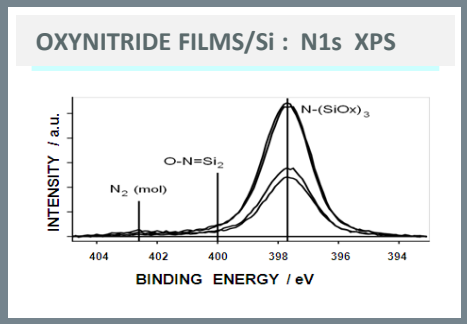
- Surface and Interface Studies of Electronic Materials
  - Material Interfaces for Organic Electronics
  - Metal-semiconductor and metal/ceramic Interfaces



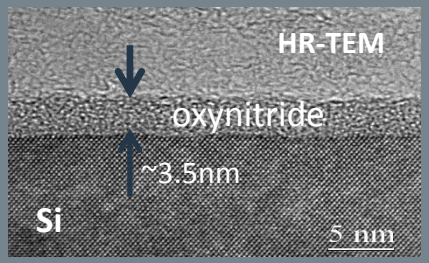
$(\sqrt{3}x\sqrt{3})R30°\ MgCl_2/Si(111)$

- Surface Science aspects of Heterogeneous Catalysis
  - Experiments on single-crystal model catalysts
  - Study of realistic model catalysts





- Ex-situ Spectroscopic Materials Characterization in the frame of :
  - Research collaborations both in Greece and abroad
  - ISO17025-Accredited Surface Analysis Services



Oxynitride properties by XPS:
N/Si ratio: 0.54 Thickness ~ 3.2 nm

SSL Researchers

- FACULTY MEMBERS (2):

  Prof. Stella Kennou  Prof. Spyros Ladas 

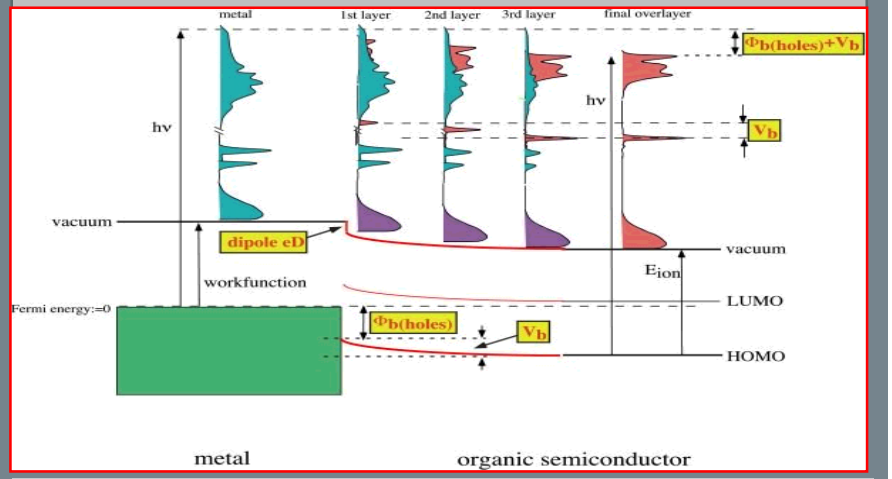
- GRADUATE STUDENTS (3):

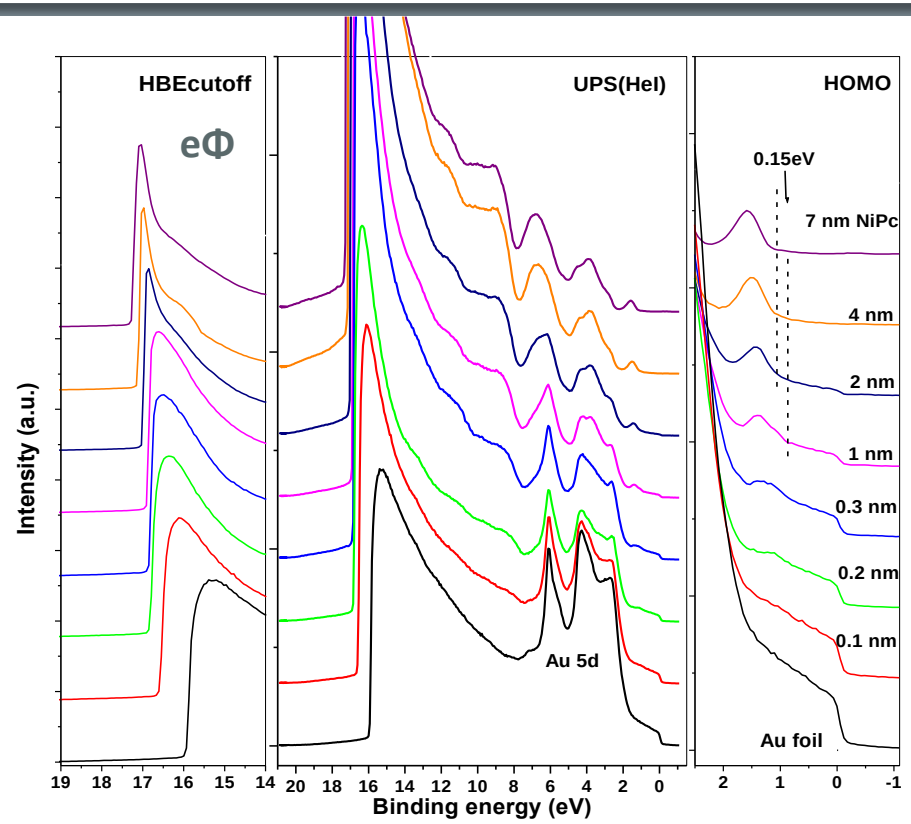
  Dimitris Tsikrintzis (Chemical Engineering)
  Giorgos Skoulatakis (Materials Science)
  Kostas Emmanouil (Materials Science)

- At the moment, there are three (3) undergraduate students working towards their Diploma Thesis.

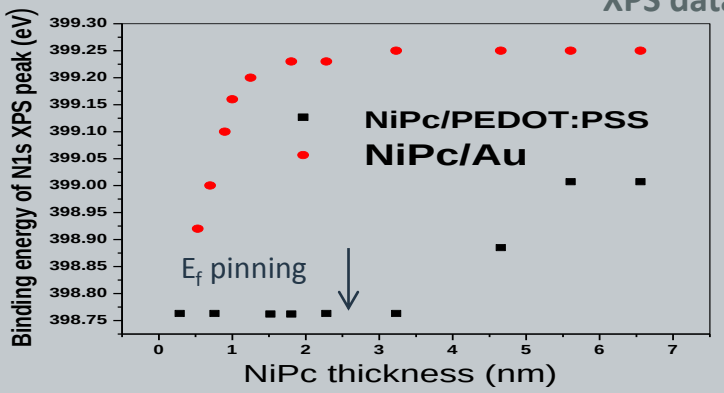
Material Interfaces for Organic Electronics
Project Description

Growth of Ni- phthalocyanine films by thermal evaporation in UHV on Au, PEDOT:PSS, Ag and ITO substrates and XPS / UPS measurements during the evolution of the NiPc /substrate interface





XPS data, V_b



Determination by XPS/UPS of :

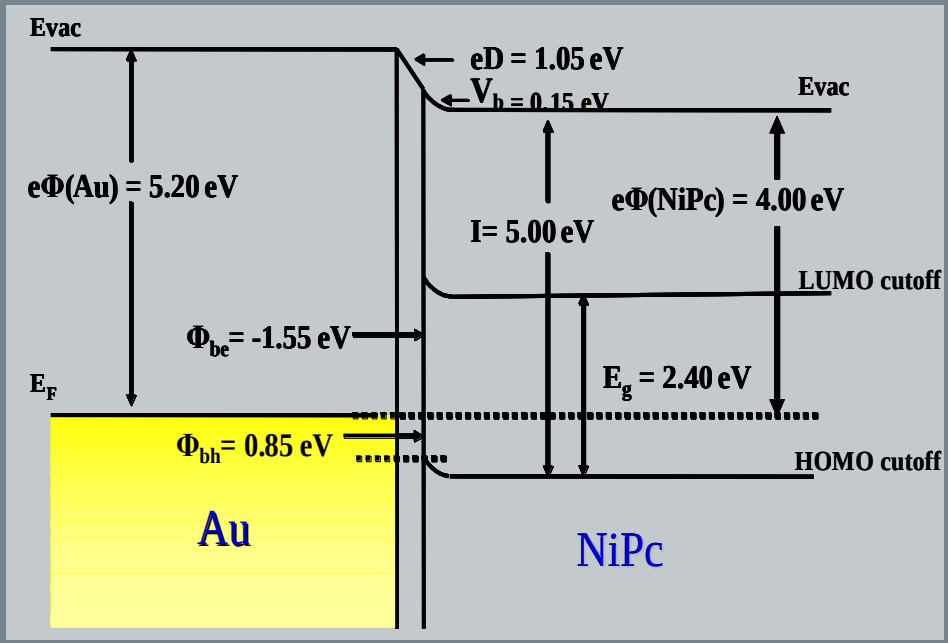
Ionization Energy : $I = e\Phi + HOMO_{cutoff}$

Band bending: V_b

Interface dipole: $eD = \Delta e\Phi - V_b$

Hole injection barrier : $\Phi_{bh} = HOMO_{cut\text{-}off} - V_b$

Material Interfaces for Organic Electronics: Results



(WF / eV)	eD (eV)	$HOMO_{c.o}$ (eV)	Φ_{bh} (eV)
NiPc(4.0)			
Au (5.2)	-1.05	0.85	0.85
PEDOT:PSS (4.9)	-0.6	0.5	**0.5**
PEDOT:PSS (4.7)	-0.4	0.5	**0.5**
Ag (4.4)	-0.3	0.9	0.9
ITO (4.2)	-0.2	1.0	1.0

- The results demonstrate the influence of the substrate type and treatment (e.g.sputtered and not-sputtered PEDOT:PSS) on the various factors affecting device performance, the main one being the **Hole Injection Barrier** (last column). The lowest (most desirable) value is obtained on the PEDOT:PSS substrate for NiPc.

Spectroscopic Thin Film Characterization

Interfaces

/inadvertent "Carbon" contamination /

\\\\\\\\\\\\\\\\\\\\Material II \\\\\\\\\\\\\\\\\\\\

//////////////////////// Material I ////////////////////

\\\\\\\SUBSTRATE (e.g. Si wafer) \\\\\\\\

< 10 nm (XPS-visible)

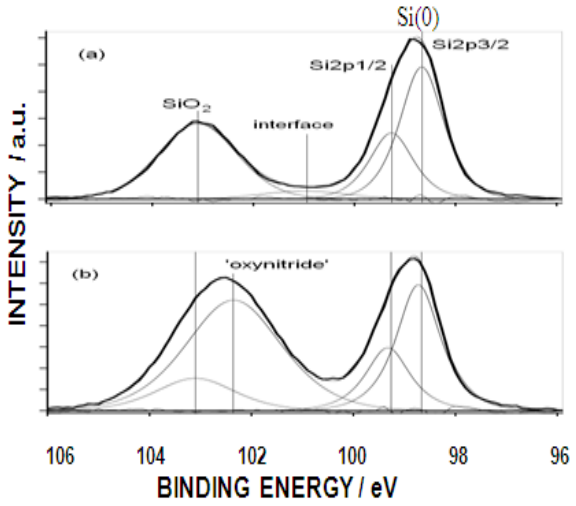
Develop methods for exploiting spectroscopic data, to extract in a single measurement composition and thickness of individual films in stacks of interest for nano-electronics (e.g.high-k oxides) and nano-coatings (e.g. anti-corrosion layers on structural alloys)

CASE STUDY : XPS on plasma-nitrided SiO_2 films ; STACK : Si substrate / nitrided film / superficial 'C'

OBJECTIVE: Obtain thickness and nitrogen content of ultra-thin oxynitride film from XPS data

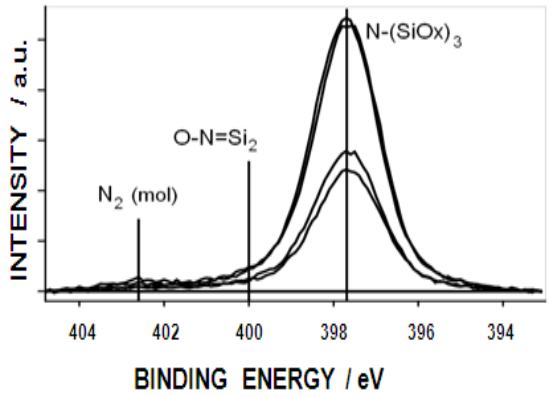
PEAK FITTING IN THE Si 2p REGION

(a) 2NM07 (plasma OFF) (b) 2NM05 (10 min plasma)

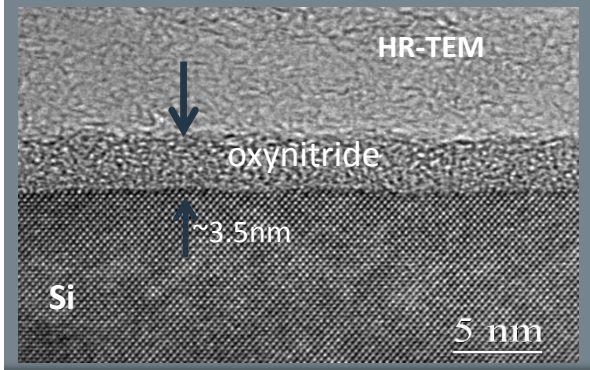


PHOTOPEAKS IN THE N 1s REGION

2NM03/45°, 2NM03/0°, 2NM05/45°, 2NM05/0° (in descending order)



For nitrided film (2NM05) :
- **N/Si ratio: 0.54 (only by XPS)**
- **XPS –derived thickness ~ 3.2 nm (in excellent agreement with HR-TEM)**

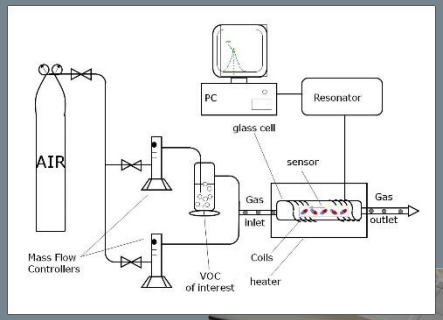


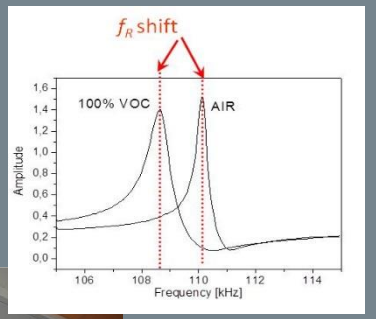
Electron Beam Lithography Lab

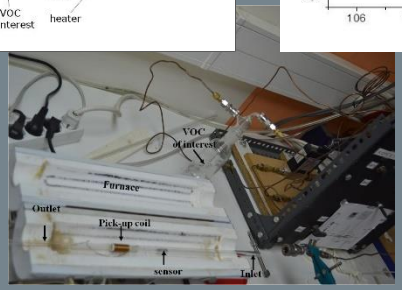
Magnetoelastic materials, sensors and zeolites

Research Activities

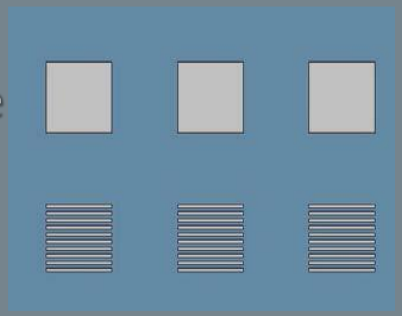
- Magnetoelastic sensors: Synthesis and characterization of zeolite films on magnetoelastic ribbons (Metglas)
  - sensors of VOC's and other gases
  - determine mechanical properties of zeolite films upon gas adsorption

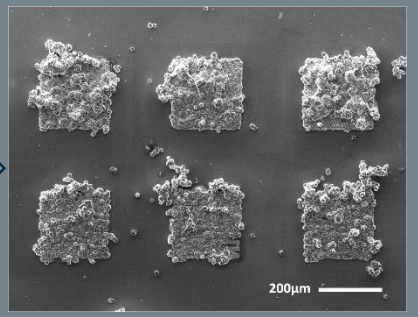






- Electron beam lithographed microfilms
  - controlled size and position of zeolite films upon Metglas
  - Dimensions in the micro-scale
  - Integration to micro-devices
  - Enhanced sensing ability





Researchers

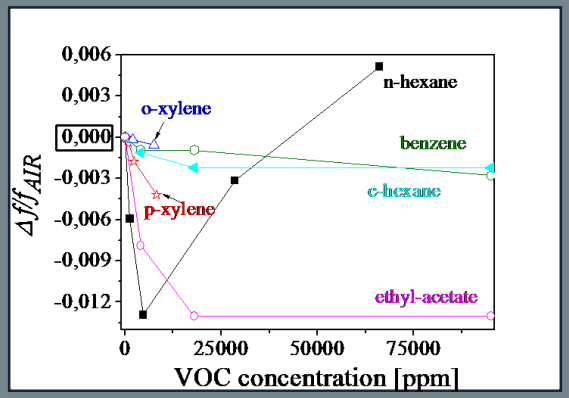
Assist. Prof. Dimitrios Kouzoudis
Magnetoelastic materials, sensors, zeolites

Theodore Baimpos, Chemical Engineer, PhD (sensors, zeolites, modelling)

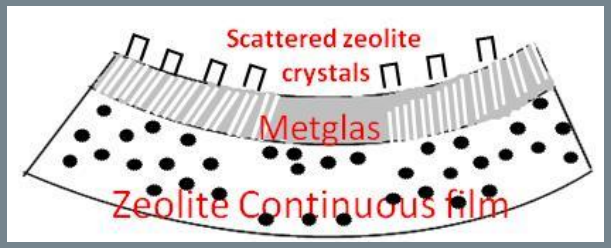
Vassiliki Tsukala, Chemical Engineer, PhD (zeolites, lithography, characterization techniques)

Research Activities: Magnetoelastic sensors

- Detection of six VOC's (o-xylene, p-xylene,n-hexane, c-hexane, benzene, ethyl-acetate)

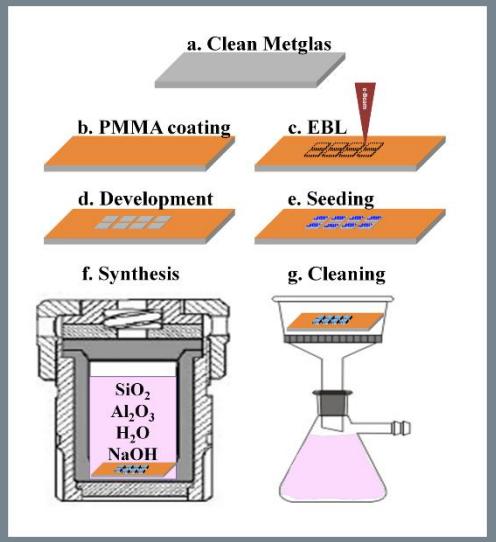


- Development of two new techniques for stress measurement

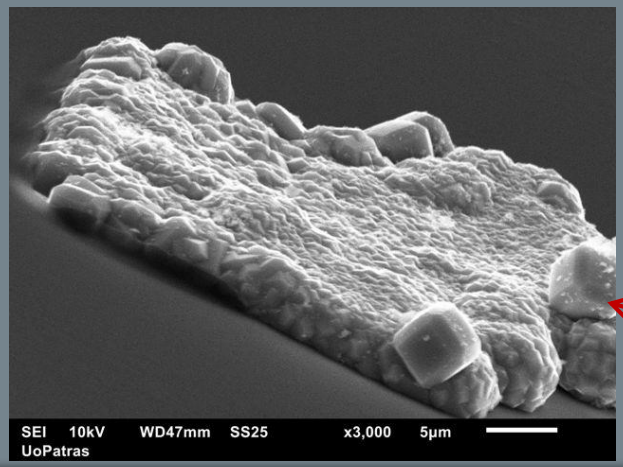


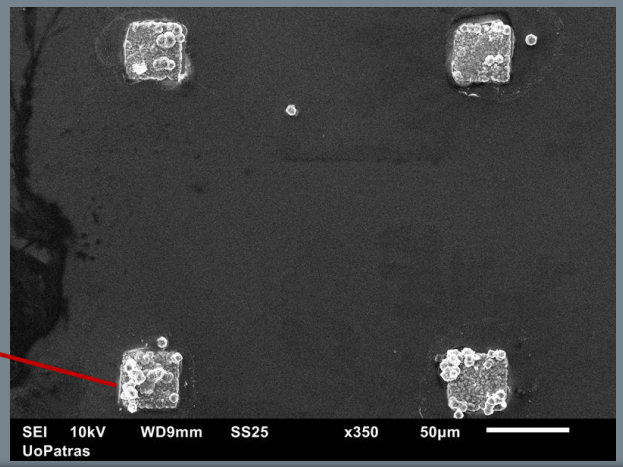
Research Activities: E-beam lithographed microfilms

- Development of a new technique for the fabrication of zeolite microfilms employing e-beam lithography



- Hydrothermal synthesis of Linde Type A (LTA) microfilm arrays of 20μm sides





Research Projects – All Groups Funding

Total Budget (2007-2013): 2.9 M€, 7 European Projects (65%), 4 National (25%), 4 Industrial (10%)

Characteristic Projects

- Joint Research and Technology Programs (Greece – Non-European countries), “Fabrication, characterization and testing of a nanostructured composite zeolite-metglas VOC/ odor sensor”, 2006-2008, 100k€
- INTERREG IIIA, GREECE – ITALY «Development of a multidisciplinary scientific network for the investigation and application of biomaterials” 2007 -2009, 650 k€
- UPAT – AIR LIQUIDE: " Catalytic Effect of Disilane Addition on μc-Si:H growth rate ", Industrial Project, Air Liquide – Patras, 2011-2013, 100 k€
- EU FP7 "Demonstration of high performance Processes and equipment's for thin film silicon photovoltaic modules produced with lower environmental impact and reduced cost and material use", 2010-2013 850 k€
- THALIS, Title: " Design and fabrication of Robust super hydrophobic/hydrophilic surfaces and their application in the realization of “smart” microfluidic valves ", 2012-2015, 250 k€
- FP6-RII3, “European Integrated Activity of Excellence and Networking for Nano and Micro-Electronics Analysis”, 2006-2011 130 k€
- FP7- NoE/ICT, “Network of Excellence for building up knowledge for improved system integration for Flexible Organic and Large Area Electronics (FOLAE) and its exploitation”, 2010-2012, 170 k€

Publications – All groups

Total No of Publications SCI journals: ~114 (2007-2013), Citations (excluding self): ~2100

Conference Proceedings and Announcements: ~210 (2007-2013)

Few examples

1. A modified method for the calculation of the humidity adsorption stresses inside zeolite films using magnetoelastic sensors, T. Baimpos, V. Tsukala, V. Nikolakis, D. Kouzoudis, Sens. Lett. (2012), 10, 879

2. A new method for measuring the adsorption induced stresses of zeolite films using magnetoelastic sensors, T. Baimpos, D. Kouzoudis, V. Nikolakis, J. of Membrane Science, 390–391, 130–140, (2012)

3. "A hybrid kinetic Monte Carlo method for simulating silicon films grown by plasma-enhanced chemical vapor deposition" D.G. Tsalikis, C. Baig, V.G. Mavrantzas, E. Amanatides and D. Mataras Journal of Chemical Physics, Accepted Corrected Proofs (2013)

4. "Growth kinetics of plasma deposited microcrystalline silicon thin Flms", E. Amanatides and D. Mataras, Surf. Coat. Technol., 205 178 (2011)

5. High performance OLEDs embedding tungsten suboxide as efficient hole injection layer" , M. Vasilopoulou, G. Papadimitropoulos, L. C. Palilis, D. G. Georgiadou, P.Argitis, S. Kennou, I. Kostis, N. Vourdas, N. A. Stathopoulos , D. Davazoglou, Organic Electronics, 13, 796 (2012).

6. "An X-ray photoelectron spectroscopy study of strontium-titanate-based high-k film stacks" , L.Sygellou, H. Tielens, C.Adelmann, S.Ladas, Microelectronic Engineering, 90, 138 (2012).

7. "Electronic and interface properties of polyfluorene films on GaN for hybrid optoelectronic applications" G. Itskos, X. Xristodoulou, E. Iliopoulos, S. Ladas, S. Kennou, M. Neophytou, S. Choulis, Appl. Phys.Lett, 102, 063303 (2013).

THANKS FOR THE ATTENTION