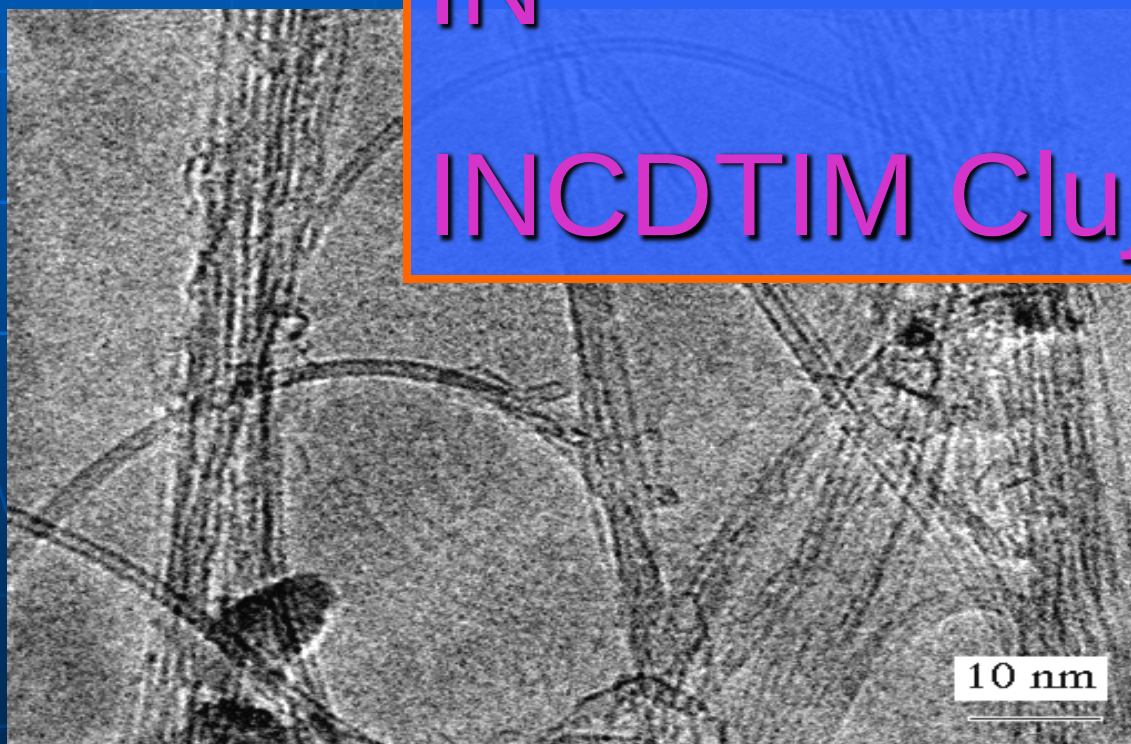




NANOTEHNOLOGII IN INCDTIM Cluj-Napoca



NANOTEHNOLOGII in activitatea de cercetare a departamentelor INCDTIM :

❑ DEPARTAMENTUL DE SPECTROMETRIE DE MASA, CROMATOGRAFIE SI FIZICA APLICATA (DSMCFA)

❑ DEPARTAMENTUL DE FIZICA SISTEMELOR NANOSTRUCTURATE (DFSN)

❑ DEPARTAMENTUL DE FIZICA MOLECULARA SI BIOMOLECULARA (DFMB)

❑ DEPARTAMENTUL DE FIZICA SI TEHNOLOGIA IZOTOPIILOR (DFTI)



DEPARTAMENTUL DE SPECTROMETRIE DE MASA, CROMATOGRAFIE SI FIZICA APLICATA (DSMCFA)

Tematici de cercetare:

- Materiale pentru stocarea hidrogenului si aplicatii in utilizarea energiilor recuperabile
- Nanostructuri de carbon: nanotuburi, grafene



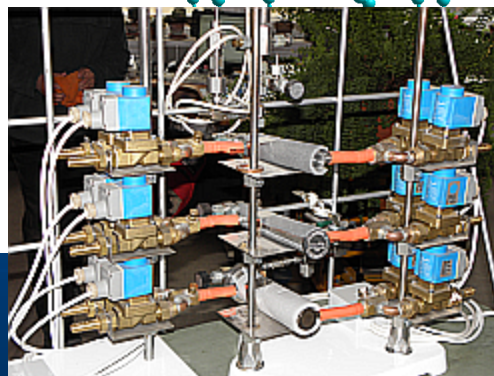
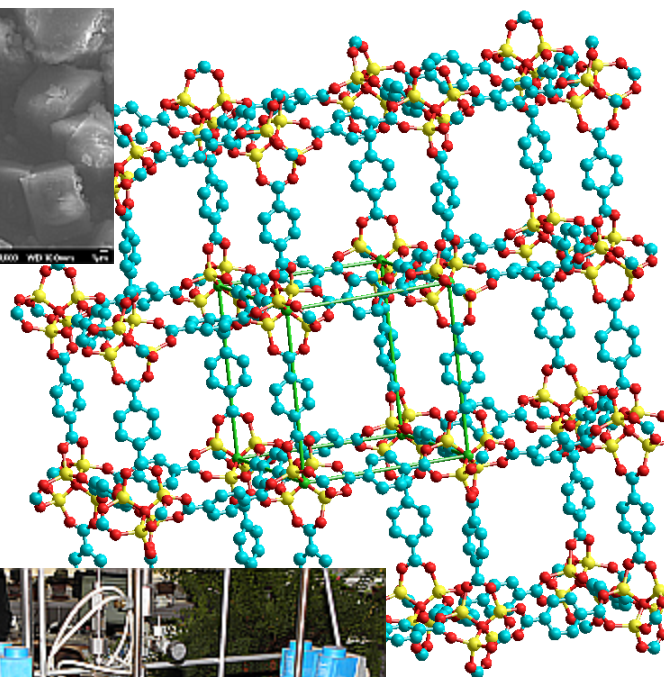
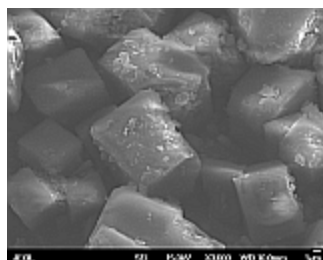
Tematica de cercetare:
**Materiale pentru stocarea
hidrogenului si aplicatii
in utilizarea energiilor
recuperabile**

*Subiecte de cercetare
abordate:*

- *Materiale de stocare a
hidrogenului (hidruri
metalice, structuri poroase
metalo-organice MOF si
compozite ale acestora cu
nanostructuri de carbon)*
- *Sinteze de noi MOF si
tehnologii noi de obtinere
de compozite cu MOF.*

Echipa de cercetare:

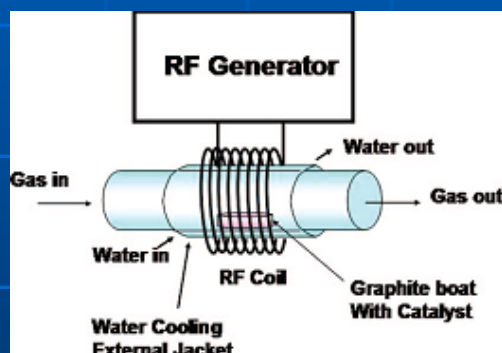
Gabriel Popeneciu, Ioan Coldea, Gabriela Blanita, Ioan Misan, Ioan Toma



Nanostructuri de carbon: nanotuburi si grafene

Colectiv: Dr. Alexandru R. Biris (biris@itim-cj.ro); Drd. Stefania Ardelean (stefania@itim-cj.ro);
Dr. Dan Lupu (lupu@itim-cj.ro)

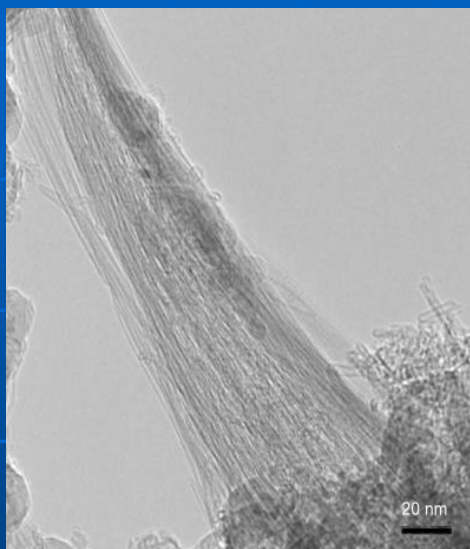
Sinteza nanostructurilor de carbon(NSC) prin metoda CCVD (*Catalytic Chemical Vapour Deposition*) cu incalzire inductiva in reactor cu perete racit cu apa;



Premiera mondiala: [Carbon, 42(3), 503-507, 2004]

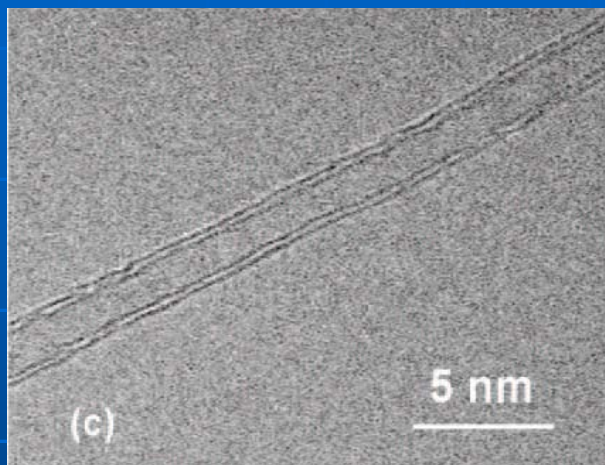
Purificarea si functionalizarea fizico-chimica a NSC-urilor;

Nanotuburi de carbon: cu unul (SWCNT), doi (DWCNT) sau mai multi pereti (MWCNT)



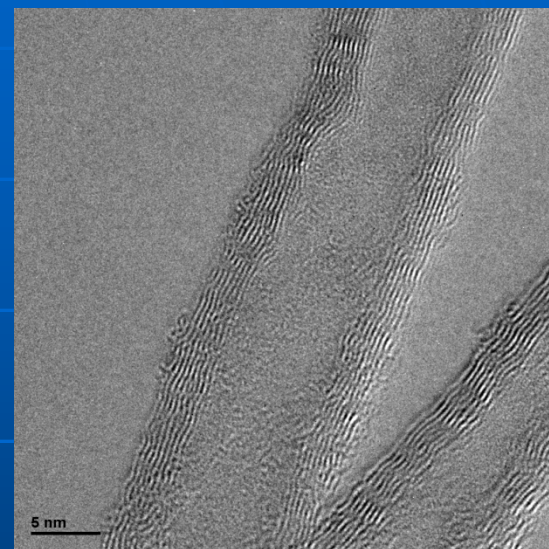
SWCNT

[*Phys. Lett. A*, **372**(17),
3051-3057, 2008.]



DWCNT

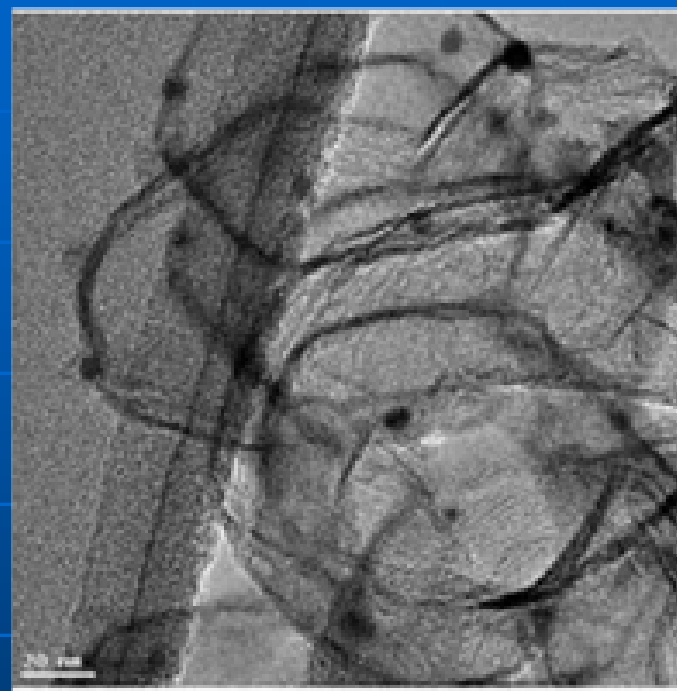
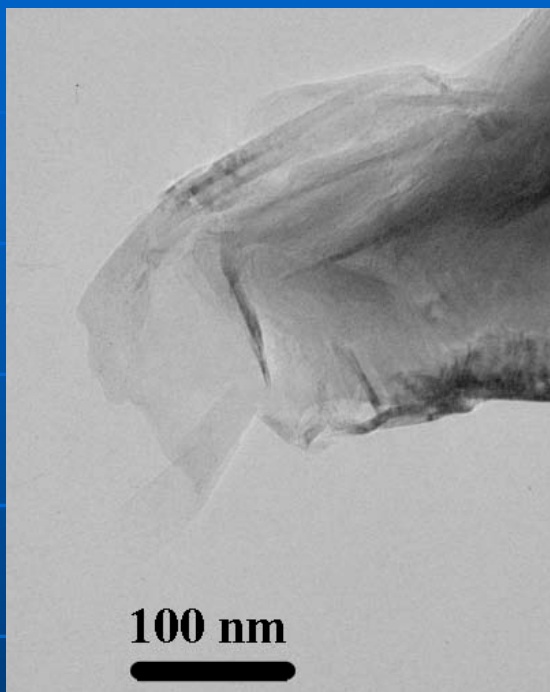
[*Chem. Mater.*, **20**(10), 3466-
3472, 2008.]



MWCNT

[*Chem. Phys. Lett.* **429**(1-3),
204-208, 2006.]

Grafene

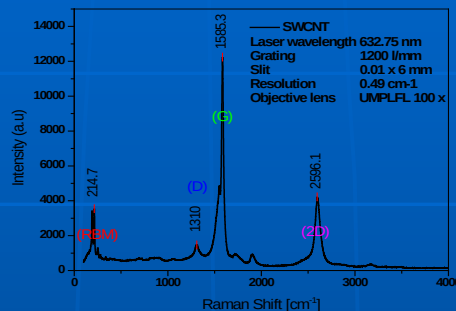


Sintetizate in premiera mondiala pe catalizatori metal/suport oxidic

[*Chem. Commun.*, Issue 27 , 4061-4063, (2009)]

Metode de analiza a nanostructurilor de carbon

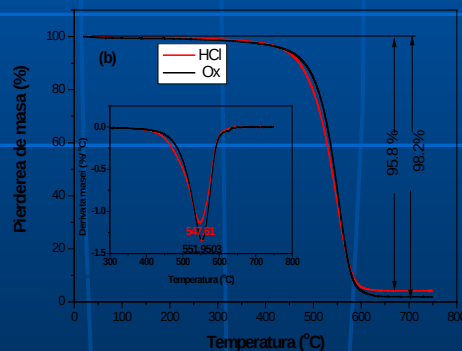
Spectroscopie Raman (NRS 3300, Jasco,)



Laseri excitare: 458, 476,
488, 633 si 785 nm

Obiective:
5X, 20X, 100X VIS
20X, 100X NIR

Analize termogravimetrice (SDT Q600, TAInstruments)



Tmax = 1500°C,
viteza de incalzire (0.01-100°C/min)
rata de purjare (0-1000 ml/min)
sensivitate 0.1 µg
sensivitate DTA= 0.001°C.

Caracterizarea prin microscopie electronica (SEM, TEM) se realizeaza in cadrul unui acord de colaborare cu: *University of Arkansas at Little Rock, Nanotechnology Center* (www.ualr.edu/nanotechnology).



Participarea la proiecte

- Program CERES, "Fenomene de interfata si suprafata la generarea nanotuburilor de carbon. CO: INCDTIM Cluj-Napoca.
- Program CEEEX, "Materiale avansate pentru industria aerospaciala: compozite C-C cu matrice mezofazica aditivata cu nanotuburi de carbon si compozite laminate figre-metal". CO: INCAS Bucuresti.
- PNCDI II, "Terapia tinta moleculara a neoplasmului pancreatic prin excitarea optic rezonanta LASER a nanotuburilor de carbon functionalizate chimic si internalizate celular". CO: UMF Cluj-Napoca
- PNCDI II, "Nanoterapia fototermica a hepatocarcinomului prin internalizarea intracelulara si mecanism de activare LASER a nanotuburilor de carbon bio-ligant functionalizate". CO: UMF Cluj-Napoca
- PNCDI II, "Evaluarea si modularea biodistributiei si toxicitatii nanotuburilor de carbon cu aplicatii biomoleculare". CO UMF Cluj-Napoca

Realizari ale colectivului in domeniul NSC

- Autori si coautor la peste 50 publicatii ISI in domeniu
- 250 citari in reviste ISI (fara autocitari)
- Indexul-Hirsch: 12
- 2 patente SUA, 2 cereri de patente OSIM



DEPARTAMENTUL DE FIZICA SISTEMELOR NANOSTRUCTURATE

Tematici de cercetare:

- Investigarea proprietatilor structurale si energetice ale sistemelor nanostructurate
- Sisteme supramoleculare cu substante bioactive. Proprietati fizico-chimice si structurale
- Sisteme semiconductoare si sisteme fotocalitice
- Nanostructuri metalice, senzori si microsenzori
- Caracterizarea materialelor micro si nanostructurate prin Rezonanta Electronica de Spin
- Sisteme nanostructurate biocompatibile pe baza de polimeri si nanoparticule magnetice
- Materiale hibride pe baza de nanoparticule magnetice. Sisteme nanomagnetice: sinteza, caracterizare, aplicatii.
- Tehnologii de analiza a compozitelor moleculare.



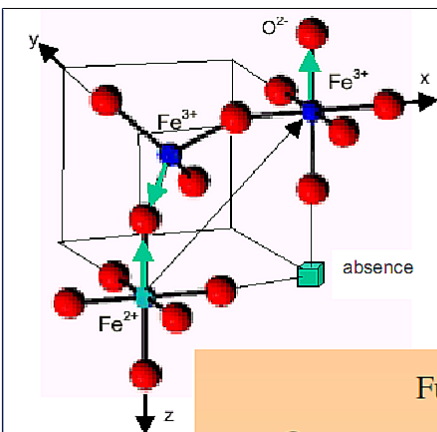
Echipa de cercetare:

Nicolae Aldea, Vasile Rednic, Lidia Rednic

Tematica de cercetare: **Investigarea proprietatilor structurale si energetice ale sistemelor nanostructurate**

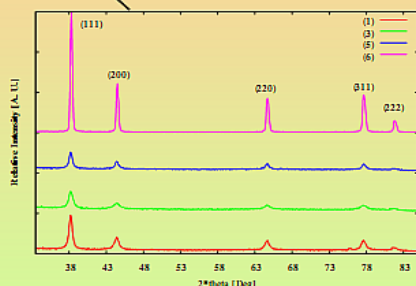
Subiecte de cercetare abordate:

Reducerea emisiilor de gaze cu efect de sera folosind catalizatori metalici suportati. Tehnologie de obtinere, preparare si caracterizare fizico-chimica;
Tehnologia de obtinere, caracterizarea structurala si electronica a catalizatorilor metalici suportati cu aplicatii directe in protectia mediului;



Fundamental equation of spectroscopy

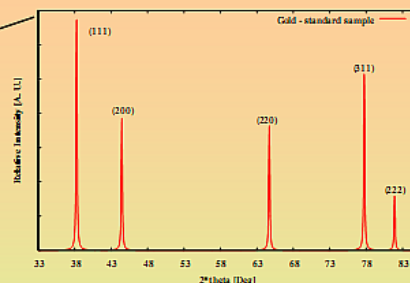
$$h(s) = \int_{-\infty}^{+\infty} f(s^*) g(s^* - s) ds^*$$



h – experimental spectrum (physical and instrumental information)

g – instrumental contribution of setup

f – true sample function as a solution



Solving methods (ill posed problem):

- Fourier transform
- Regularization
- Third order spline functions

f and its FT contain all nanostructural information

Metode de investigare a sistemelor nanostructurate cu structura core-shell si a clusterilor metalici prin difractie de raze X si spectroscopie de absorbtie de raze X, XPS si de tunelare.



Tematica de cercetare:

**Sisteme supramoleculare cu
substante bioactive.**

**Proprietati fizico-chimice si
structurale**

Subiecte de cercetare abordate:

*Noi sisteme vitroase telurate si
germanate cu aplicatii in
telecomunicatii;*

*Metode fizice si computationale
performante in astrofizica nucleara
si aplicatii pentru nuclee si fascicule
radioactive;*

*Sisteme supramoleculare de
incapsulare si cedare controlata de
principii bioactive.*



Echipa de cercetare:

Ioan Bratu, Irina Kacsó, Sorina Ciupe

Tematica de cercetare:

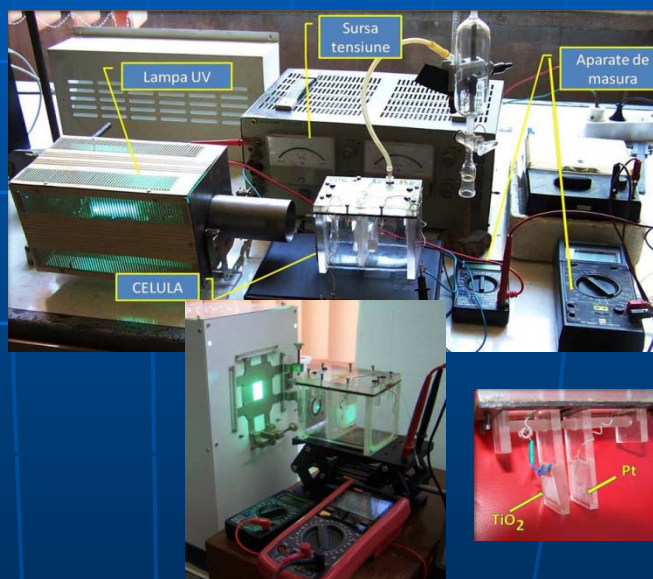
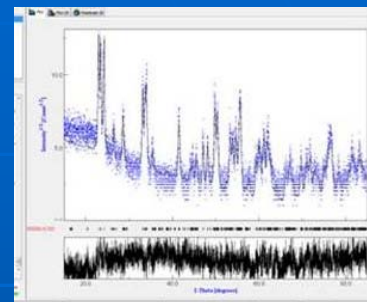
Sisteme fotocatalitice si sisteme semiconductoare

Subiecte de cercetare abordate:

- Sisteme semiconductoare cu eficienta fotocatalitica ridicata pentru aplicatii biomedicale;
- Noi sisteme fotocatalitice cu eficienta ridicata pentru reactiile de foto-degradare si pentru producerea de hidrogen prin reactia de foto-disociere a apei;
- Procedee chimice avansate de obtinere a peliculelor oxidice fotocatalitice semiconductoare de eficienta ridicata pentru conversia energiei solare;
- Preparate biocompatibile multifunctionale pe baza de polimeri naturali pentru aplicatii in medicina inovativa si reparatorie;



sisteme fotocatalitice



conversia energiei solare



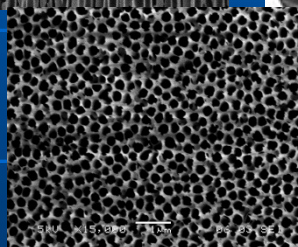
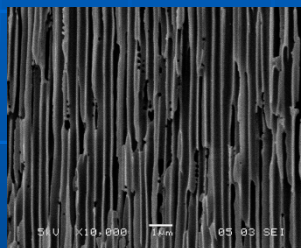
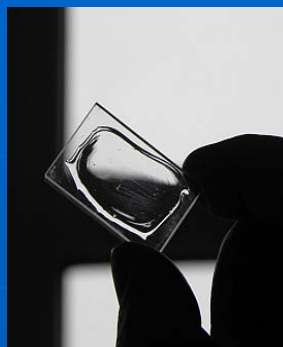
Echipa de cercetare: Indrea Emil, Silipas Teofil-Danut, Simina Dreve, Ramona Suciu, Marcela Rosu

Tematica de cercetare:

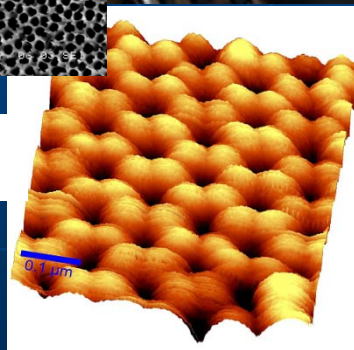
**Nanostructuri metalice,
senzori si microsenzori**

*Subiecte de cercetare
abordate:*

- *Obtinerea de nanostructuri metalice folosind matrici de oxid anodic de aluminiu;*
- *Studiul structurilor supramoleculare cu nanoparticule biofunctionalizate;*
- *Obtinere si caracterizare de nanoparticule metalice (aur, argint, cupru);*
- *Obtinerea si caracterizarea nanostructurilor hibride pe baza de nanoparticule metalice si biomolecule.*



Aluminiu poros



Echipa de cercetare: Gheorghe Mihailescu, Sorina Garabagiu





Tematica de cercetare:

**Caracterizarea materialelor
micro si nanostructurate prin
Rezonanta Electronica de Spin**

Subiecte de cercetare abordate:

- *Cercetari privind sinteza si
caracterizarea materialelor
avansate cu aplicatii
supraconductoare si tribologice*

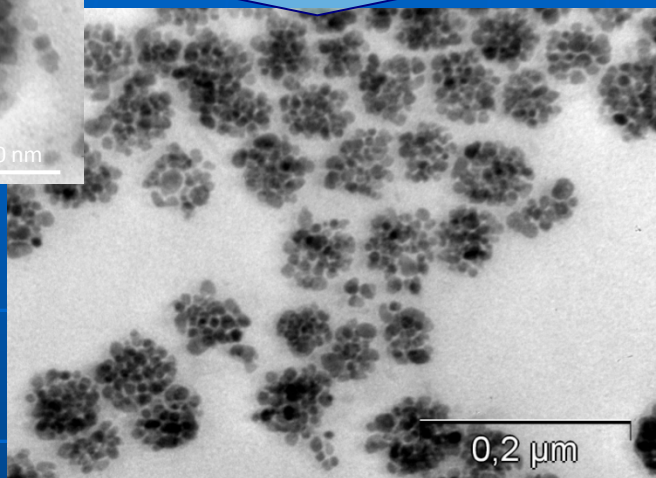
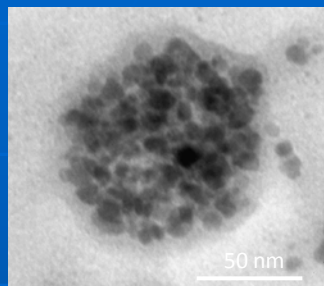
Echipa de cercetare:

Oana Raita, Adriana Popa, Dana Toloman

Encapsulation of magnetic nanoparticles into stimuli responsive hydrogels

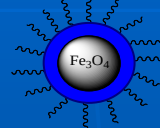
Poly (N-isopropylacrylamide) – PNIPA
Poly(acrylic acid) – PAAc

MICRO/NANO GELS

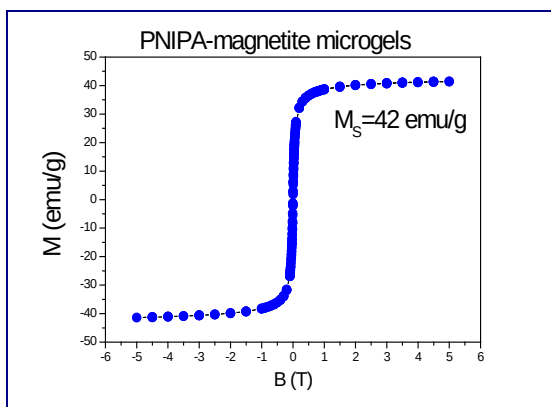
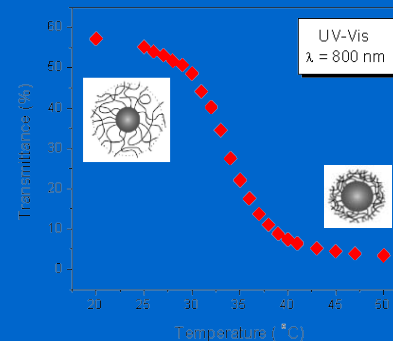
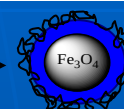


Temperature induced transition between swollen state and collapse state

$T < LCST$



$T > LCST$



- ✓ thermo and pH responsive properties;
- ✓ superparamagnetic behaviour;
- ✓ high stability and *in vitro* biocompatibility;
- ✓ applicability as new magnetic carriers in bioseparation equipments or as magnetothermally-triggered drug delivery systems.

Echipa de cercetare: Rodica Turcu, Alexandrina Nan, Izabell Craciunescu



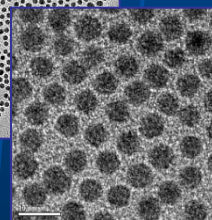
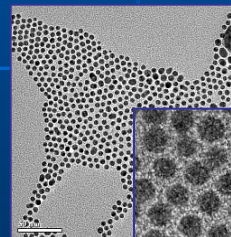
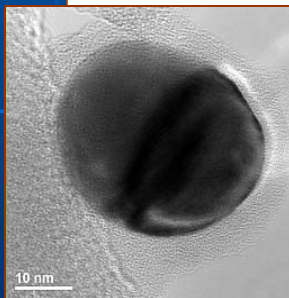
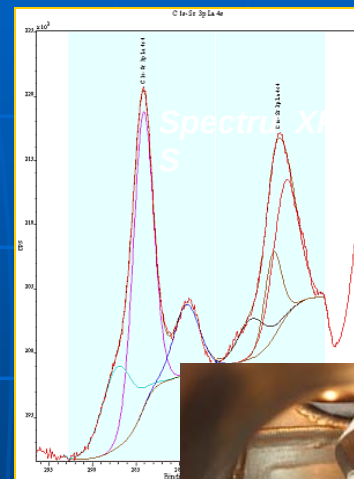
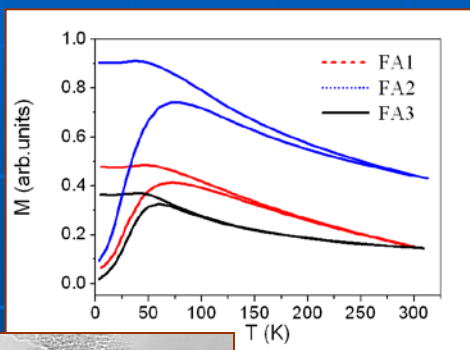
Tematica de cercetare:

Materiale hibride pe baza de nanoparticule magnetice. Sisteme nanomagnetice: sinteza, caracterizare, aplicatii. Tehnologii de analiza a compozitelor moleculare.

Subiecte de cercetare abordate:

- Nanoparticule magnetice metalice, oxidice si pe baza de aliaje: sinteza, caracterizare si aplicatii;
- Nanoparticule magnetice cu structura „core-shell”;
- Sisteme hibride polimeri / nanoparticule magnetice;
- Configuratii ordonate de nanoparticule feromagnetice „hard” si superparamagnetice;
- Nanostructuri de semiconductori oxidici transparenti cu proprietati controlabile prin dopaj;
- Materiale magnetice nanocompozite intarite prin schimb;
- Metode de investigare complexa a sistemelor nanostructurate prin difractie de raze X, spectroscopie de absorbtie de raze X (XANES, EXAFS), spectroscopie de fotoelectroni cu excitare in raze X (XPS) si spectroscopie de tunelare (STS-STM).

Masuratori ZFC-FC pentru nanoparticule magnetice cu structura core-shell de tip Fe@Au



Structura core-shell de tip LSMO@Au



Camera de masura XPS

Echipa de cercetare: Ioan–Ovidiu Pana, Maria–Loredana Soran, Gabriel Sergiu Macavei, Cristian Leostean



DEPARTAMENTUL DE FIZICA MOLECULARA SI BIOMOLECULARA

Tematici de cercetare:

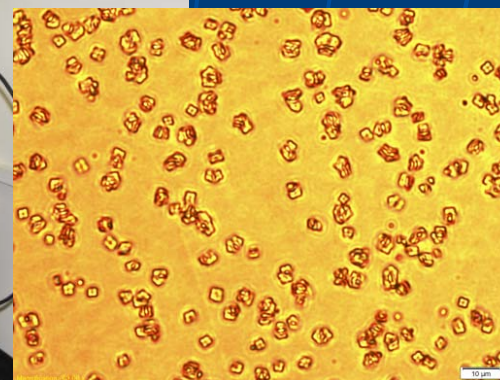
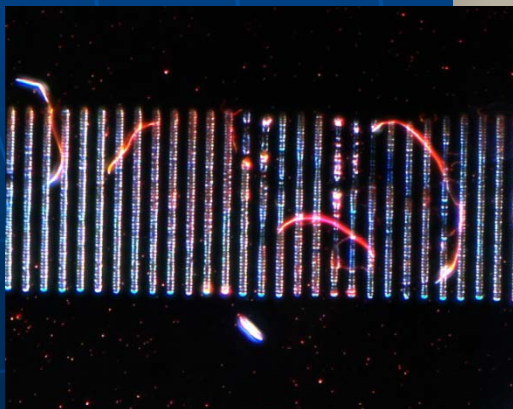
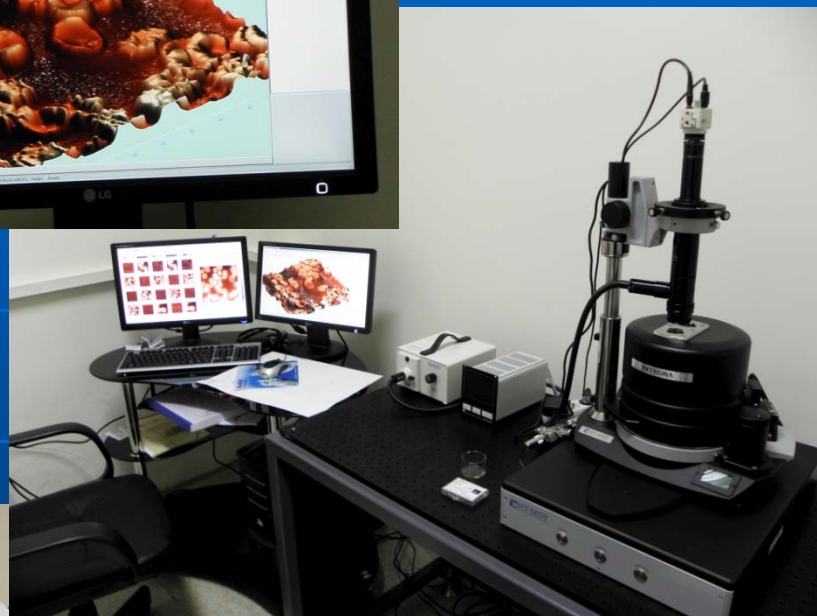
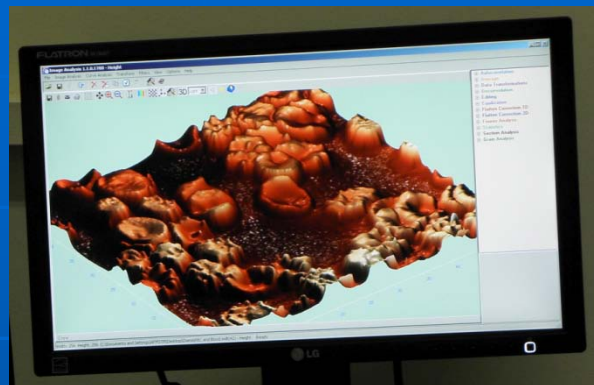
- Structuri moleculare si biomoleculare autoasamblate
- Modelare numerica
- Analiza structurala in solide
- Spectroscopia sistemelor moleculare si supramoleculare
- Fenomene fototermice
- Aplicatii ale interactiei microundelor cu substanta



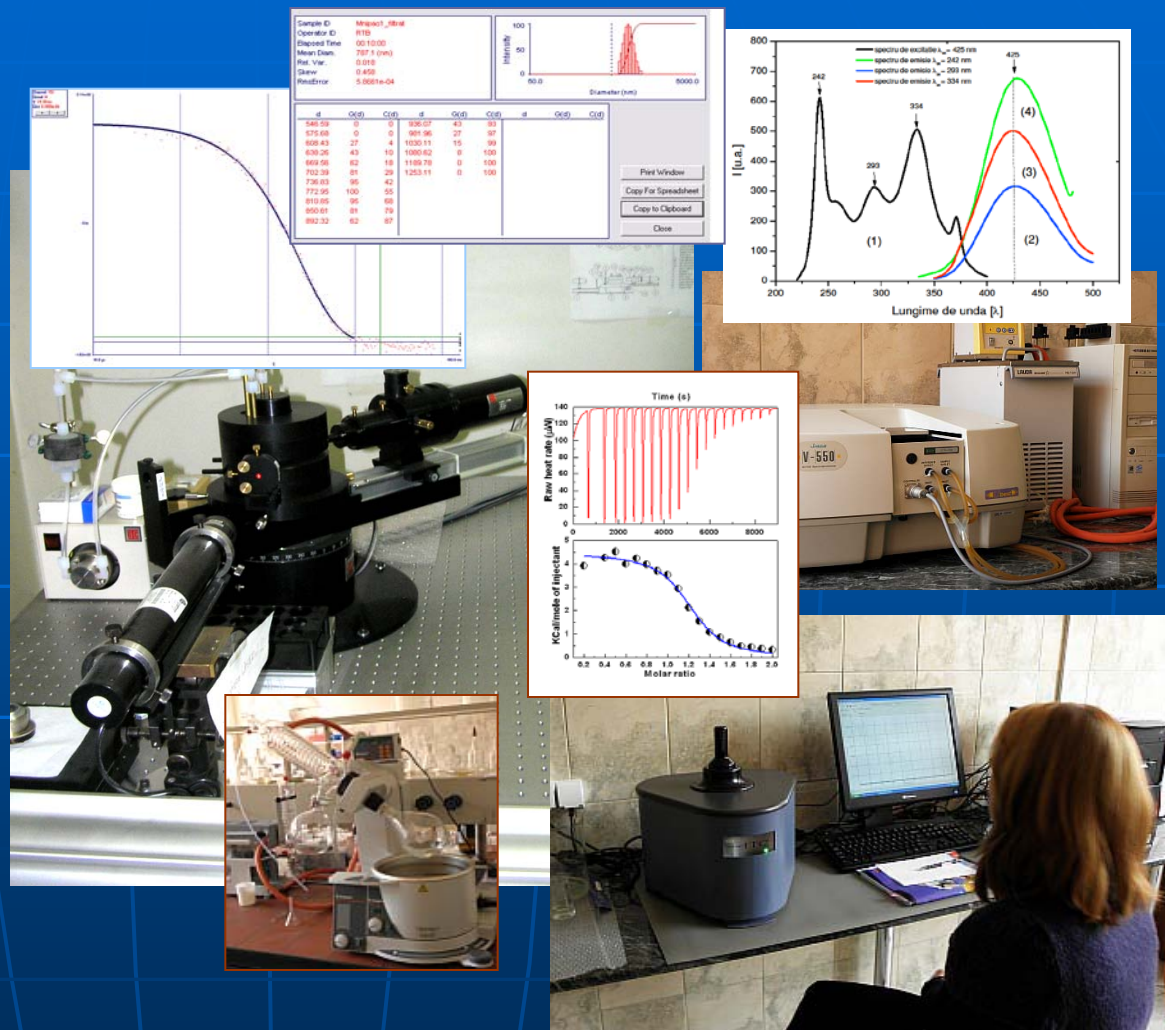
Tematica de cercetare: **Structuri moleculare si biomoleculare autoasamblate**

Subiecte de cercetare
abordate:

- *Recunoastere moleculara si procese de autoasamblare;*
- *Structuri moleculare bidimensionale autoasamblate pe suprafete metalice;*
- *Structuri supramoleculare cu arhitectura controlata (straturi monomoleculare, nanocapsule moleculare);*



- Corelatii neliniare in sisteme moleculare naturale (ADN si proteine);
- Procese de neechilibru, haos si structuri fractale in biosisteme;
- Imprastierea radiatiei laser pe nanoparticule si celule biologice.



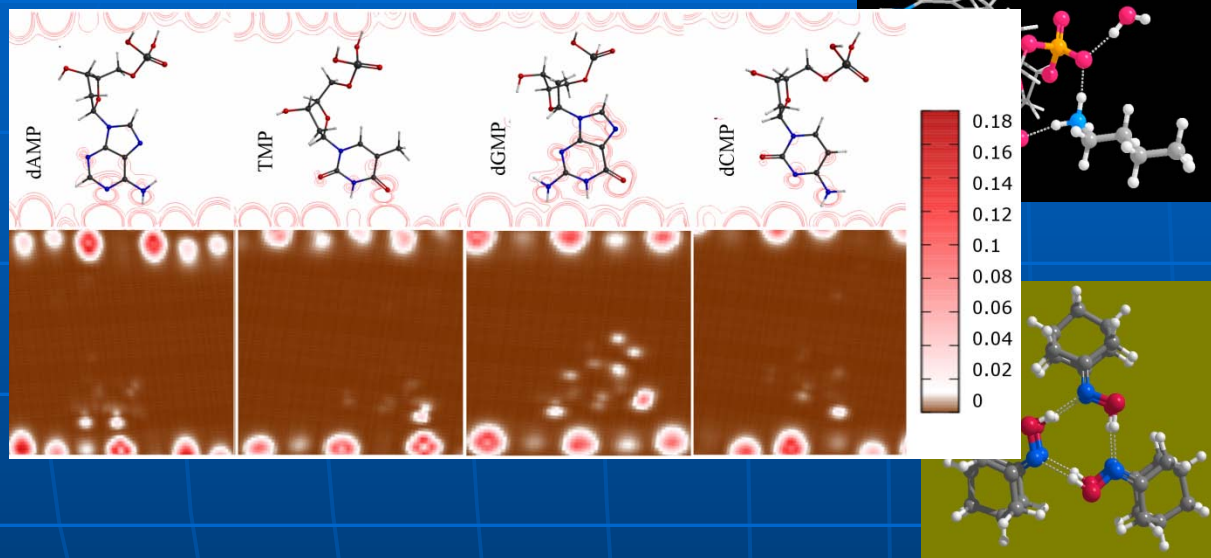
Echipa de cercetare: Ioan Turcu, Radu Bratfalean, Silvia Neamtu, Mihaela Mic, Nicoleta Tosa, Luiza Iarinca-Buimaga



Tematica de cercetare: **Modelare numerica**

Subiecte de cercetare abordate:

- *Arhitecturi supramoleculare cu aplicatii in nanotehnologie;*
- *Modelarea propagarii pulsurilor laser ultrascurte si ultraintense in medii gazoase ionizante*



- *Modelarea generarii de armonice superioare si de pulsuri de attosecunde;*
- *Calculare ab-initio de chimie cuantica, teoria functionalei de densitate (Gaussian, MolPro, etc.);*
- *Interactii intermoleculare, structuri geometrice, constante de forta, vibratii moleculare armonice si anarmonice;*
- *Modificari structurale ADN puse in evidenta prin spectroscopie vibrationala;*
- *Dinamica moleculara;*
- *Tranzitii structurale si dinamica in ADN.*

C. Morari, et all "Electronic transport properties of 1,1'-ferrocene dicarboxylic acid linked to Al(111) electrodes" **ACS Nano** 3(12), 4137-4143 (2009).

C. Morari, et all, "Electronic properties of 1-4,dicyanobenze and 1-4,diisocyanidebenzen molecules contacted between two platinum and palladium electrodes: a first-principles study" **Phys. Rev. B** 76, 115428 (2007).

C Morari: "Modelarea transportului electronic în sisteme nanoscopice", Casa Cărții de Știință, Cluj-Napoca, 2007

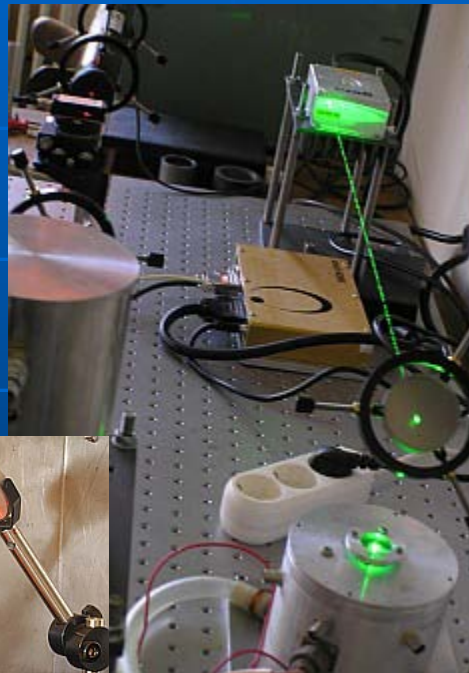
Echipa de cercetare: Valer Tosa, Cristina Muntean, Cristian Morari, Attila Bende, Diana Bogdan, Katalin Kovacs



Tematica de cercetare:
Fenomene fototermice

Subiecte de cercetare
abordate:

- *Spectroscopie si calorimetrie fotopiroelectrica aplicata materialelor aflate in stare condensata;*
- *Tranzitii de faza;*
- *Radiometrie fototermica;*
- *Aplicatii biomedicale ale tehnicilor fototermice.*



Echipa de cercetare: Dorin Nicolae Dadarlat,
Mihaela Streza, Mircea Pop

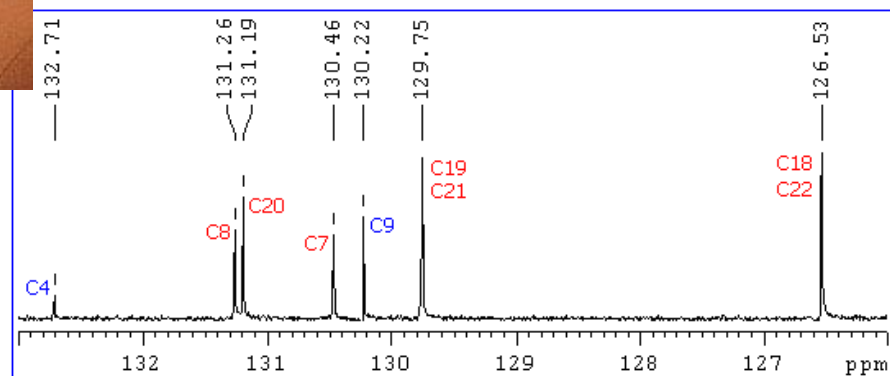
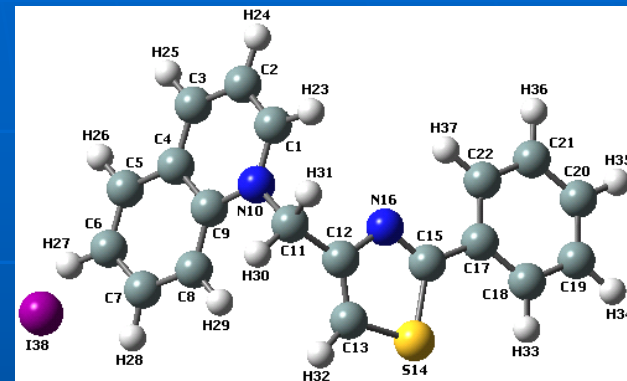
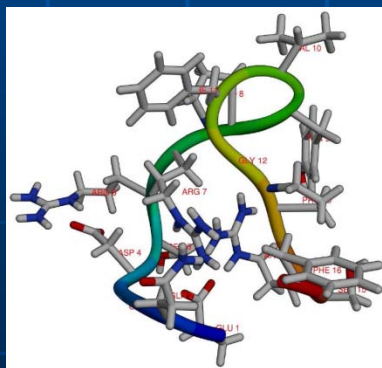
Tematica de cercetare:

Spectroscopia sistemelor moleculare si supramoleculare

Subiecte de cercetare abordate:

Complecsi de incluziune ai ciclodextrinelor cu biomolecule:

caracterizare fizico-chimica, stoichiometrie, constante de stabilitate, modelare moleculara; interactiuni ligand – proteina; interactiuni intra si intermoleculare; dinamica moleculara;



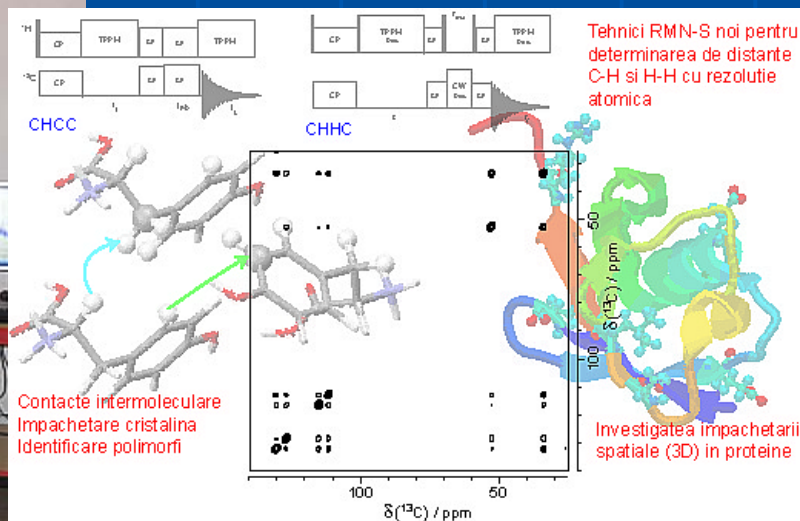
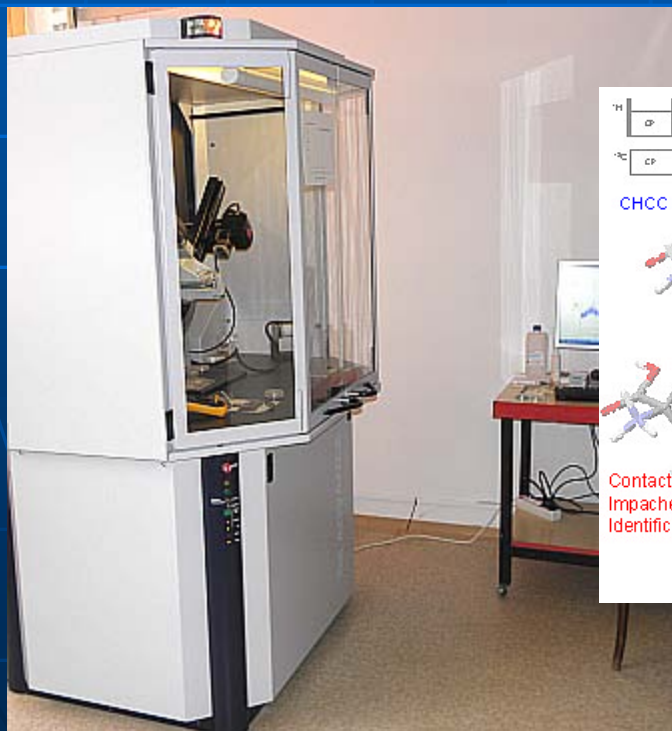
Echipa de cercetare: Mircea Bogdan, Calin G. Floare, Adrian Pirnau



Tematica de cercetare: **Analiza structurala in solide**

Subiecte de cercetare abordate:

- *Tehnici avansate ale spectroscopiei RMN pe solide (RMN-S) pentru caracterizare structurala in sisteme (bio)moleculare;*
- *Determinarea structurii cristaline si moleculare prin metode de difractie de raze X;*
- *Aplicatii in domeniul farmaceutic: identificarea si caracterizarea de noi forme solide prin combinarea de metode RMN-S si difractie de raze X;*
- *Dezvoltare metodologica RMN-S;*
- *Dinamica de spin si metode numerice pentru aplicatii RMN-S.*



Echipa de cercetare: Claudiu Filip, Gheorghe Borodi, Xenia Filip, Carmen Tripon



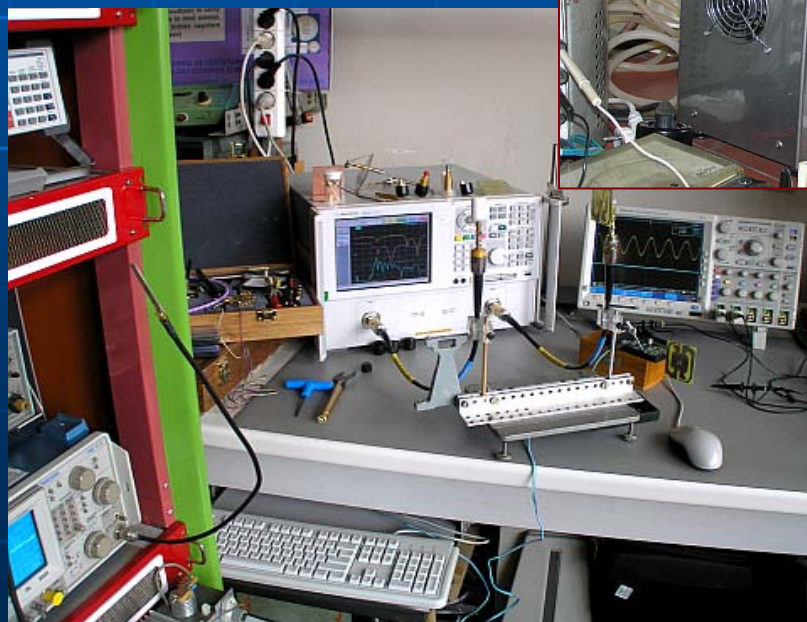
Tematica de cercetare: **Aplicatii ale interactiei microundelor cu substanta**

Subiecte de cercetare abordate:

- *Procesarea materialelor cu radiatie de microunde de putere:*
 - Tratamente termice neconventionale;*
 - Caracterizarea proceselor termice (TGA/DSC);*
 - Procesare dinamica a substantei in camp de microunde de putere;*
 - Sinteze chimice, extractii de compusi naturali, digestia unor probe solide;*
- *Masuratori ale proprietatilor dielectrice;*
- *Determinari de conductivitate in compozite cu faza lichida,*
- *Studii de interactie cu medii biologice;*
- *Aplicatii : traductori, aplicatoare de microunde de putere, etc.*

Echipa de cercetare:

Emanoil Surducan, Camelia Neamtu, Vasile Surducan, Ildiko Lung, Cristian Tudoran



Modernizarea Departamentului de Fizica Moleculara si Biomoleculara (MDFMOLBIO)

2 PM / I / 07.10.2008 Director proiect: Dr. Ioan Turcu

**Proiect Finanțat integral de Guvernul României -
Ministerul Educației, Cercetării și Tineretului - MECT
prin Autoritatea Națională pentru Cercetare Științifică - ANCS -
în cadrul Programului Național "Capacități"**
Valoarea proiectului: **30.034.930 lei**

Dotari pentru dezvoltarea tehnologiilor nano-moleculare

2010:

Sistem de masura a proprietatilor dielectrice si spectroscopie de microunde
Difractometru de raze X pentru monocristale
Microscop inversat automat + accesorii
Microscopie de scanare a suprafetelor

2011

Modernizare laborator de chimie: sinteza, analiza fizico-chimica si biochimie
Spectrometru RMN pe Solide de 500 MHz
Instalatie de epitaxie moleculara
Instalatie de nano-imprintare
Microspectrometru Raman confocal cu accesorii
Echipament fototermie
Sistem laser Ti:Sa in impulsuri ultrascurte (femtosecunde)
Spectrometru de dicroism circular vibrational
Statie de lucru pentru calcul de inalta performanta
Instalatie de Molecular Inkjet Printing



DEPARTAMENTUL DE FIZICA SI TEHNOLOGIA IZOTOPILOR

Tematici de cercetare:

- Catalizatori nanostructurati de tipul metal/oxid
- Materiale nanostructurate (metale nobile si nanocarbon)

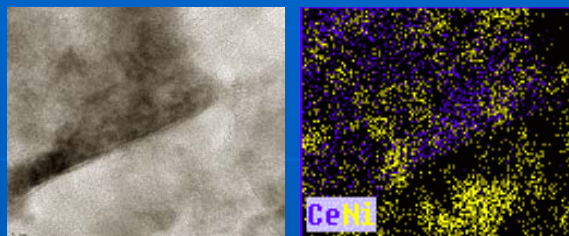


Materiale Nanostructurate Catalizatori nanostructurati de tipul metal/oxid

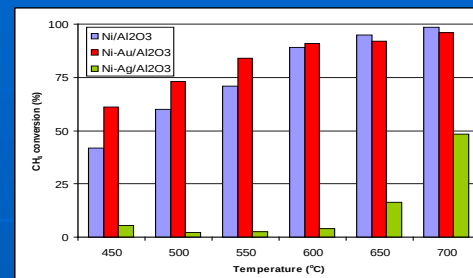
Echipa de cercetare: Diana Lazar, Maria Mihet, Monica Dan, Valer Almasan

Subiecte de cercetare abordate:

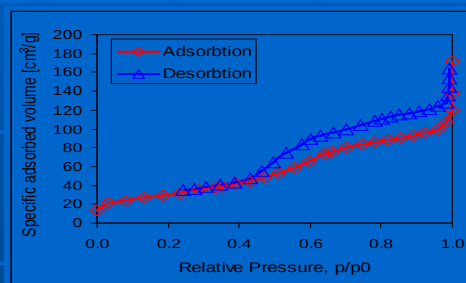
- Prepararea si caracterizarea catalizatorilor nanostructurati de tipul metal/suport;
- Caracterizarea dinamicii suprafetei catalitice folosind schimbul izotopic H/D;
- Testarea catalizatorilor metal/suport in reactiile de reformare a hidrocarburilor si a compusilor organici oxigenati;
- Testarea catalizatorilor metal/oxid in reactiile de reducere a oxizilor de azot cu hidrogen la temperaturi scazute



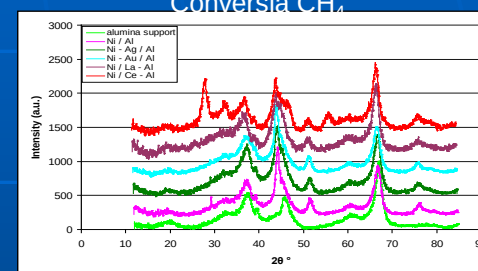
Imagini TEM a catalizatorului Ni/CeO₂-Al₂O₃



Conversia CH₄



Izotermele de ads-desorb pentru Ni-Au/Al₂O₃



XRD catalizatori de Ni

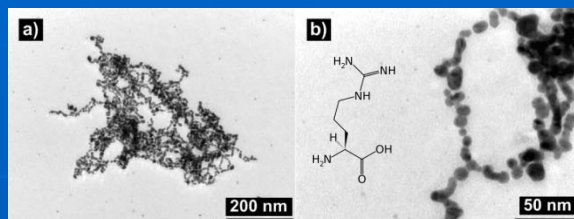


Materiale Nanostructurate I. Aplicatii in microelectronica

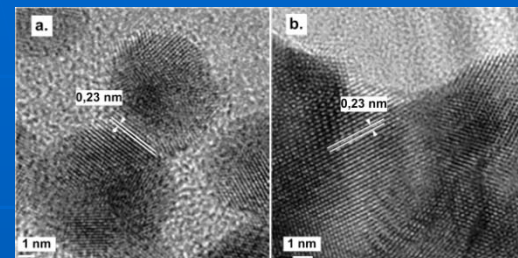
Echipa de cercetare: Stela Pruneanu, Liliana Olenic, Alexandru R. Biris, Florina Pogacean, Camelia Grosan, Adriana Vulcu

Subiecte de cercetare abordate:

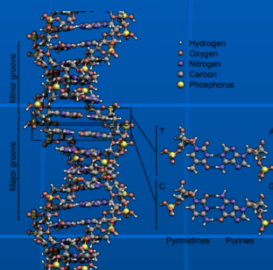
- Prepararea de nanoparticule metalice (aur, argint, platina)
- Nanostructuri hibride pe baza de nanoparticule metalice si biomolecule (ADN, aminoacizi, colagen, peptide)
- Studii de adsorbtie de biomolecule pe nanostructuri de carbon;
- Utilizarea nanoparticulelor metalice si a nanostructurilor hibride in microelectronica, medicina si in domeniul senzorilor



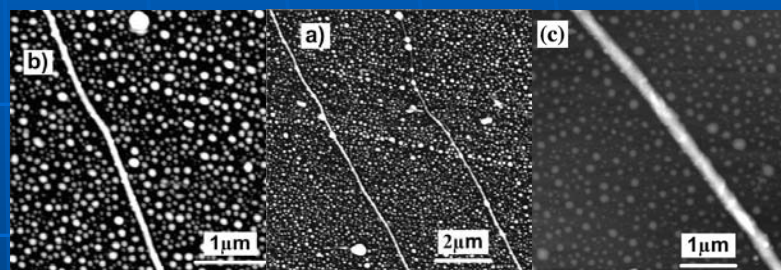
Imagine TEM: nanoparticule de aur functionalizate cu L-arginina



Imagine HR-TEM: fuziunea intre nanoparticule are loc de-a lungul planului cristalin (111)



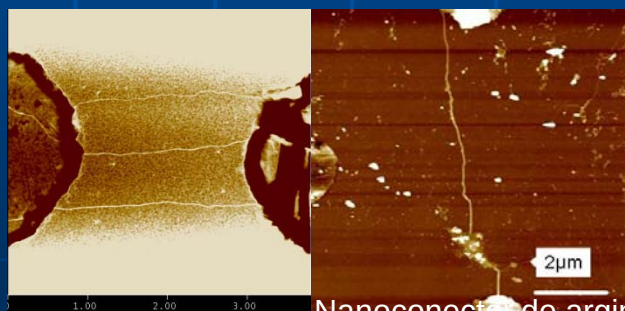
Molecula de ADN (diametrul = 2 nm)



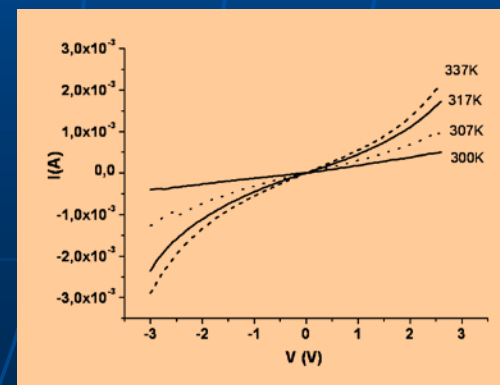
Nanofire de argint pe suport de ADN (diametrul 10-30 nm)



Solutii coloidale de aur



Nanoconector de argint pe suport de ADN (diametrul = 20 nm)



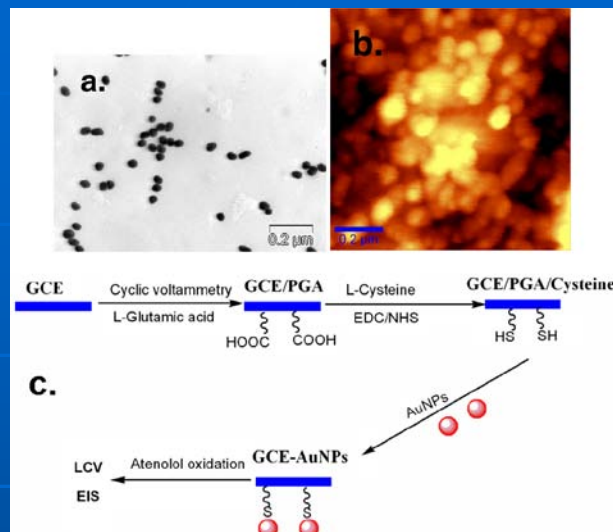
Caracteristici I-V ale nano-conectorului de argint pe suport de ADN

S. Pruneanu et al. J Mater Sci (2010) 45:3151–3159

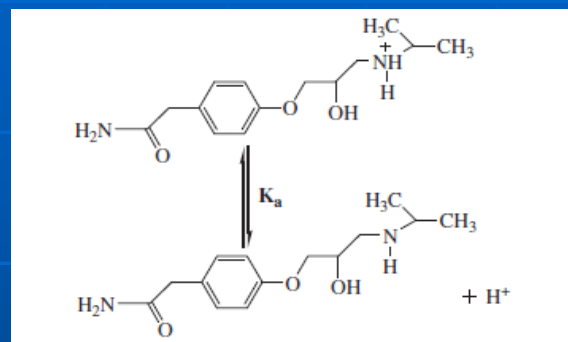


II. Aplicatii in electrocataliza.

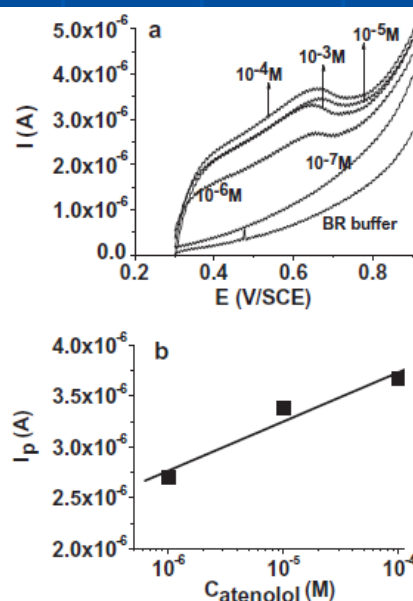
Electrod nanostructurat cu efect electrocatalitic in oxidarea atenololului



Imagine TEM a nanoparticulelor de aur (20-30 nm) (a); Imagine AFM a electrodului nanostructurat (b); reprezentarea schematica a modului de atasare a nanoparticulelor de aur pe suprafata electrodului (c).

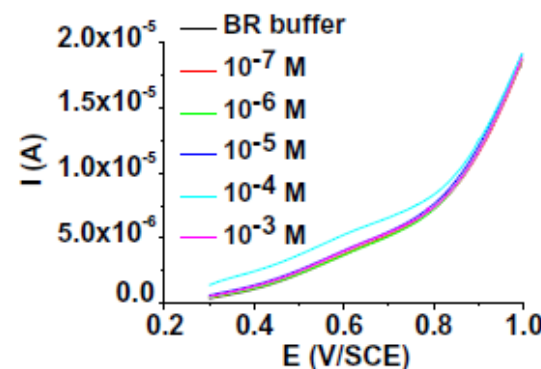


Atenolol: electro-oxidarea are loc la gruparea amino



Oxidarea atenololului are loc la un potential de 0.6V/SCE

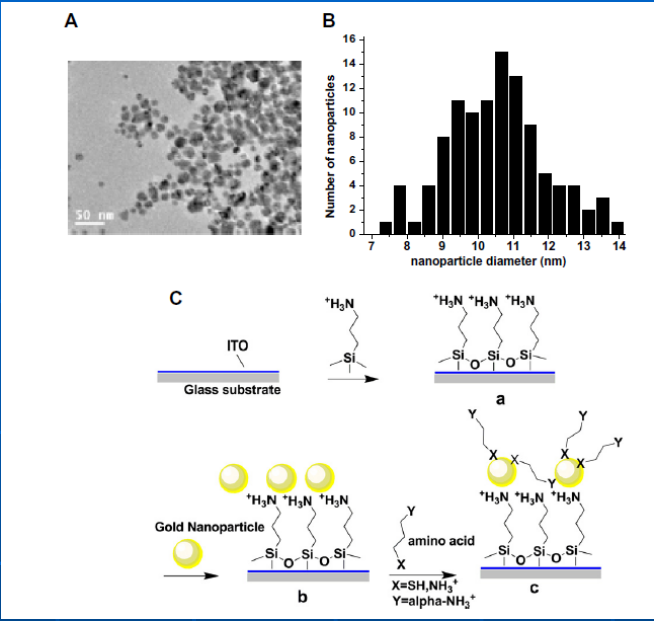
Curba de calibrare pentru detectia atenololului
(limita de detectie $3.9 \times 10^{-7} M$)



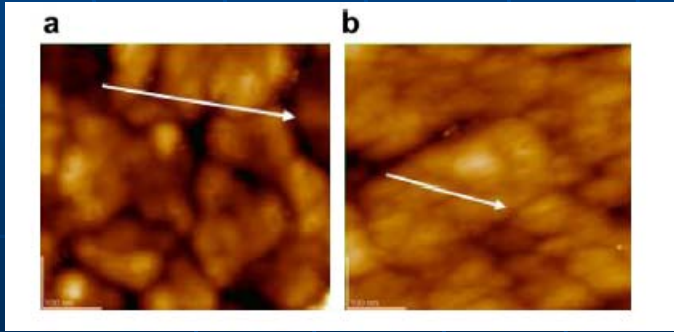
Electrodul nemodificat nu detecteaza oxidarea atenololului
(nu apare maxim de oxidare)



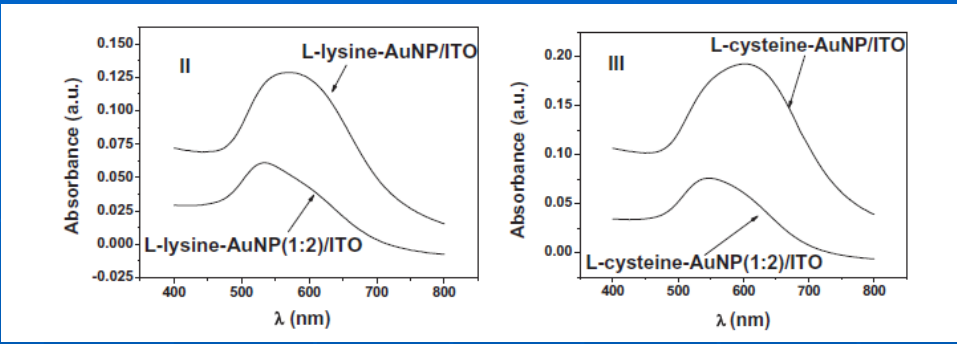
III. Proprietati conductoare ale nanostructurilor de aur in urma interactiunii cu diferiti amino-acizi



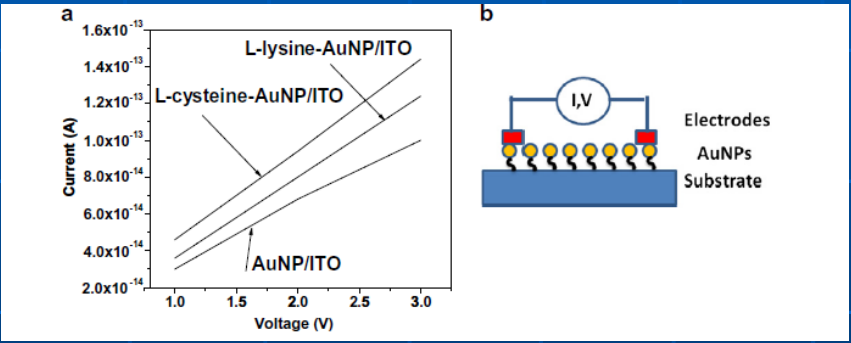
Schema de atasare a nanoparticulelor de aur la un substrat ITO



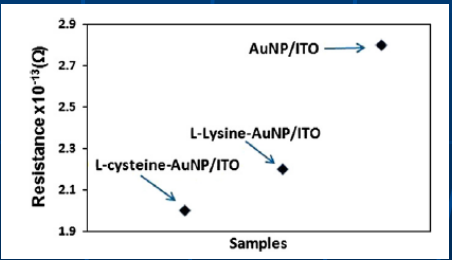
Imagini AFM ale nanostructurilor de aur: inainte (a) si dupa (b) interactiunea cu un amino-acid



Modificarea spectrelor UV-Vis ale monostratului de aur, in urma interactiunii cu un amino-acid (L-lizina si respectiv L-cisteina)



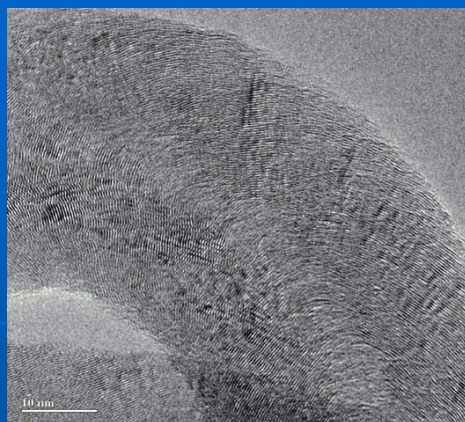
Caracteristici curent-tensiune ale monostratului de aur, inainte si dupa interactiunea cu un amino-acid



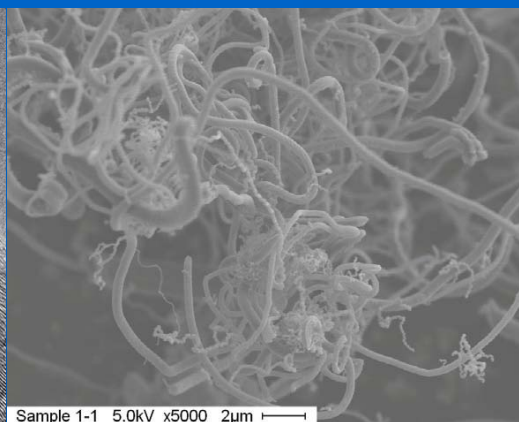
L. Olenic et al.
Chemical Physics 373(2010)295-299

Scaderea rezistentei electrice a monostratului de aur, dupa interactiunea cu un amino-acid

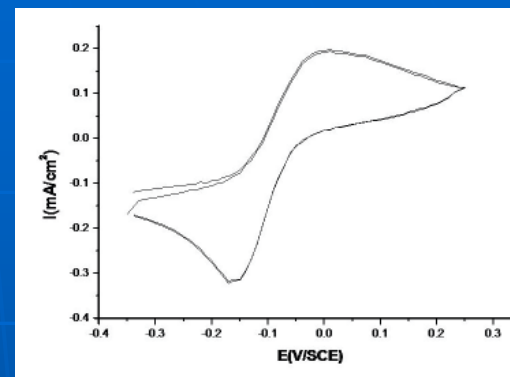
IV. Oxidarea ADN-lui pe electrozi modificati cu nanofibre de carbon



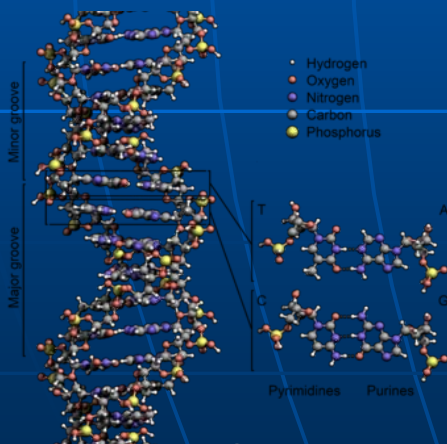
Imagine HR-TEM a nanofibrei de carbon



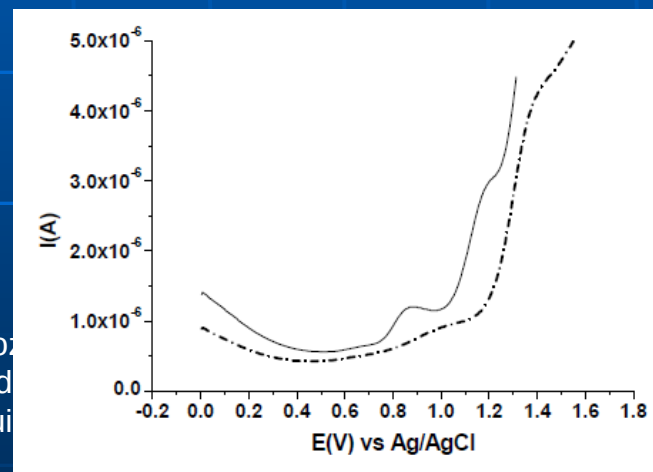
Imagine SEM a nanofibrelor de carbon



Proprietatile conductoare ale electrodului modificat au fost evidentiata prin voltametrie ciclica

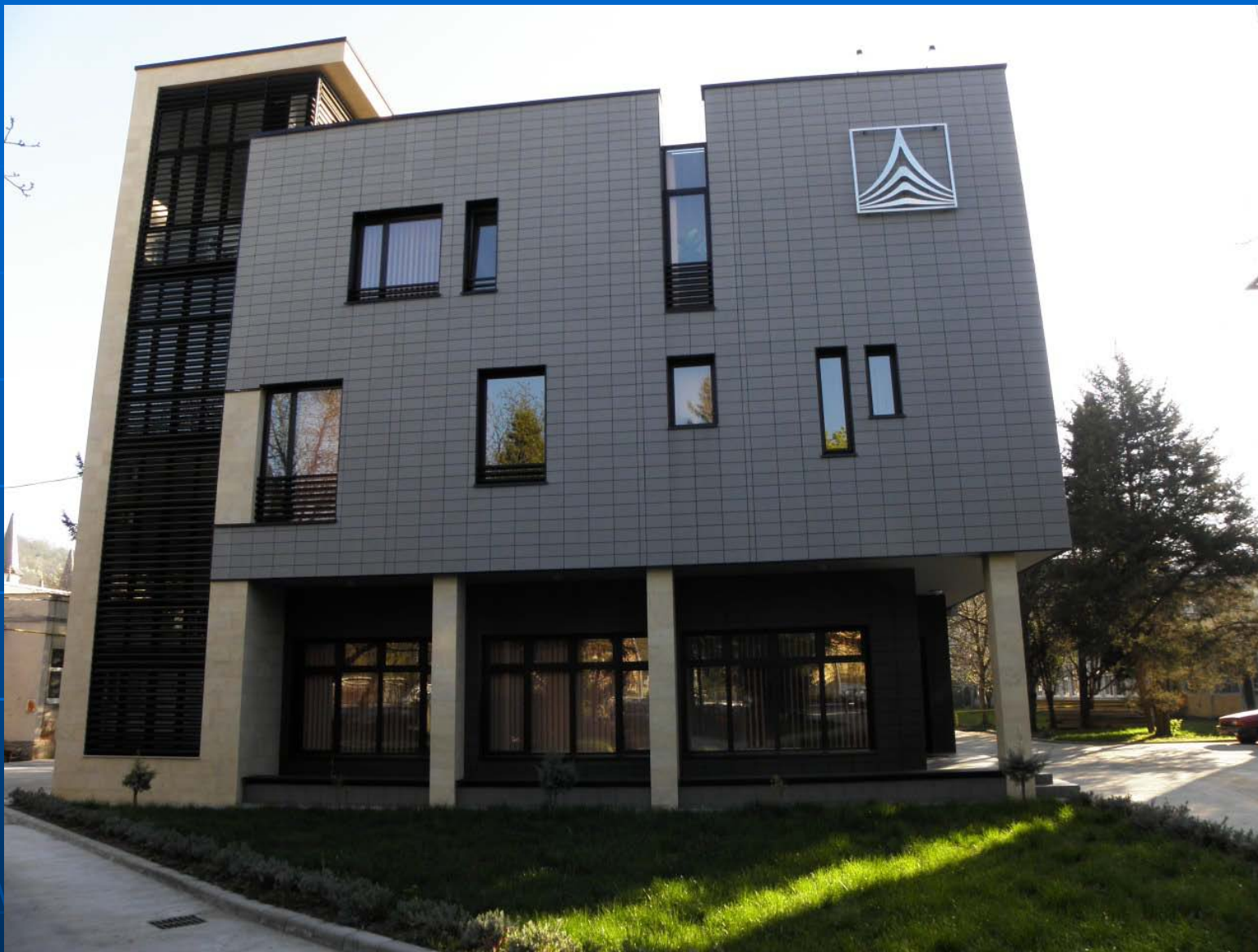


- Modificarile genetice ale ADN-lui duc la aparitia cancerului;
- Procesele oxidative pot afecta cele 4 baze ale ADN-lui: adenina, guanina, tiimina si citozina;
- Studiul oxidarii electrochimice a ADN-lui ne da informatii despre gradul de degradare a acestui



Oxidarea ADN-lui pe electrod modificat cu nanofibre de carbon (s-au inregistrat maximele corespunzatoare guaninei si adeninei)





**NATIONAL INSTITUTE FOR RESEARCH AND DEVELOPMENT
OF ISOTOPIC AND MOLECULAR TECHNOLOGIES CLUJ-NAPOCA, ROMÂNIA**

