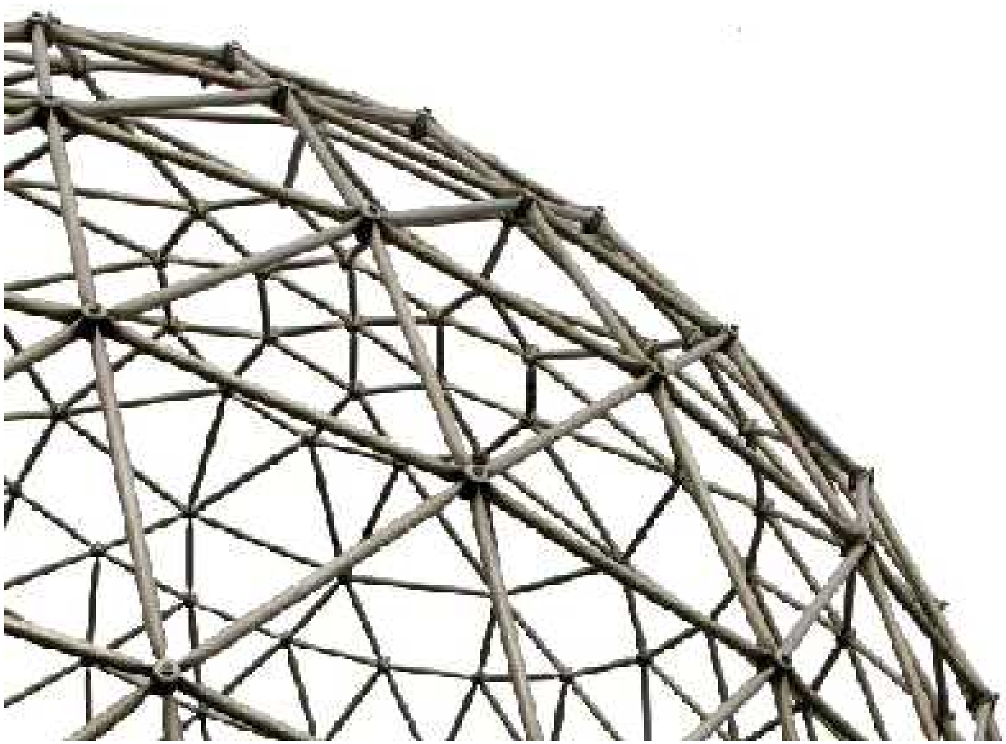
Advanced Technology Institute

Faculty of Engineering and Physical Sciences



Vlad Stolojan

University of Surrey

Guildford GU2 7XH

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Concentrori parabolici pentru spectroscopie Raman

Dr Vlad Stolojan

Lecturer, RCUK Fellow

Sumar

- Institutul de Tehnologie Avansata
- CV
- Microscopie electronica
- Concentrori parabolici

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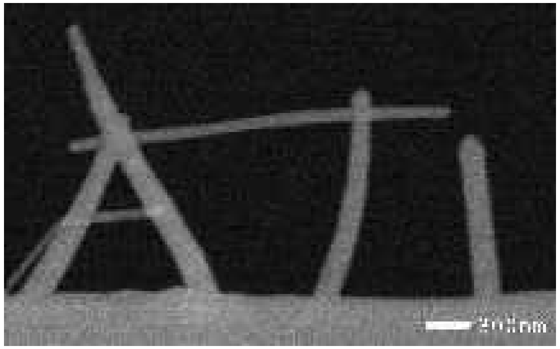
Colective de cercetare

Nano-electronica

- Componente avansate bazate pe Si.
- Circuite si componente de microunde.
- Electronica pe scara mare, inclusiv celule solare si panouri de afişaj.
- nanoelectronica, inclusiv nanotuburi de carbon

Fotonica

- Materiale si componente optoelectronice
- Photonica bazata pe Si
- Spintronica si analiza dinamica ultra-rapida
- Sensori optici



Centrul de acceleratori de ioni

- implantare ultra-precisa
- Modificare de materiale
- Analiza cu ioni, inclusiv studii arheologice si criminalistice.
- Aplicatii bio-medicale

Theory and Advanced Computation

- Cuantica computaţionala
- Modelare la scare atomica

CV

- Universitatea East Anglia (1996) BSc
- Universitatea Cambridge (2000) PhD
  - Nanochimia interfețelor cristaline in fier
- Universitatea Cambridge -postdoc
  - holografie-tomografie componente magnetice
- Universitatea Surrey – postdoc, research fellow, lecturer

- microscopie electronica si cu ioni + spectroscopie

(TEM, SEM, STEM, FIB + EELS, EDX)

- materiale ceramice, funcționale, nanomateriale (QD, nanotuburi, mecanisme de formare etc), adezivi, bio (celule, viruşi)

Microscopie electronica

Electroni: λ~pm. Aberație sferica – rezoluție nm-0.5Å (cu ochelari)

- TEM (transmisie), SEM (scanare – reflexie), STEM (scanare transmisie)

    - imaginea = amplitudine + fază

- Spectroscopie: EELS (electron energy-loss spectroscopy), EDX (energy-dispersive X ray spectroscopy *sau* EDS)

    - EELS: energia pierduta de electronii ce au traversat materialul

    •- EDX: raze X emise ca urmare a pierderii de energie de electroni (tranzitii induse in atomii materialului, urmate de relaxarea electronilor.

Informații despre structura electronica cu rezoluție sub-nanometrică.

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Microscoape- transmisie

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Philips(FEI) CM200 TEM

Imagini formate in paralel:

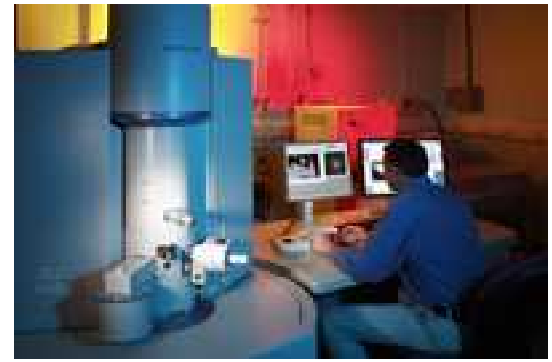
Rezoluție (interferență) >1.8Å

diametrul fasciculului de e^- ~10nm.

LaB_6, 80-200keV

EDX, EELS

Hitachi HD2300A STEM



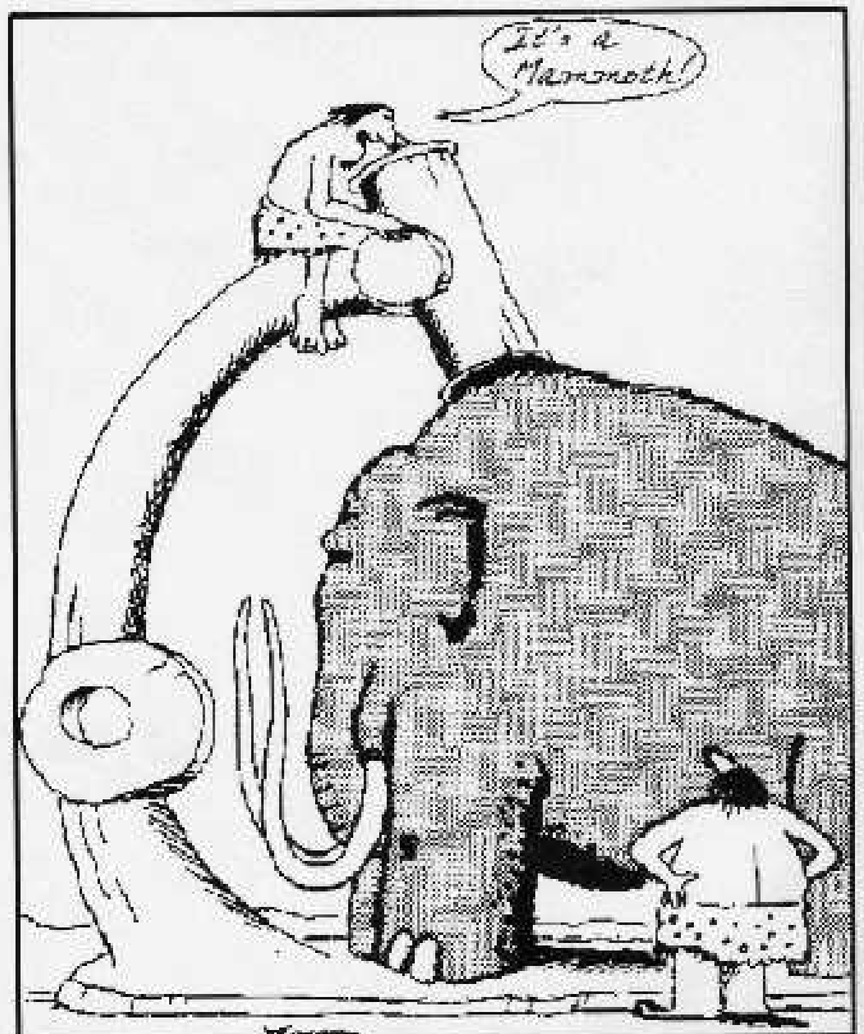
Imagini formate pixel cu pixel:

diametrul fasciculului de e^- >2.5Å

Schottky, 120keV, 200keV

EDX, EELS

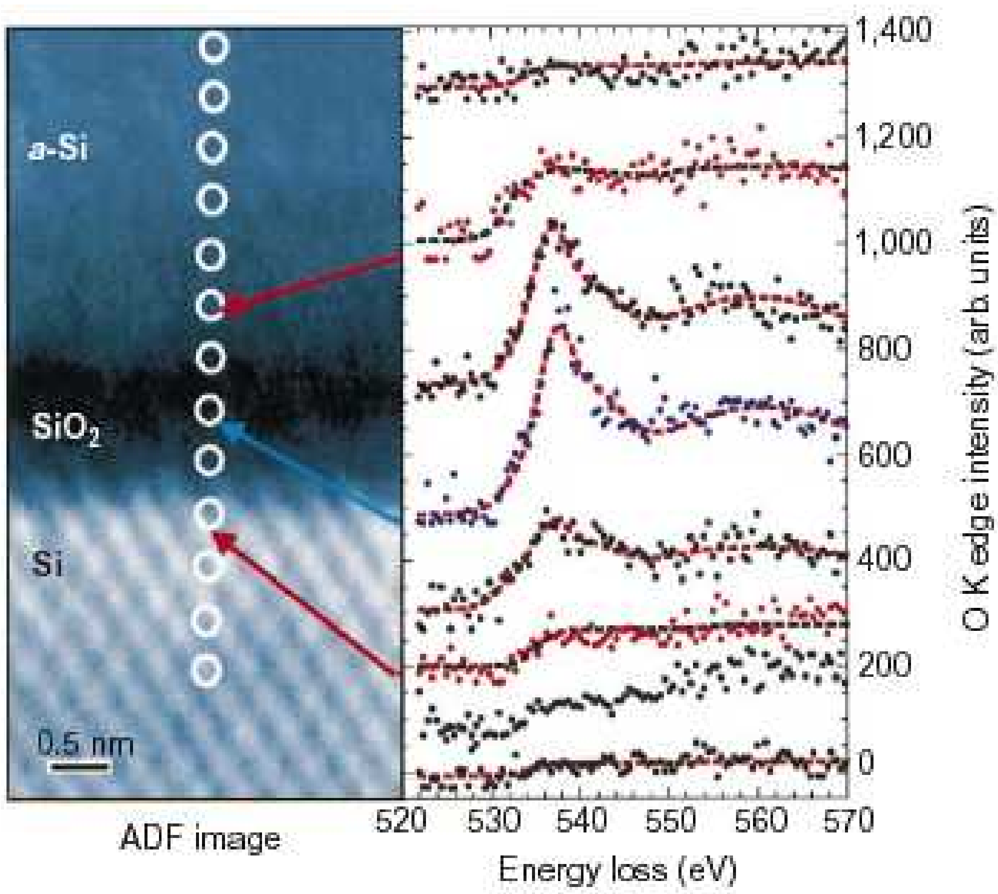
Microscopie- o viziune alternativa



Early Microscope

Microscopie cu rezolutie sub-nanometrica

DA Muller et al Nature 399 (1999) 758

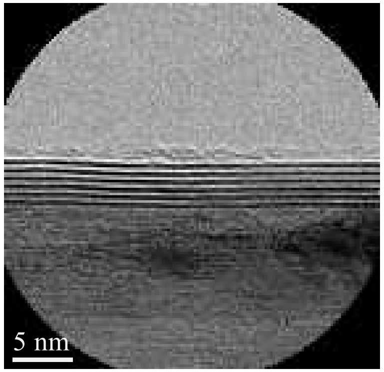


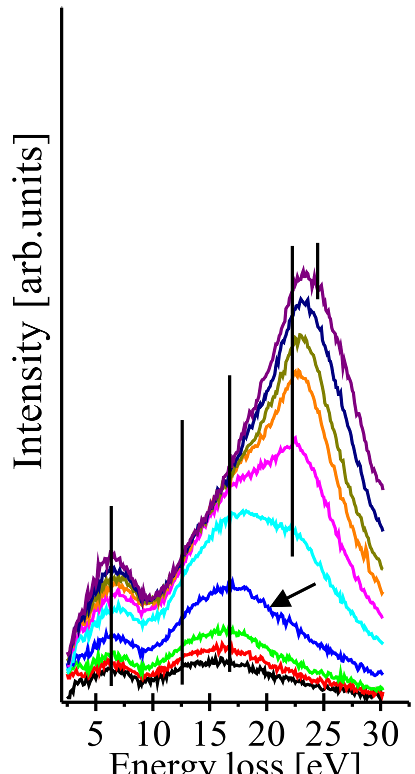
Limita fizică a Si – minimum 4 planuri atomice!

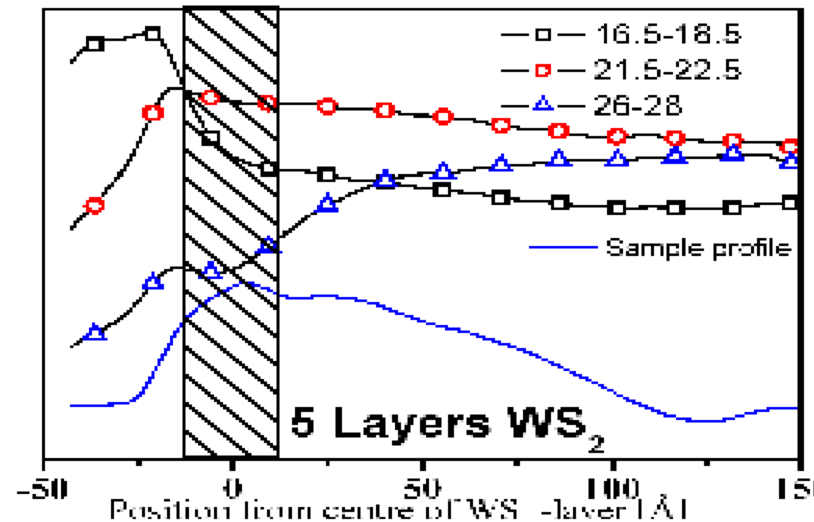
Plasmoni

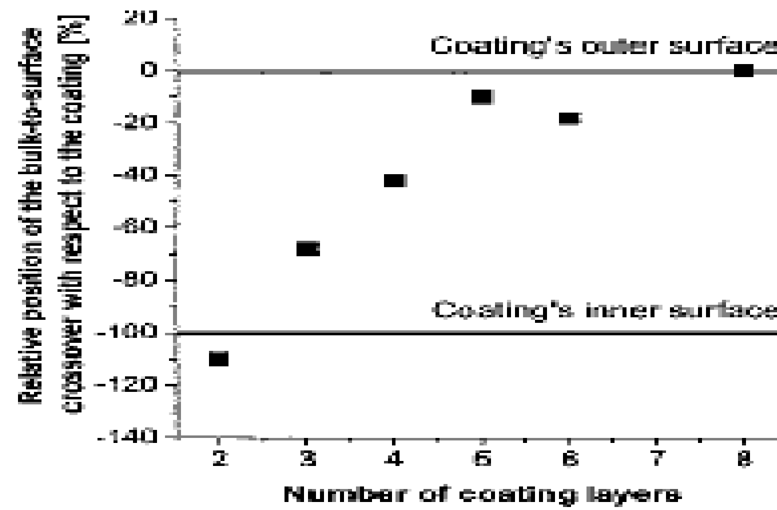
- Oscilații colective ale electronilor: culori metalice, vitralii, transmisii in afara ionosferei.
- Cel mai probabil mod de interacție cu electronii. Energie si impuls suficiente pentru a interacționa cu plasmonii in orice material. Moduri de oscilație <u>delocalizate!</u>
- Plasmoni de suprafață, interfață (moduri de oscilație cu dimensionalitate redusă.
- Plasmonii de interfață/suprafață ecranează interiorul materialelor: i.e. interacțiile nu sunt aditive = localizare.

Nanotuburi de carbon invelite in WS_2









V.Stolojan et al. Appl. Phys. Lett. **86**, 063112 (2005)

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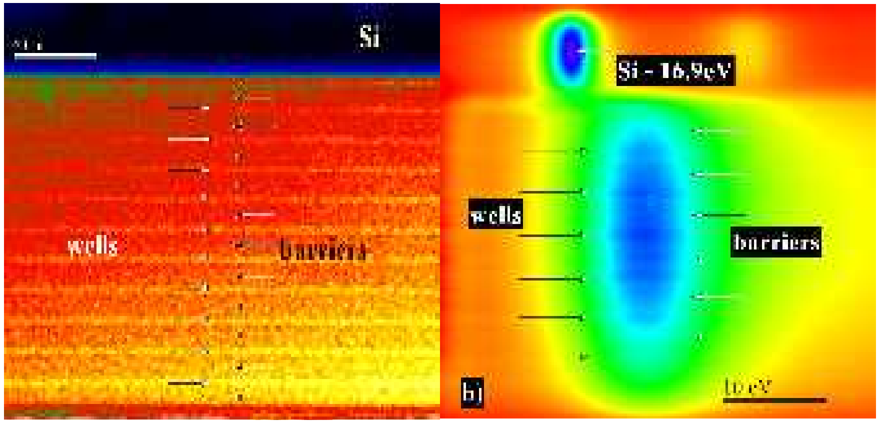
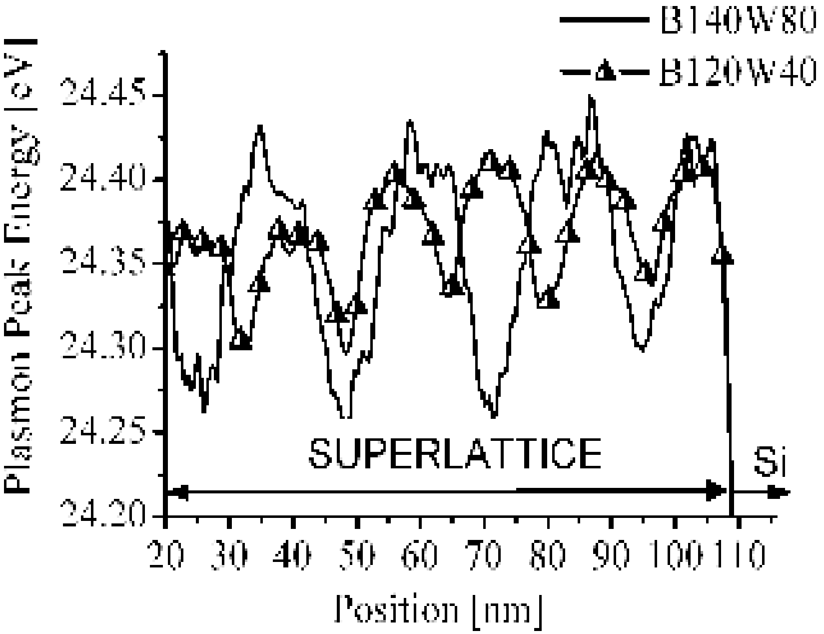
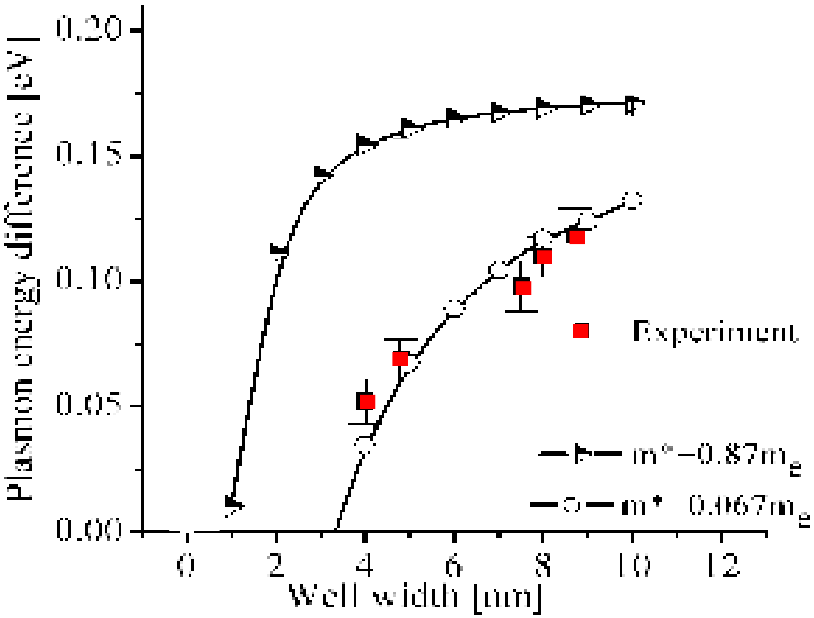
Super-structuri de aC







V Stolojan et al Appl Phys Lett. 88, 122109.

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STEM

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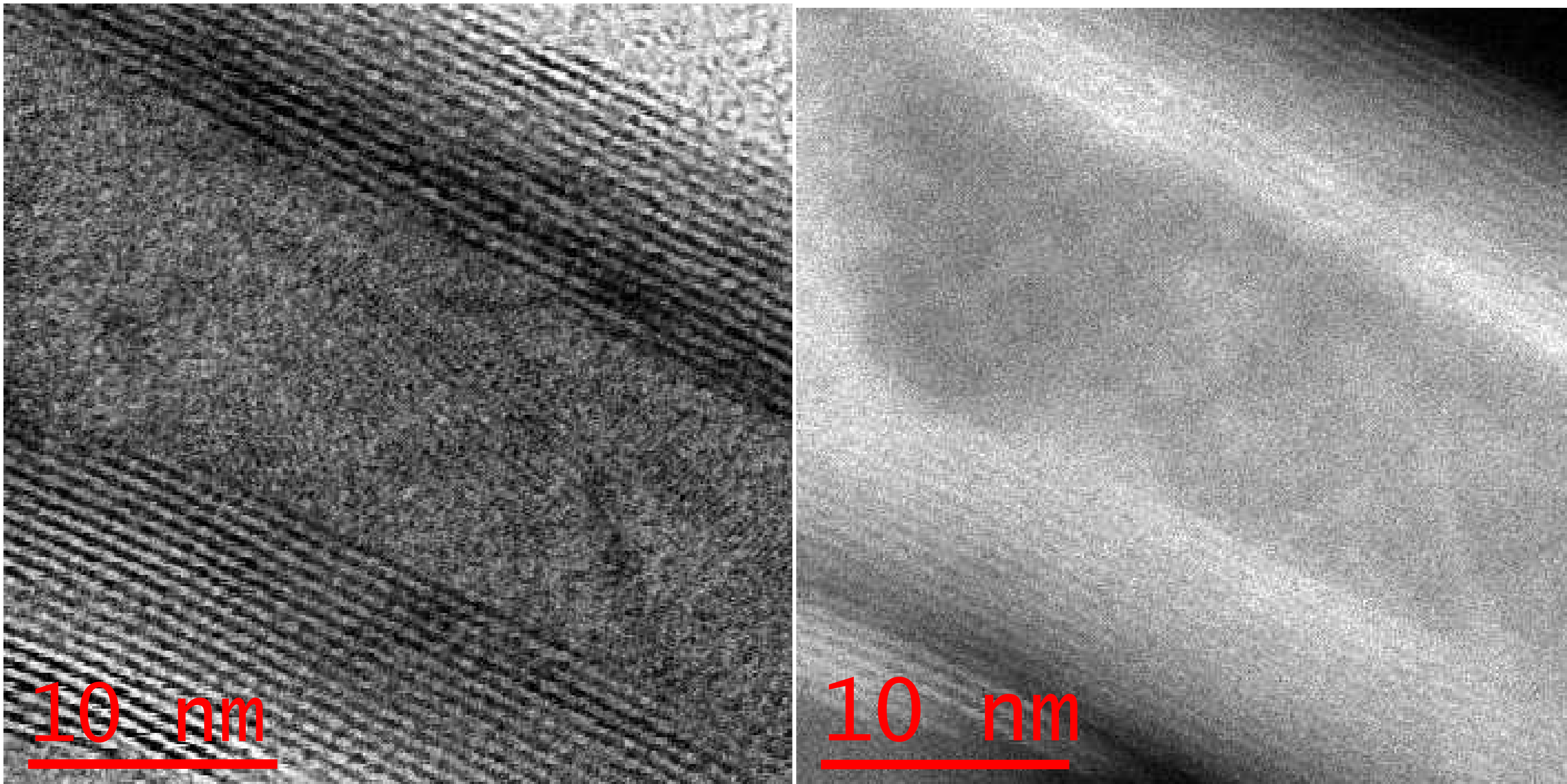
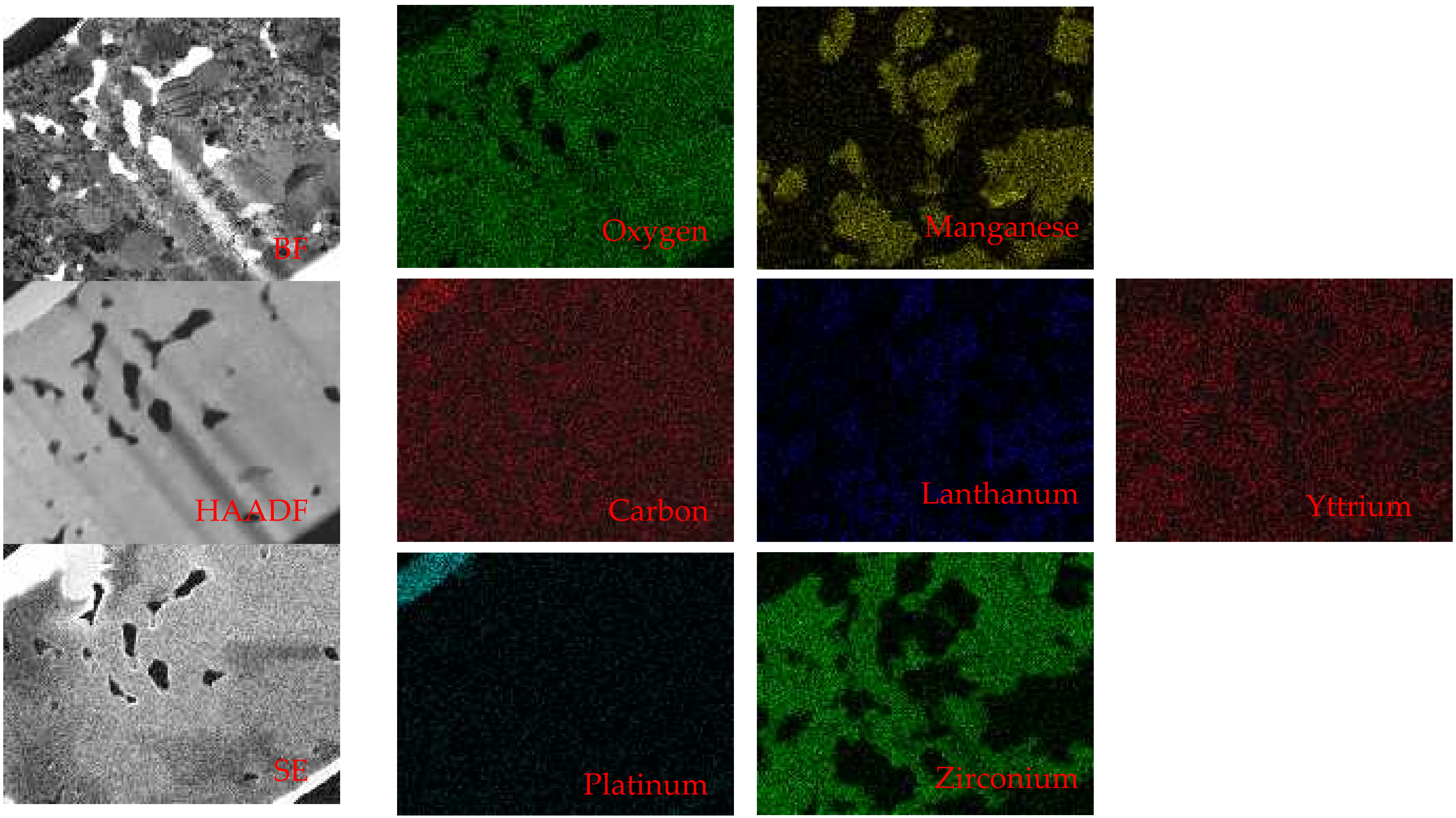
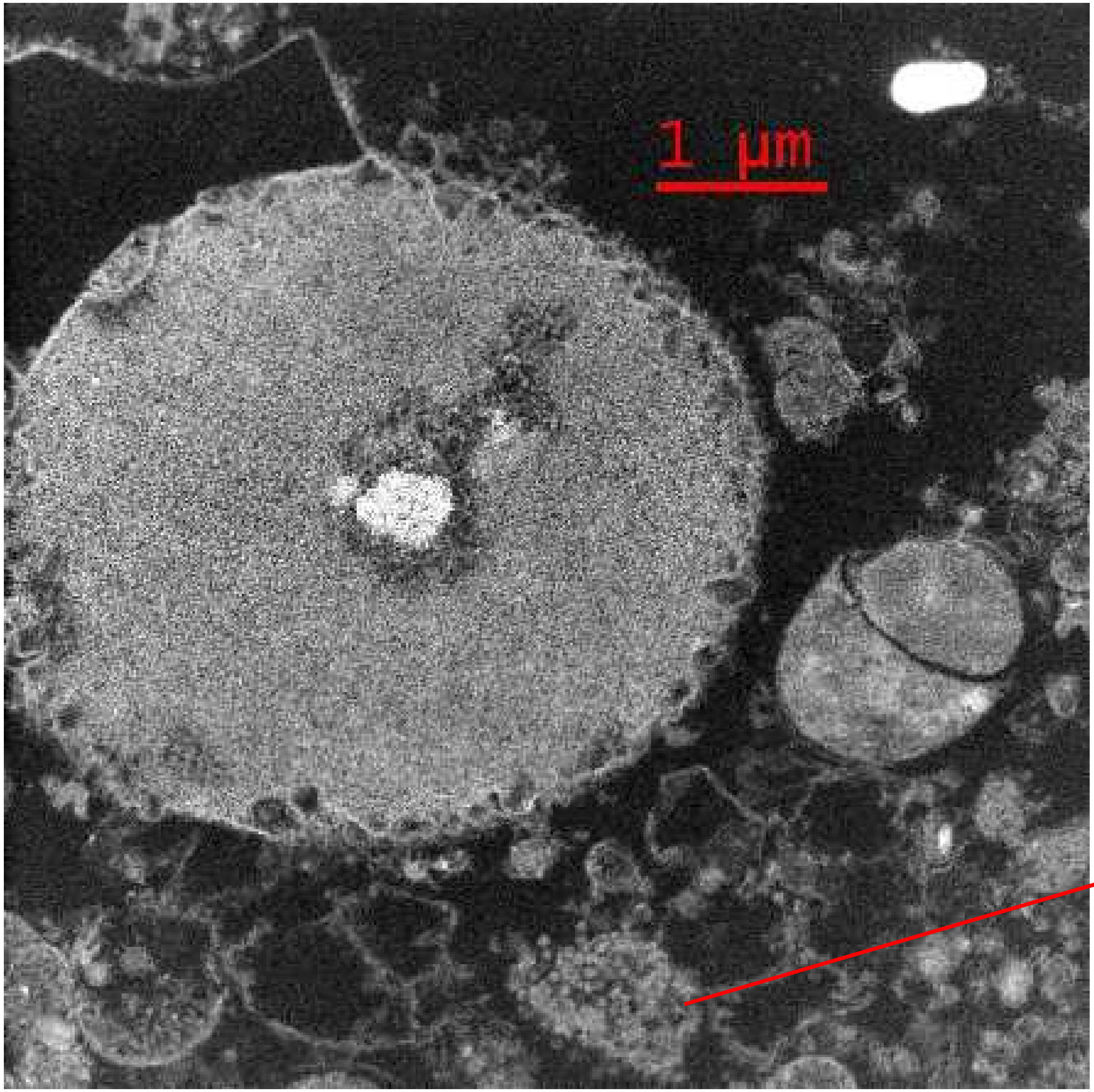


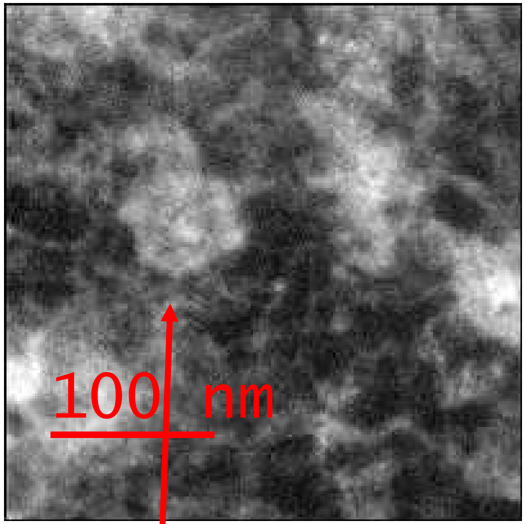
I_{HAADF} ◎ density x thickness x Z^2

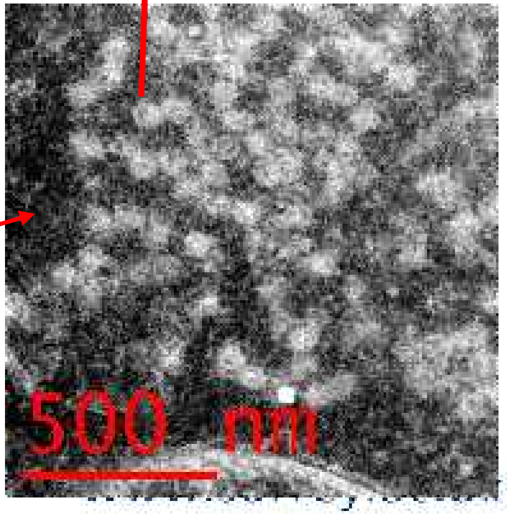
STEM


BF
Oxygen
Manganese
HAADF
Carbon
Lanthanum
Yttrium
SE
Platinum
Zirconium

STEM - biologie







Microscopul cu ioni

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Microscopul cu ioni

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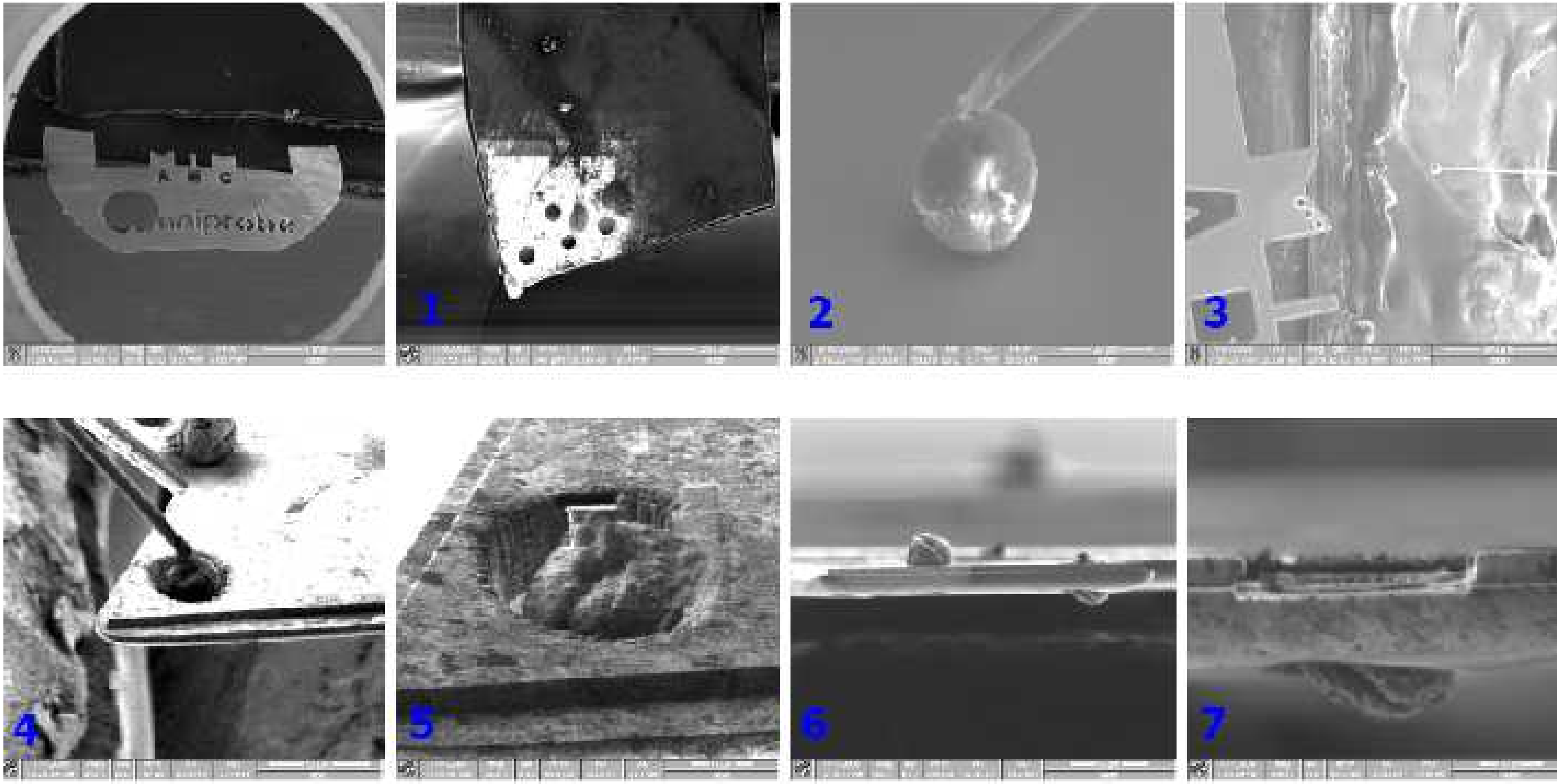

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FIB

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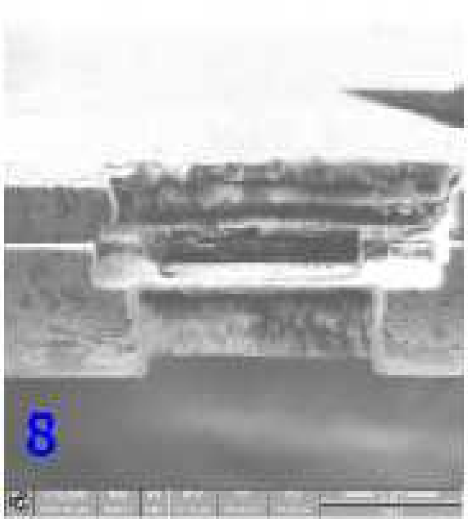

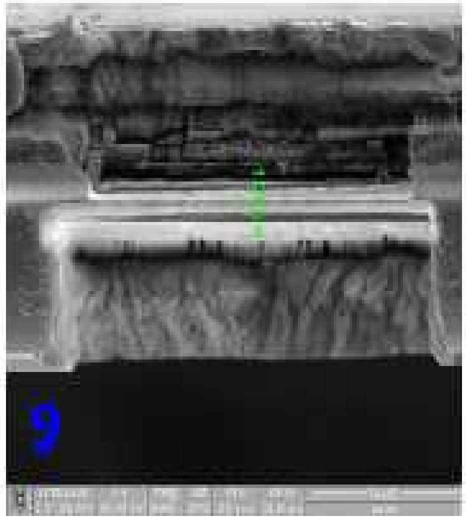

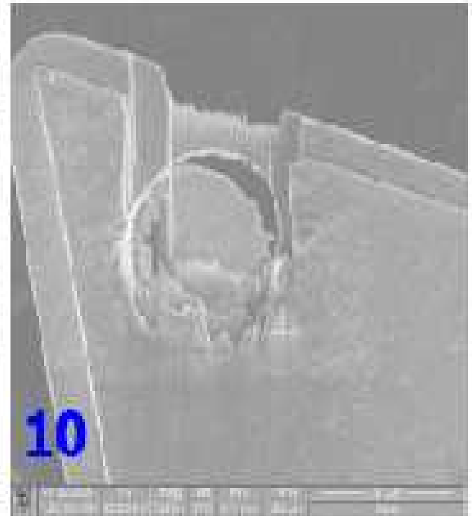

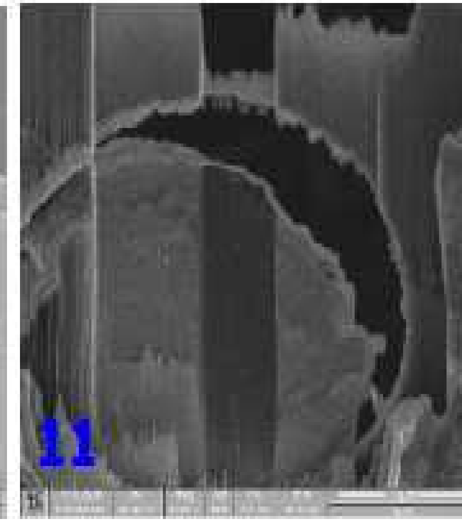

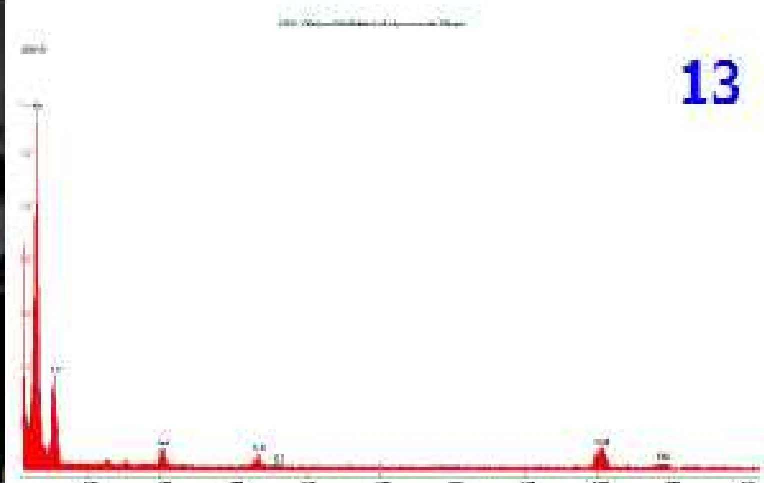

13

Molie

7/22/2009 12:12:48 PM
HV 30.0 kV
Spot 3.0
Mag 108x
Det ETD
WD 9.7 mm
HFW 2.51 mm
500.0µm
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Antireflexie + concentrare

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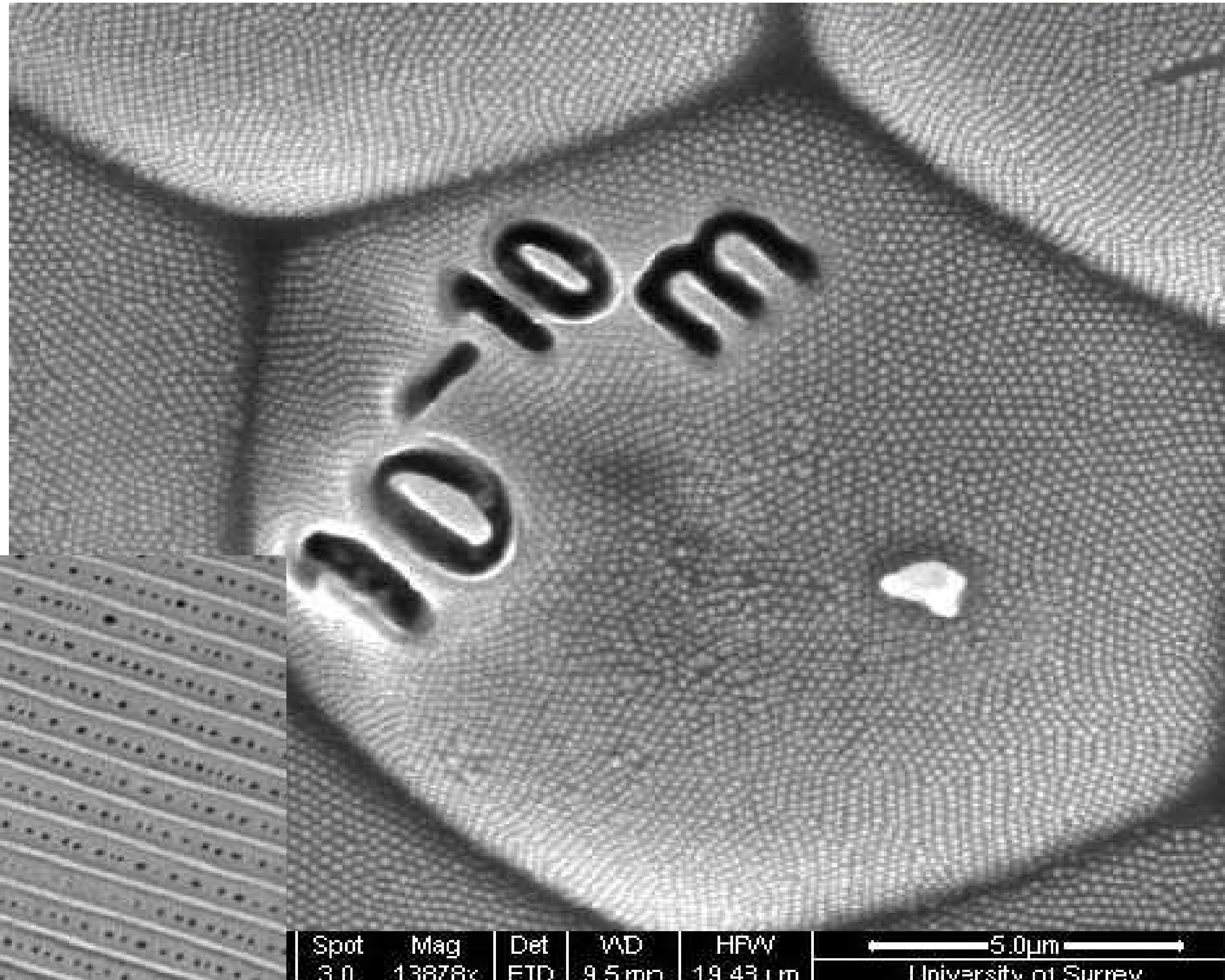

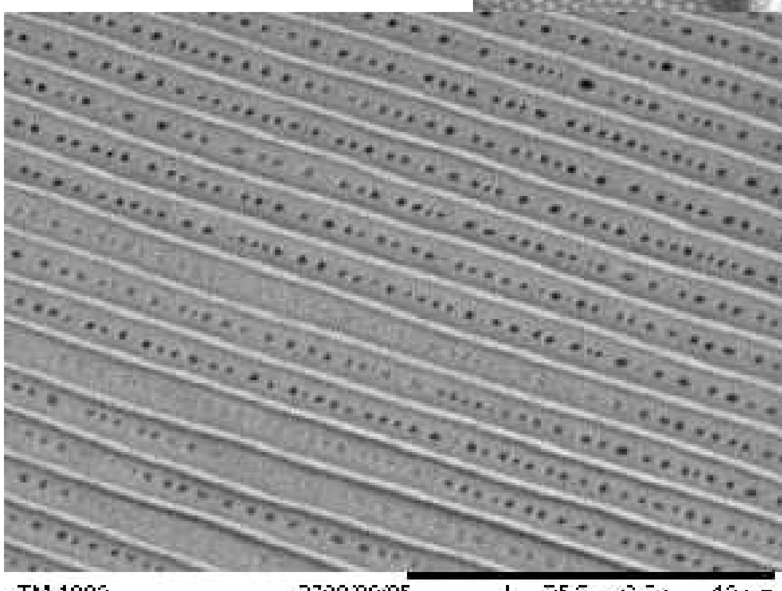

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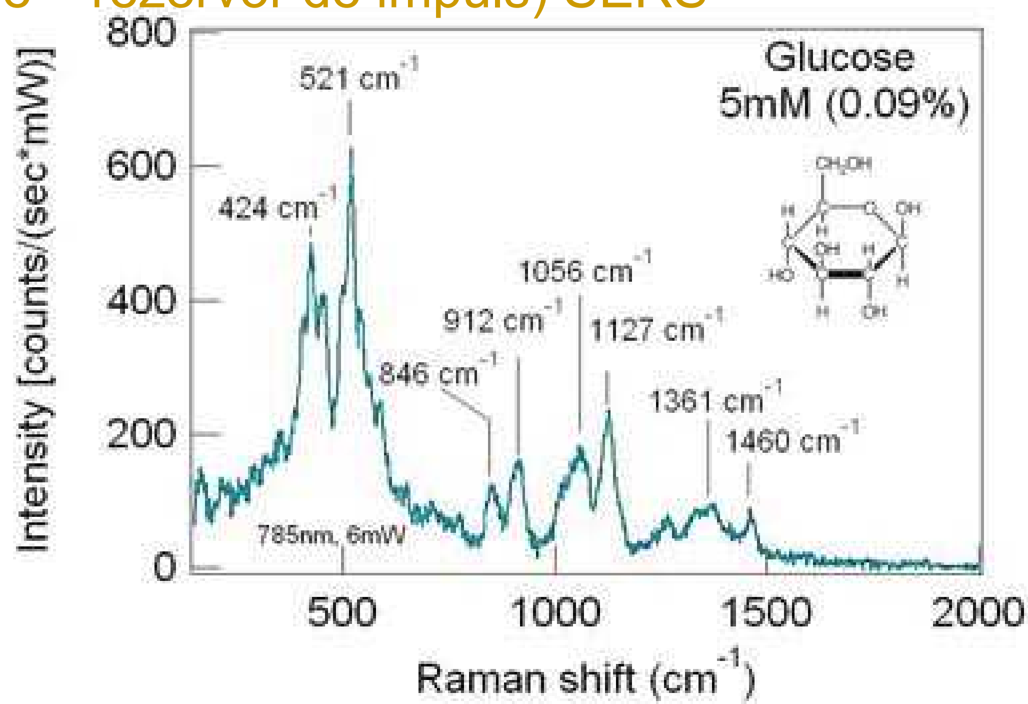
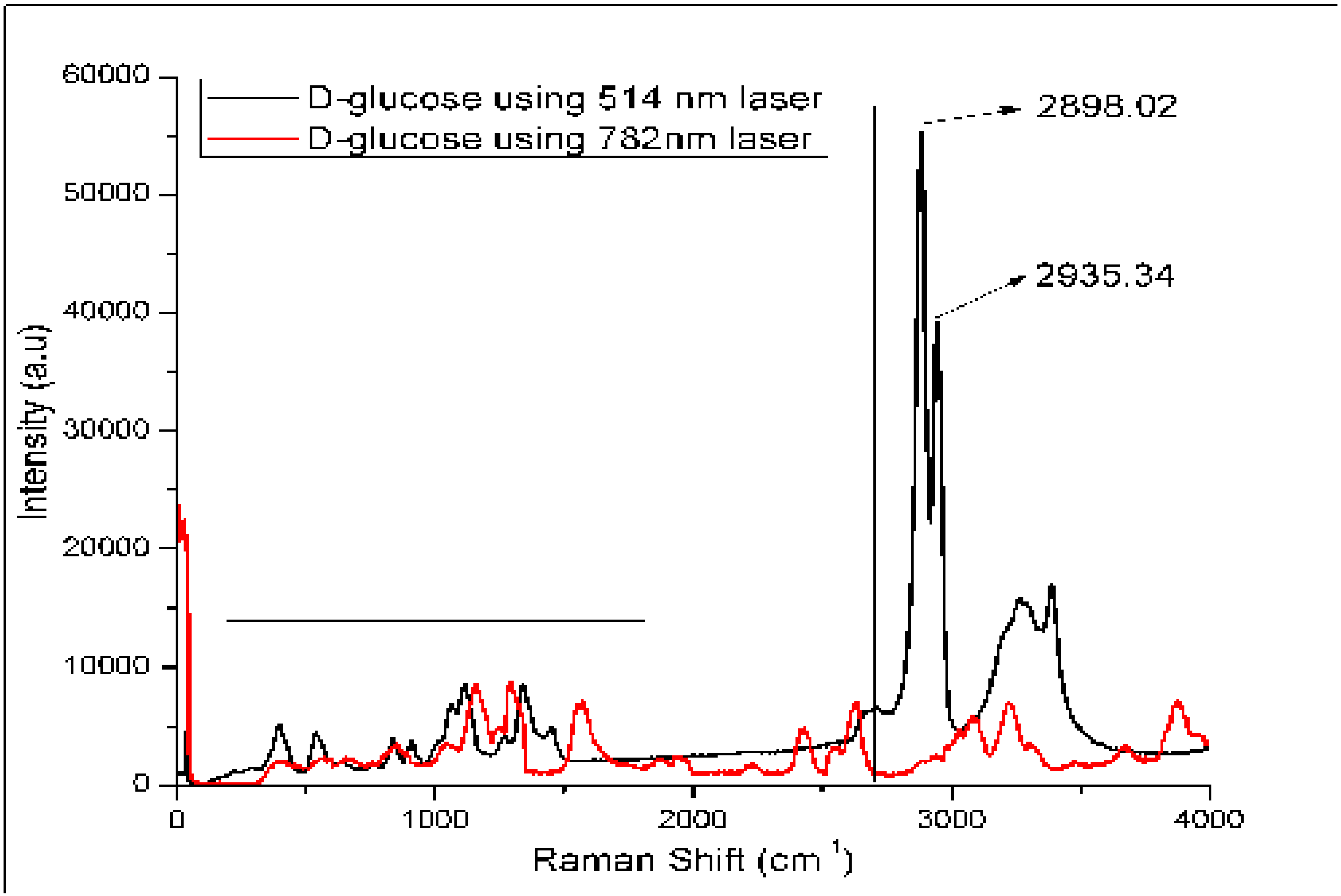
Spectroscopie Raman

- Interacție inelastică a radiației cu substratul (relfectiv)
- Stokes sau Anti-Stokes
  - regula de selecție: schimbarea polarizării
- Probabilitate ~ 1:10^4
  - plasmoni de suprafață/interfață modifică această probabilitate (i.e. polarizare – rezervor de impuls) SERS
- Tehnică non-contact
- 'ne-destructivă'

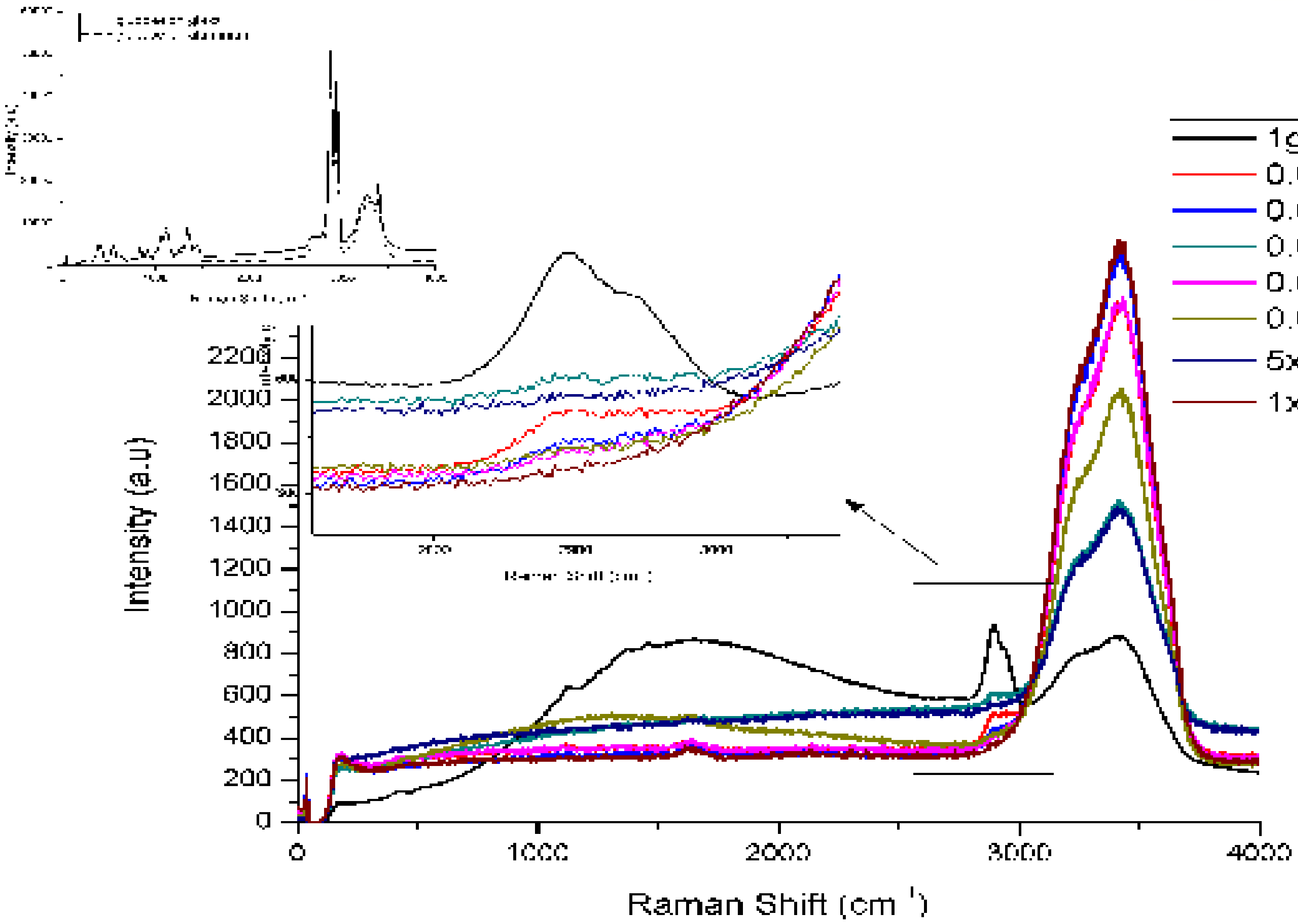


Glucoza

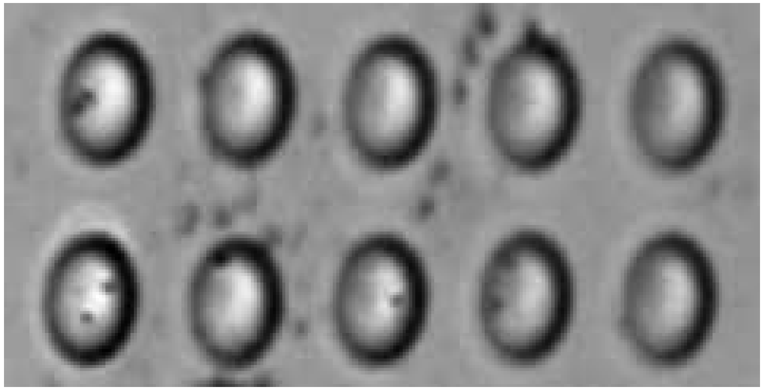


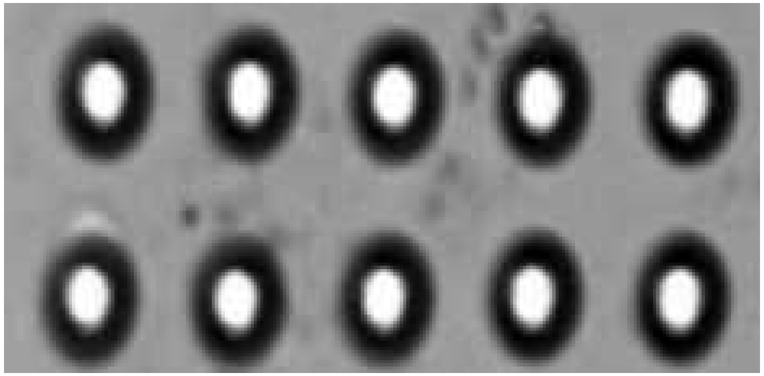
D-glucose using 514 nm laser
D-glucose using 782nm laser
2898.02
2935.34
Intensity (a.u)
Raman Shift (cm⁻¹)
0
10000
20000
30000
40000
50000
60000
0
1000
2000
3000
4000

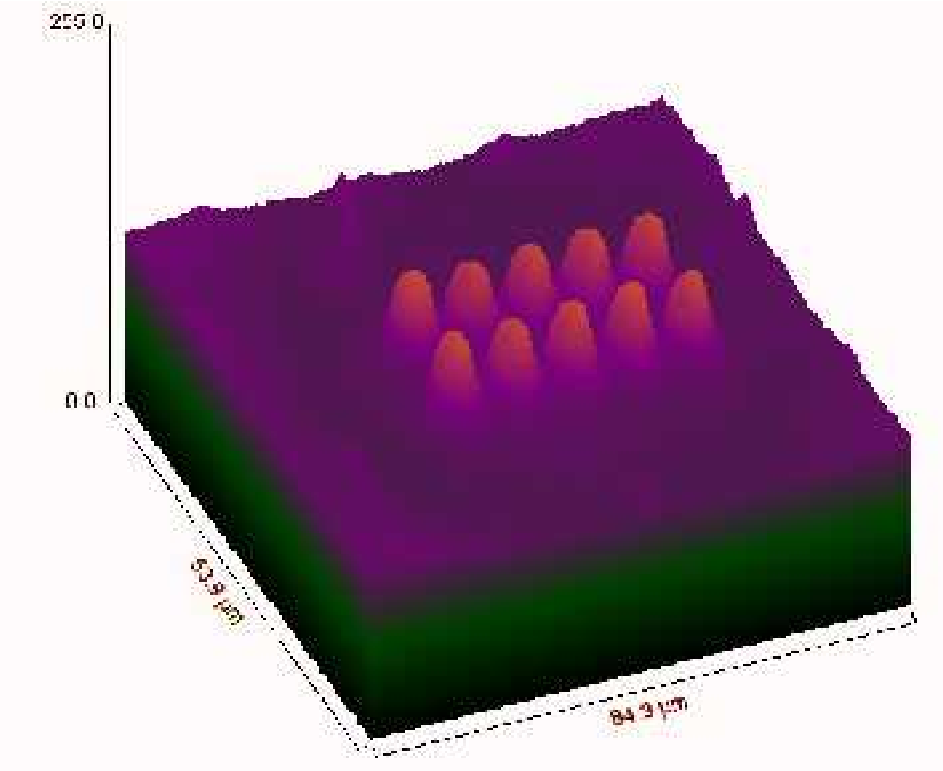
Glucoza in apă

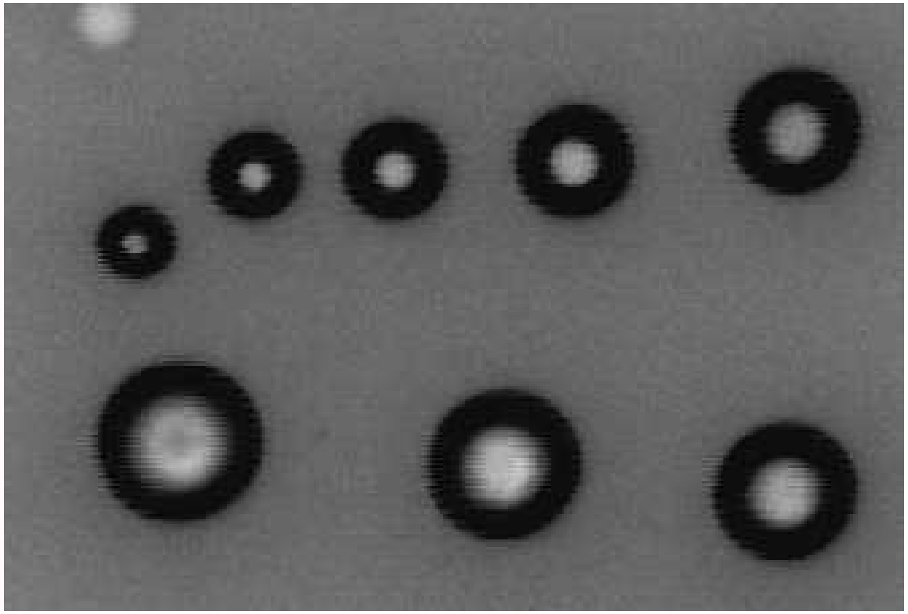


Concentrori parabolici

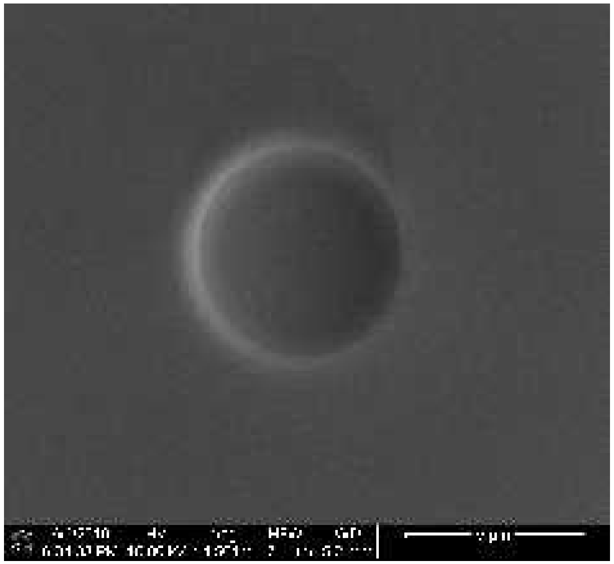


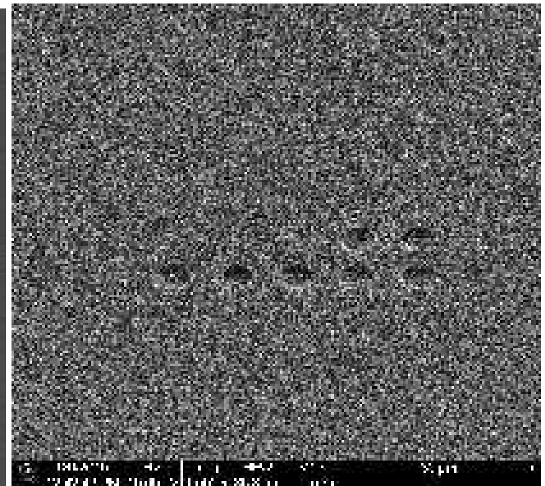


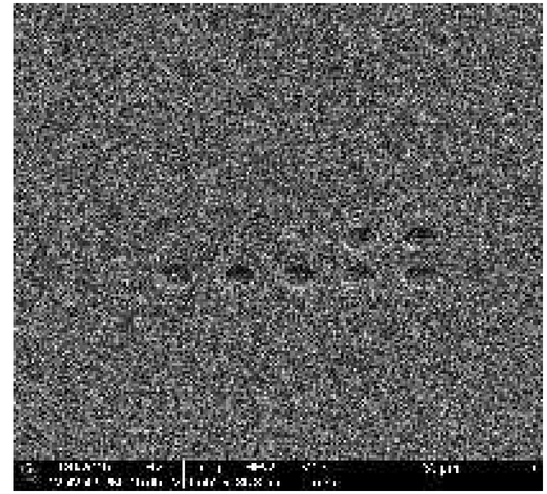


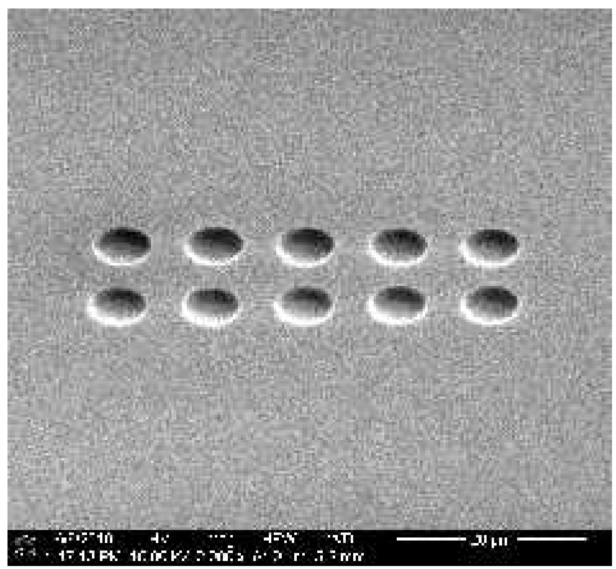


Controlul dozei si al fasciculului de ioni



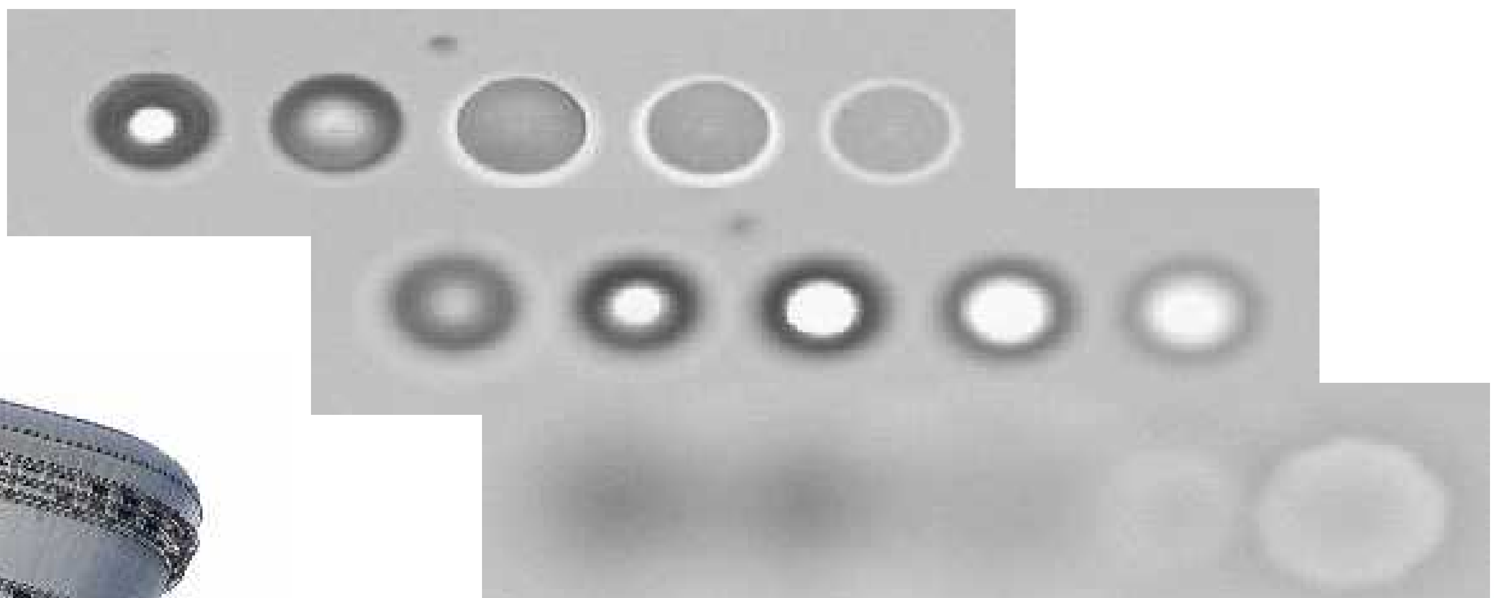




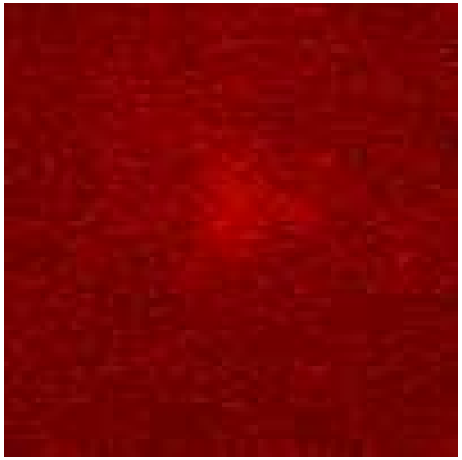


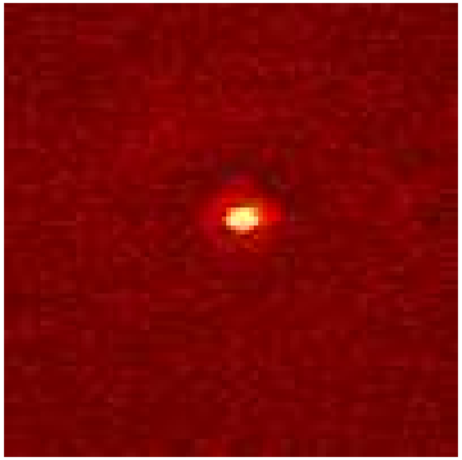
Concentrori

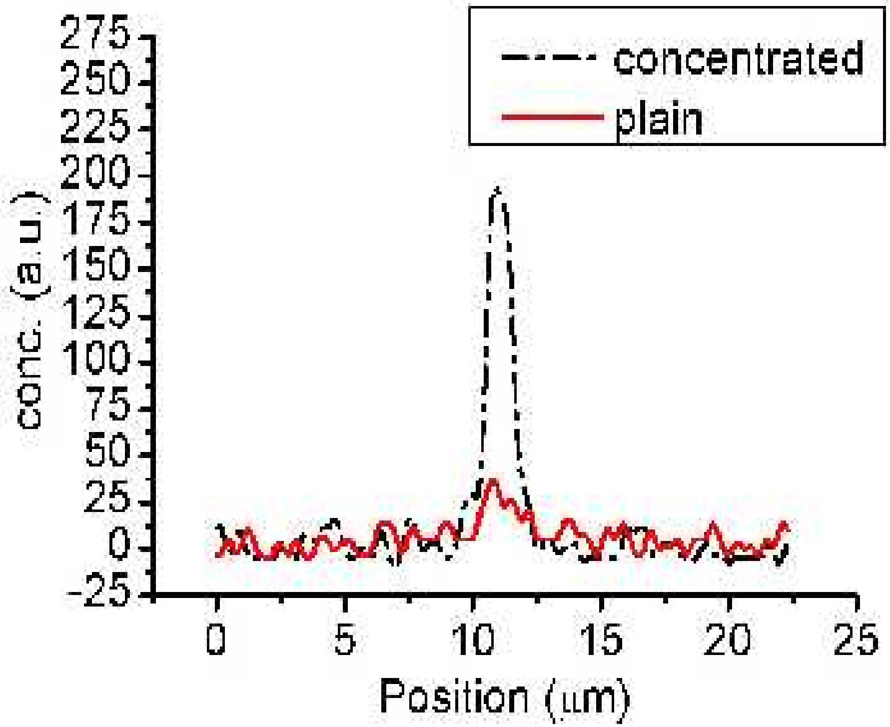
- Eficienți la iluminare redusă
- Cresc eficiența de colectare/detectare (semnalul ~ X+A lnX) si unghiul solid de colectare $[d^2\sigma/(dEd\Omega)]$
- Nu se substituie SERS.



Concentrori







Microscopul Raman
(aberatii sferice)

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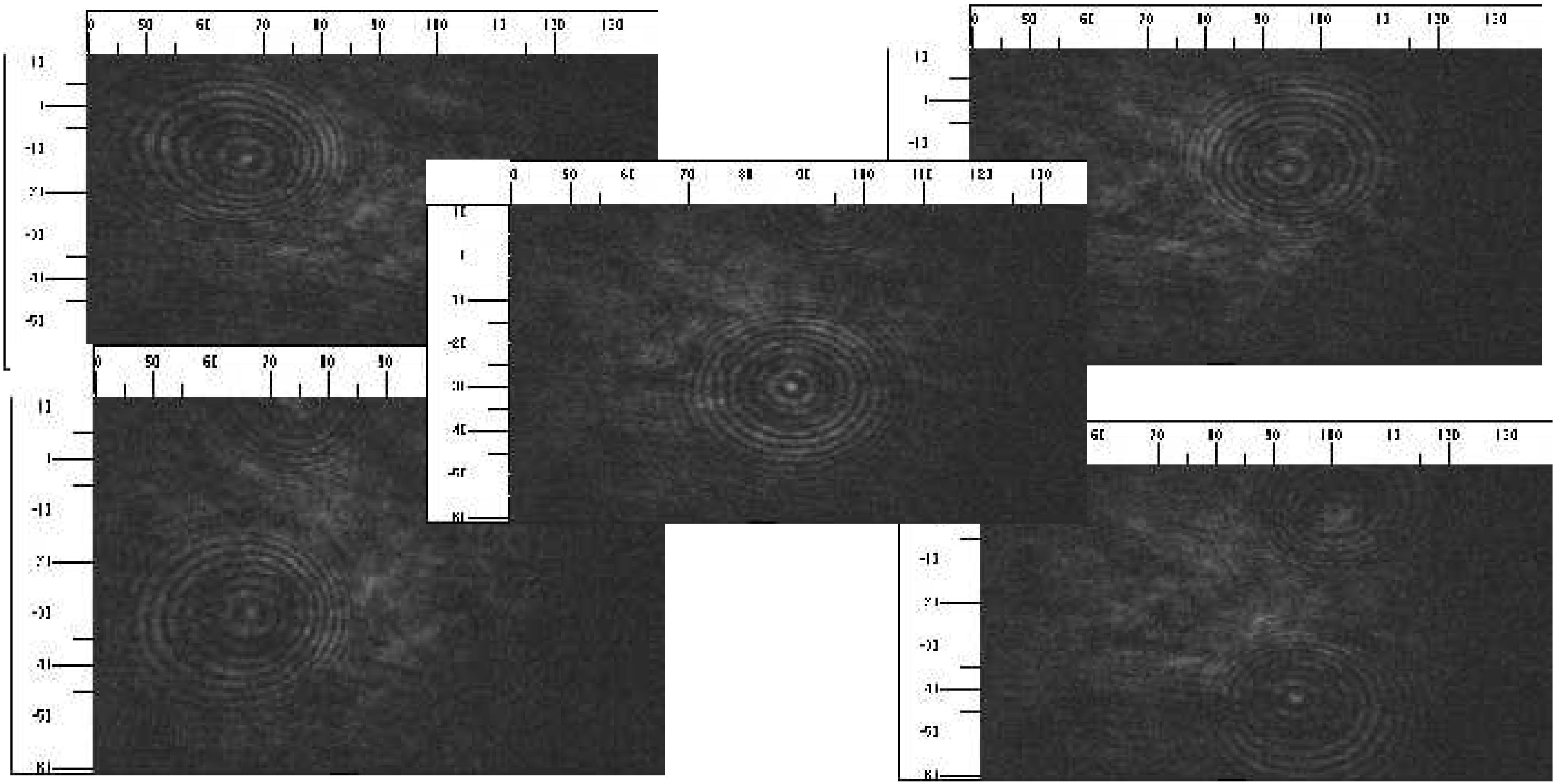
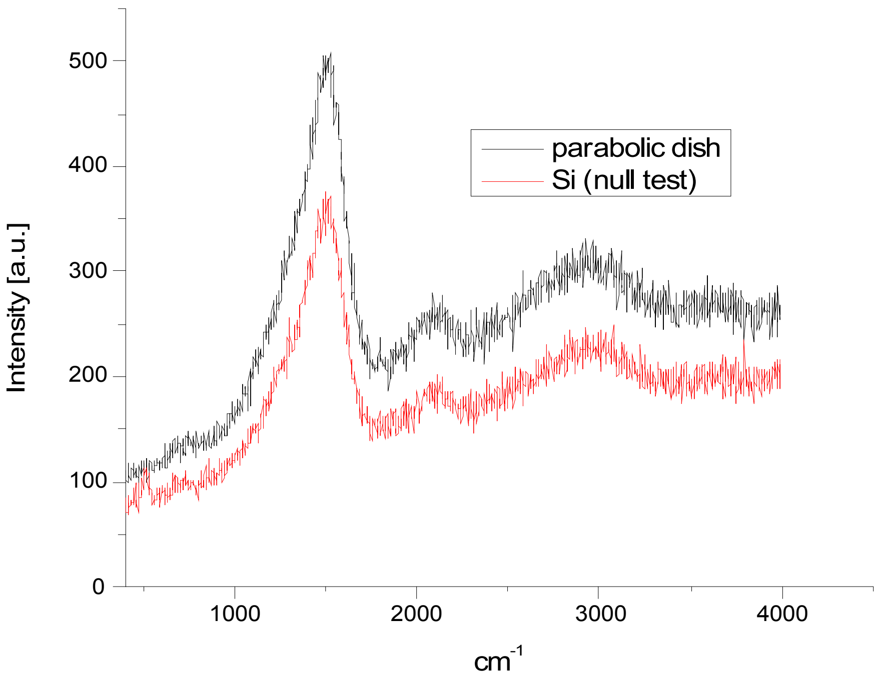
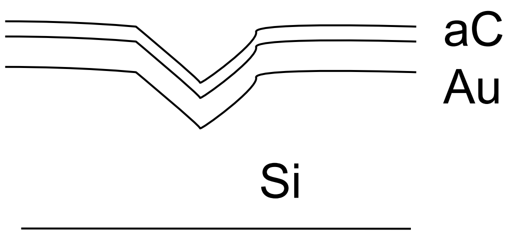


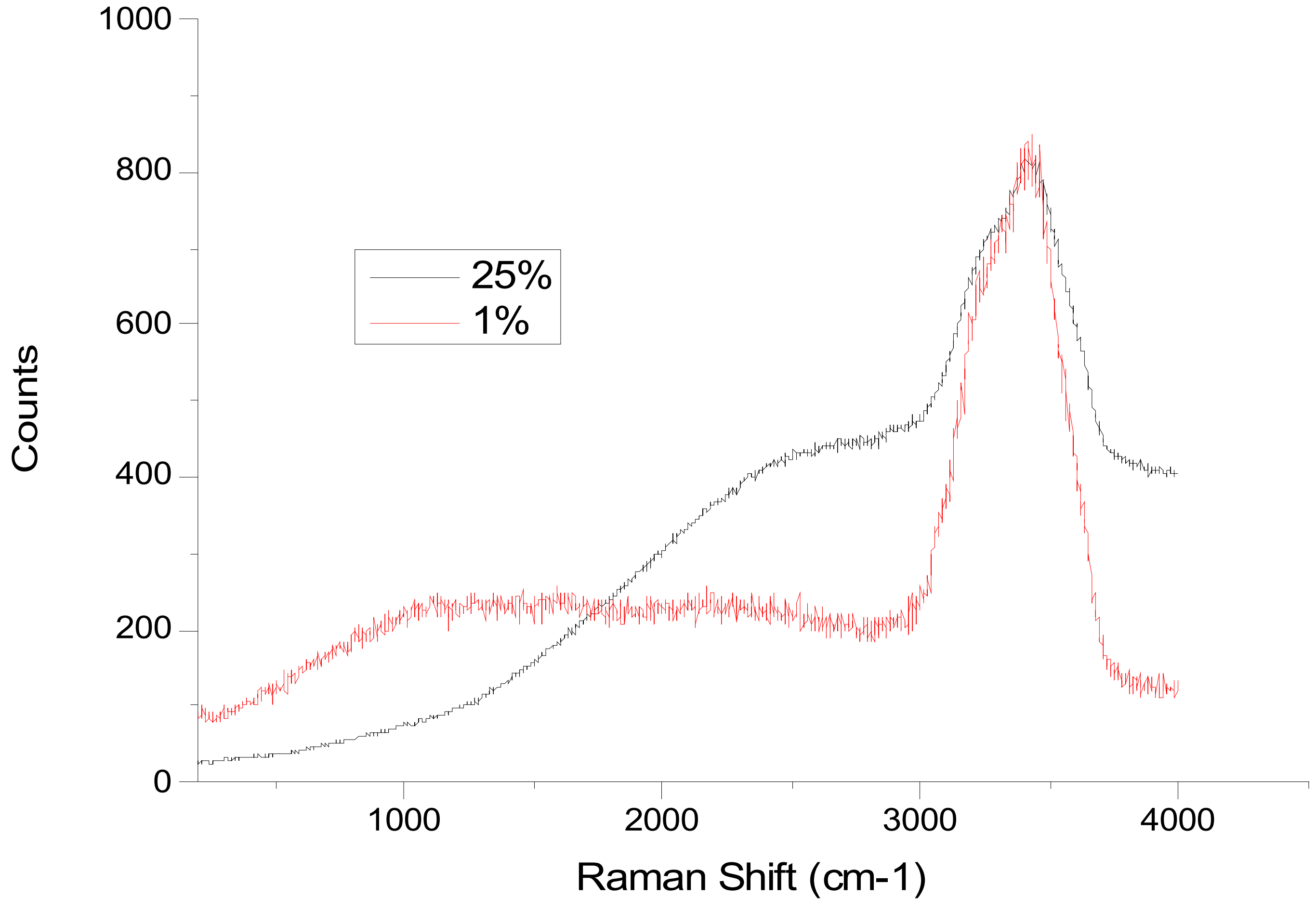


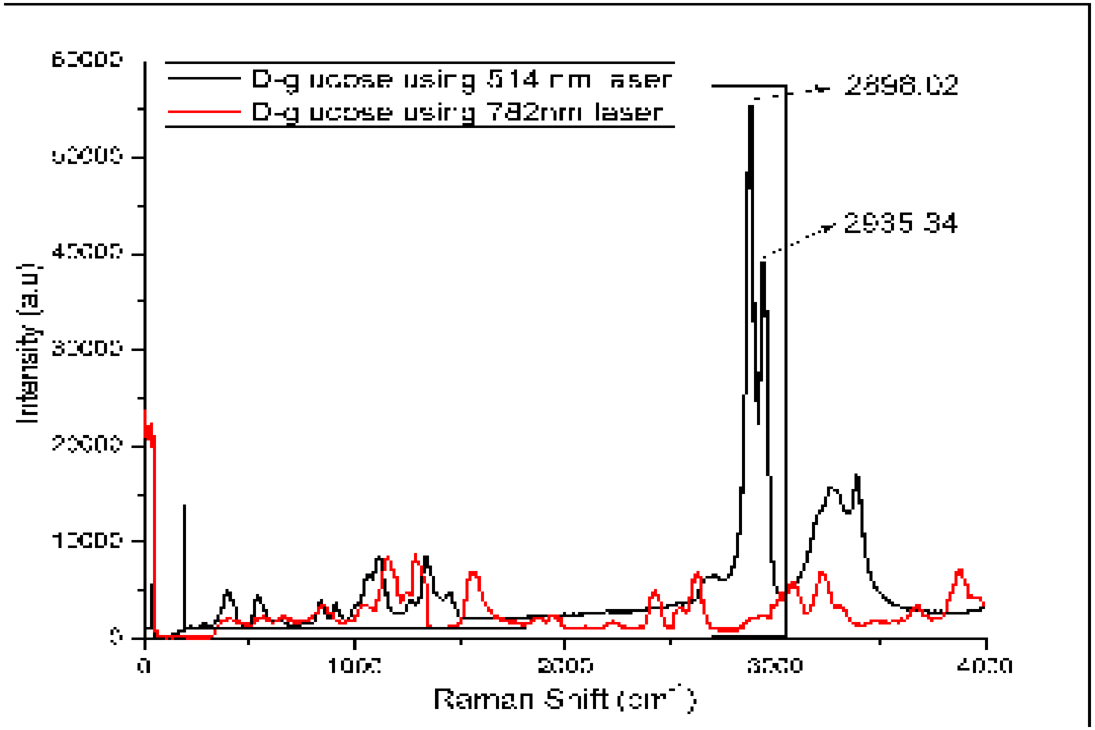
500
400
300
200
100
0
Intensity [a.u.]
1000
2000
3000
4000
cm-1
parabolic dish
Si (null test)



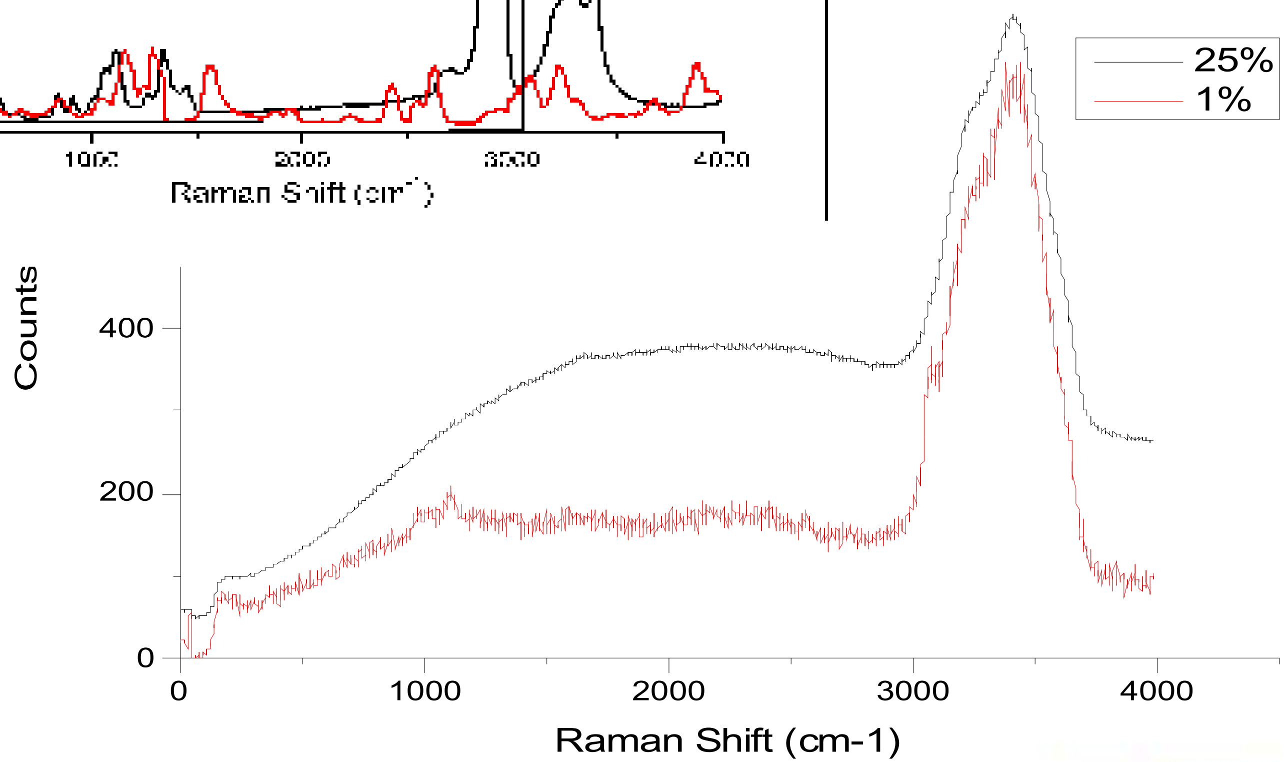
aC
Au
Si

Spectru Raman la intensitate mică (Laser = 532nm) -test nul (pe suprafață plată)
$1x10^{-3}$ g/ml





Concentrori: $1x10^{-3}$ g/ml



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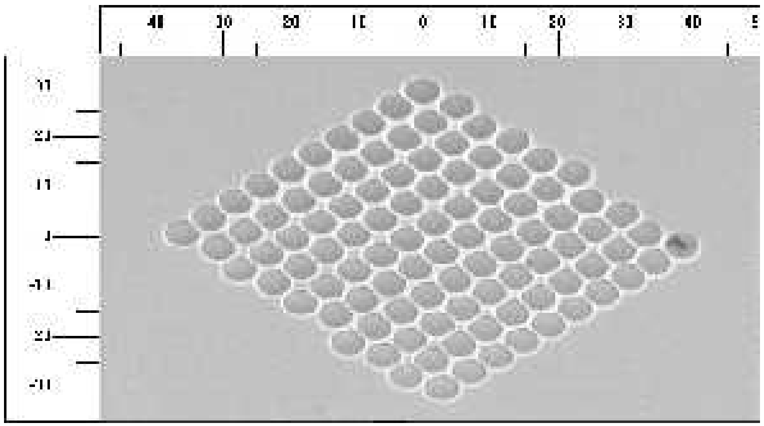
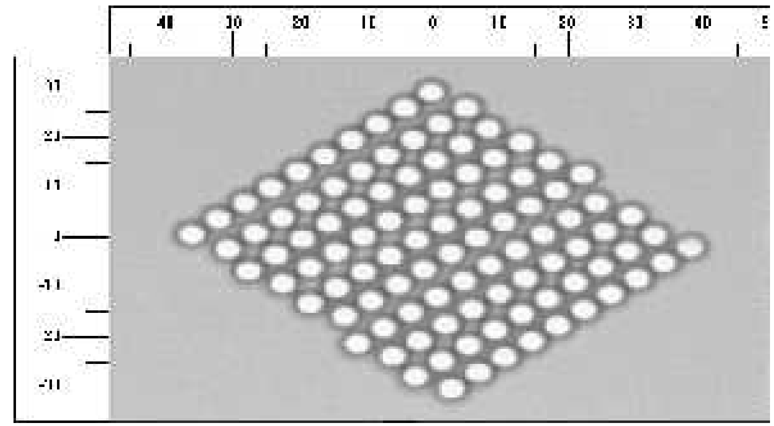
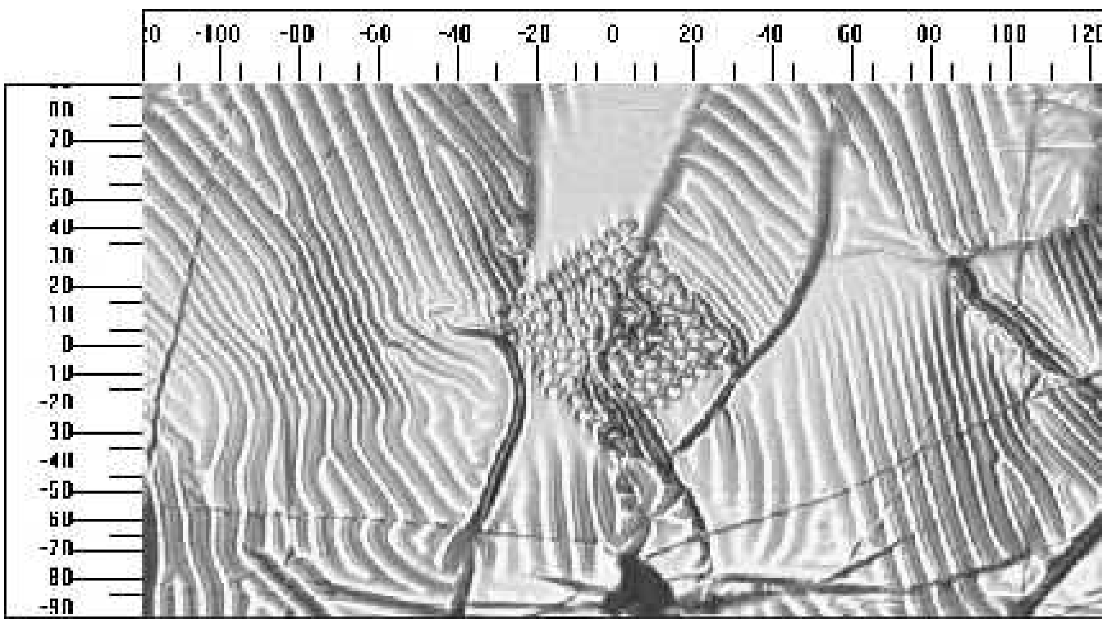
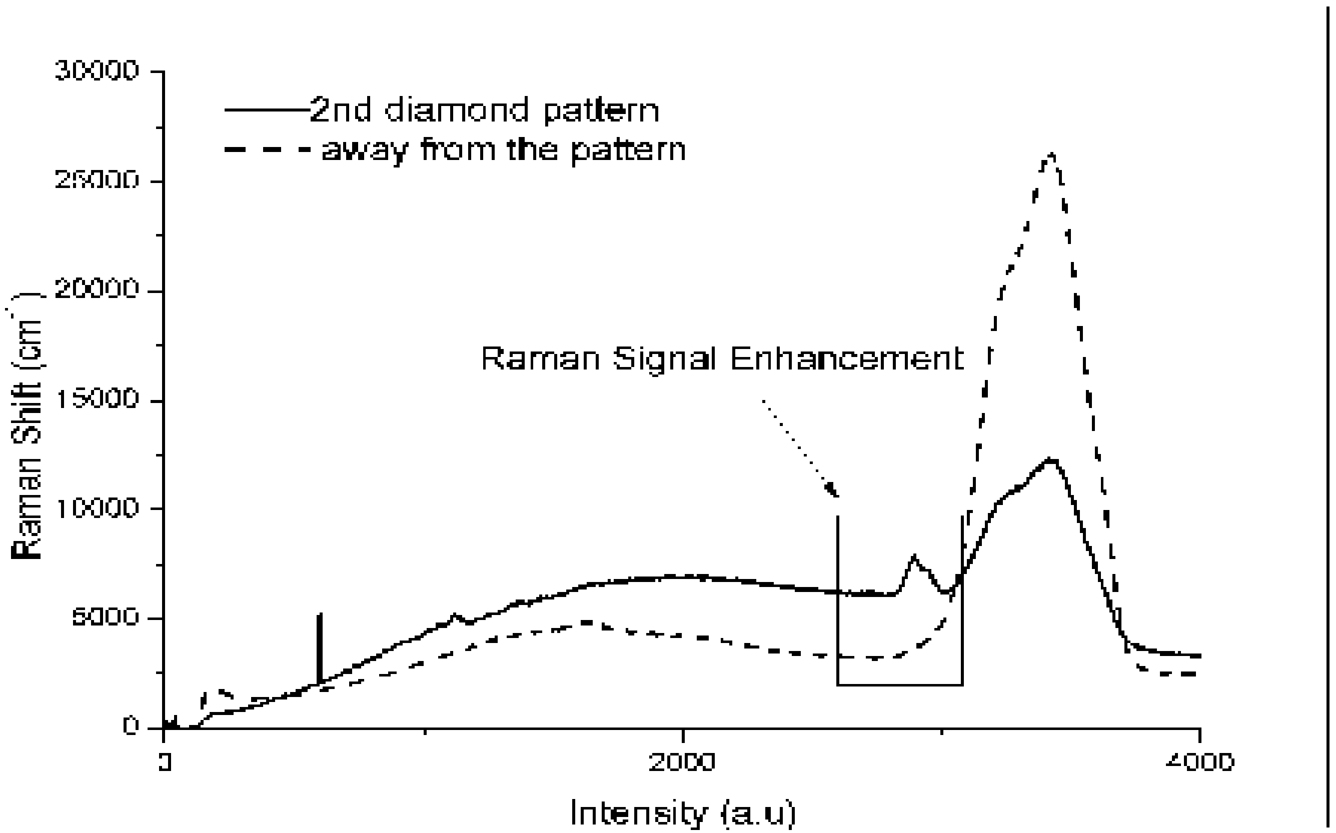
Rezultate (preliminare) pe glucoză







SERS (Au), green laser, $5x10^{-3}$g/ml

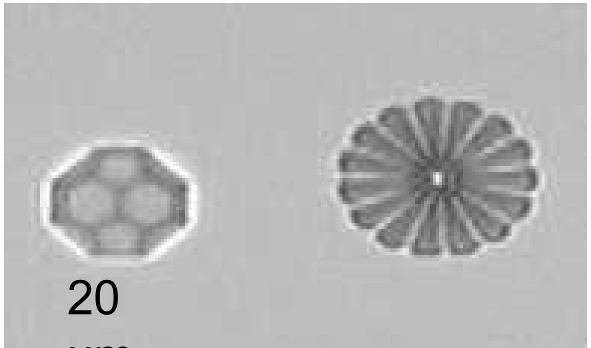


Concluzii

Concentrorii par să amplifice semnalul Raman. O interpretare este creşterea unghiului solid de colectare a semnalului. SERS necesar.

Recipient 'ideal' pentru lichide; Efecte optice reproductibile.

- Modificarea aperturii optice poate demonstra această teorie
  - (aproape) totul e posibil cu FIB, dar serial (încet).
- Microscopie electronica
  - EELS cu rezoluție sub-nanometrică.



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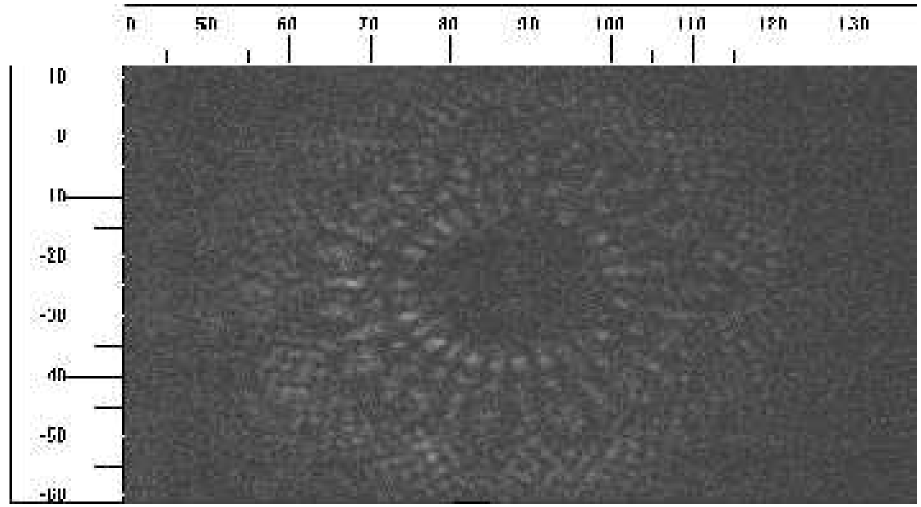
um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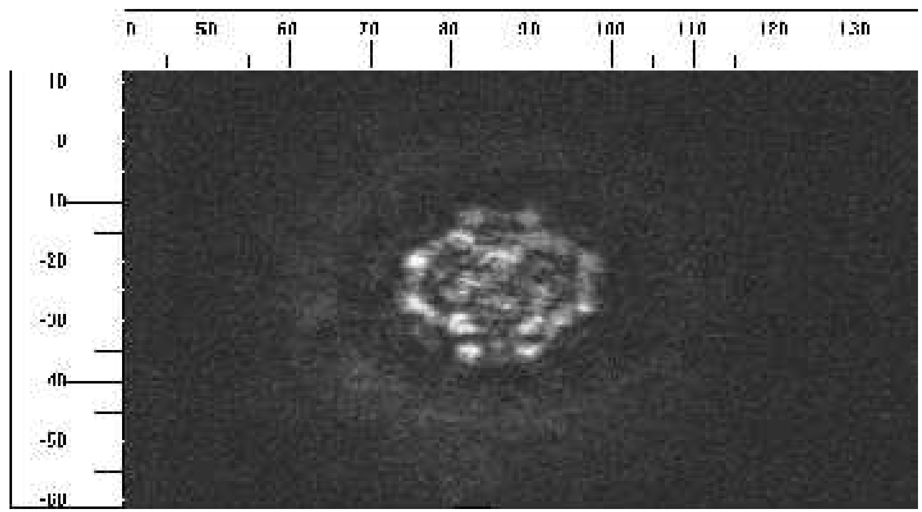
10 0 -20 -30 -40 -50 -60


50 60 70 80 90 100 110 120 130
10 0 -20 -30 -40 -50 -60