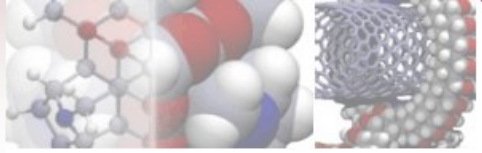


RECENT ADVANCEMENTS IN THE DEVELOPMENT OF A SENSITIVE ANALYTICAL PLATFORM BASED ON MAGNETICO-OPTIC SURFACE PLASMON RESONANCE

CONTRIBUTII RECENTE LA DEZVOLTAREA UNEI PLATFORME ANALITICE SENSIBILE BAZATE PE REZONANTA PLASMONILOR DE SUPRAFATA MODULATA PRIN EFECT MAGNETO-OPTIC

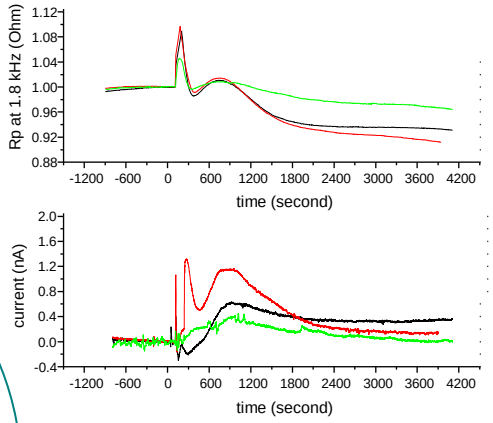
Mihaela Gheorghiu

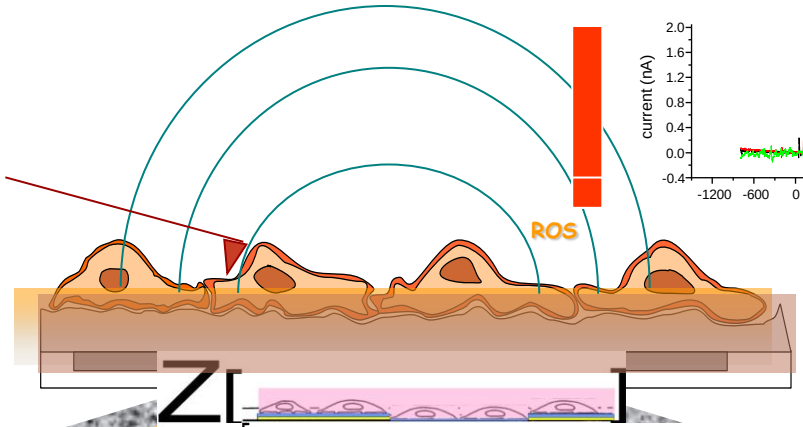
Sorin David, Cristina Polonschii, Dumitru Bratu, Eugen Gheorghiu
International Centre of Biodynamics, Bucharest

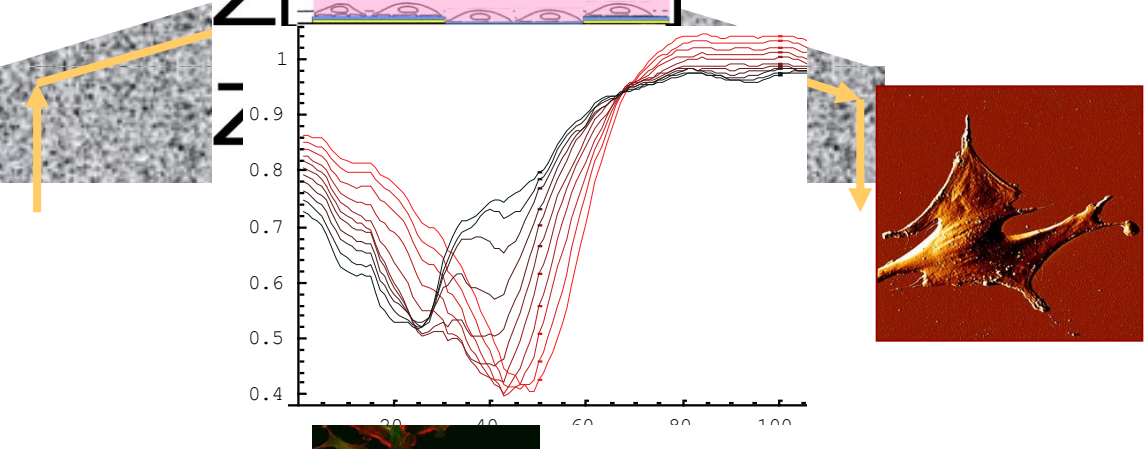
Dezvoltarea de noi Metode si Instrumentatie ne-invazive
Methods and Instrumentation
pentru analiza rapida a biosistemelor
(Sisteme celulare & Biosenzori)

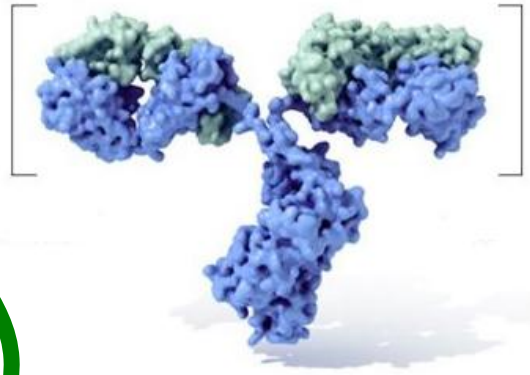
Monitorizare, Detectie: Analiza BioInterfetelor

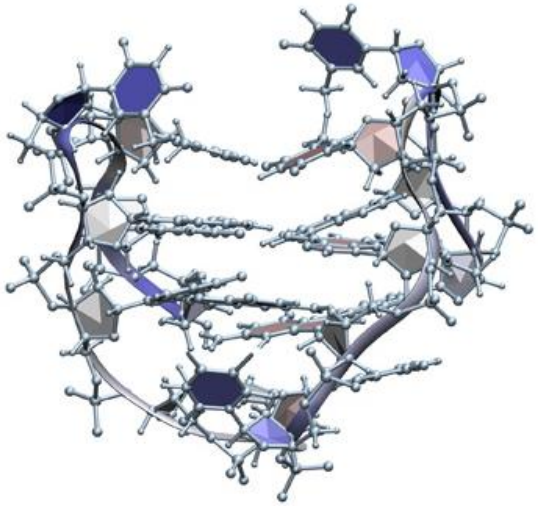
- Sisteme celulare (monostrat)
- Interfete
- Reactii bioafine
- Procese de interfata

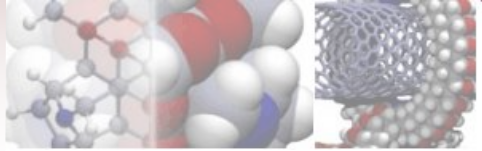










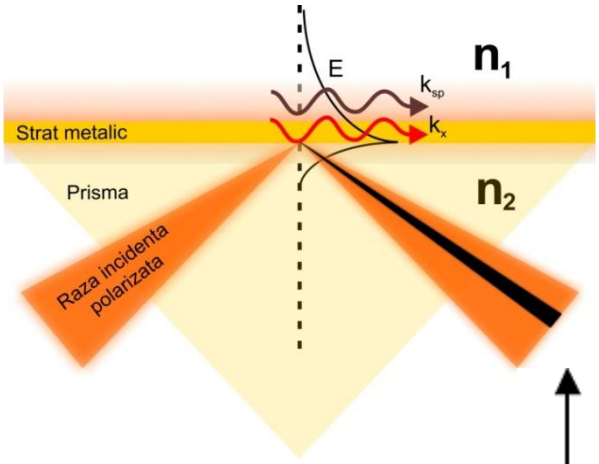


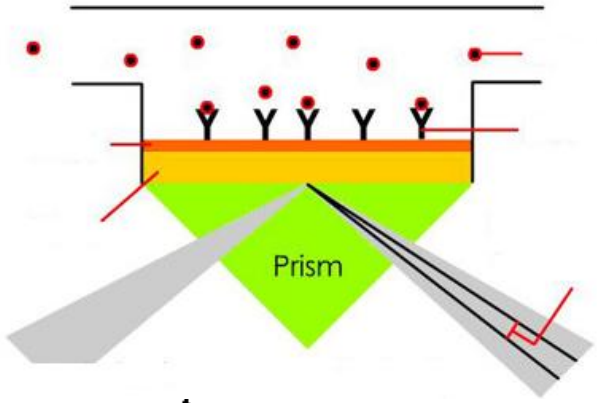
Infrastructura CIB

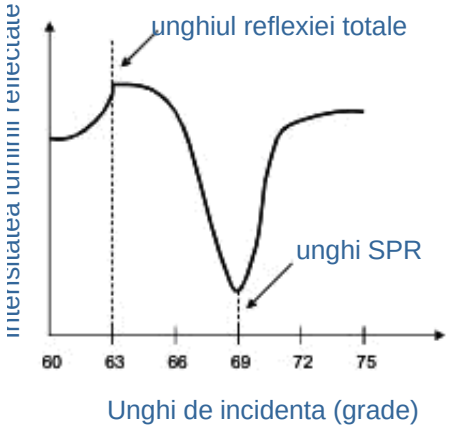
Metode

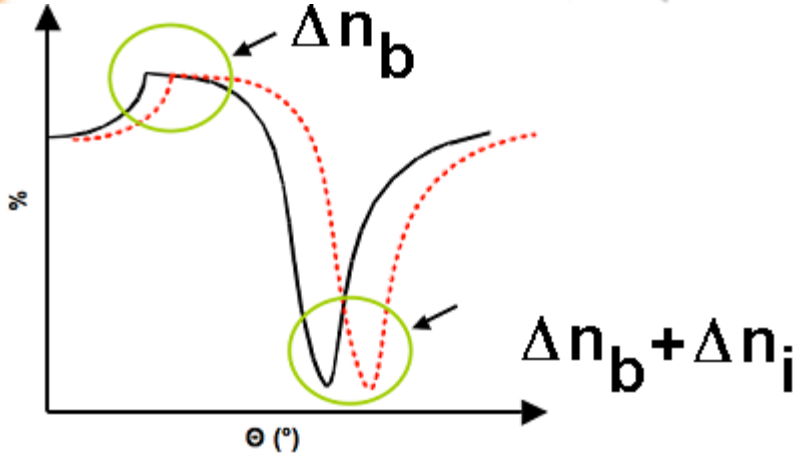
- Rezonanta Plasmonilor de Suprafata

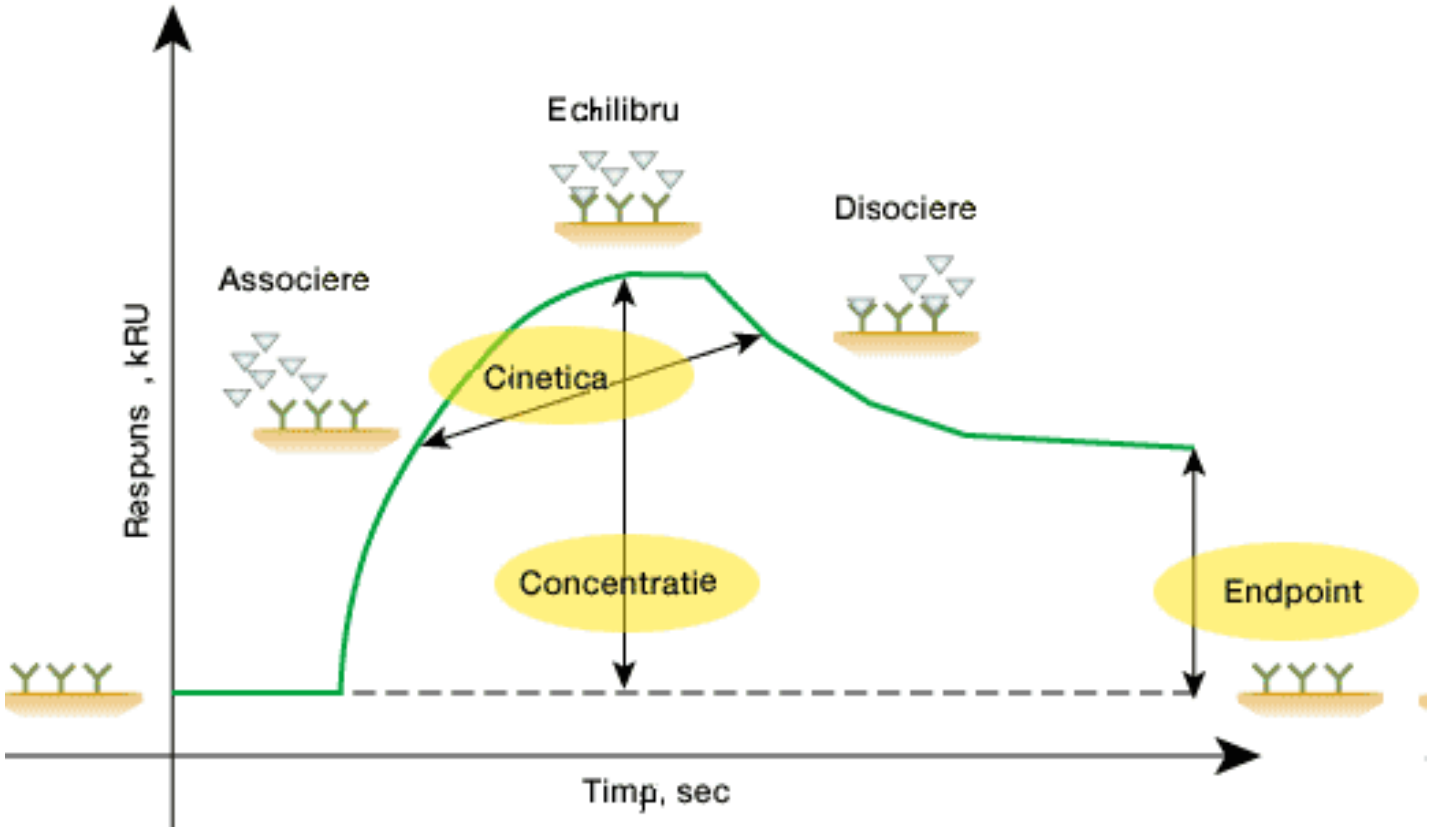
$$\theta = \arcsin \frac{\sqrt{\frac{\varepsilon_m^* n_1^2}{\varepsilon_m^* + n_1^2}}}{n_2}$$



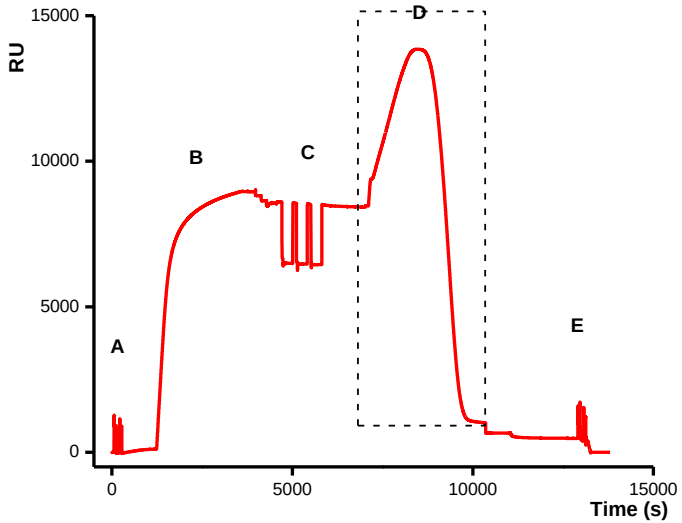


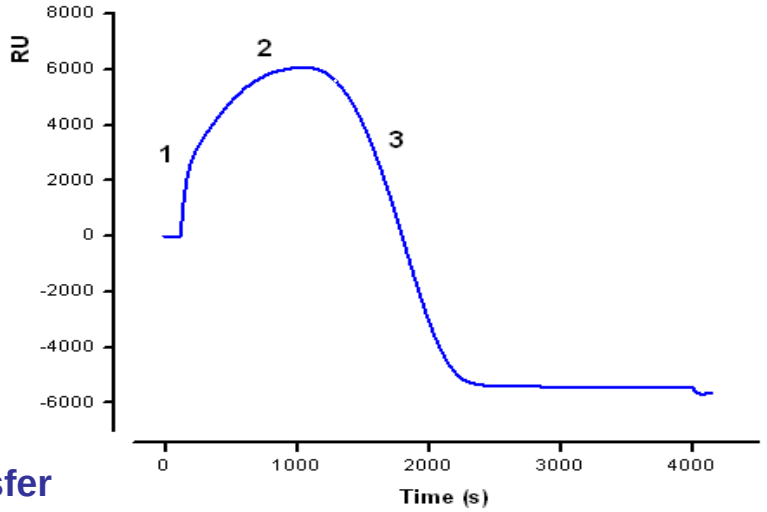





Echilibru
Disociere
Associere
Cinetica
Concentratie
Endpoint
Raspuns , kRU
Timp, sec

Evaluarea procesului multifazic de interactie intre melitina si membranele lipidice





Model cinetic

+

Matrice de transfer

Parametri (cinetici) cantitativi

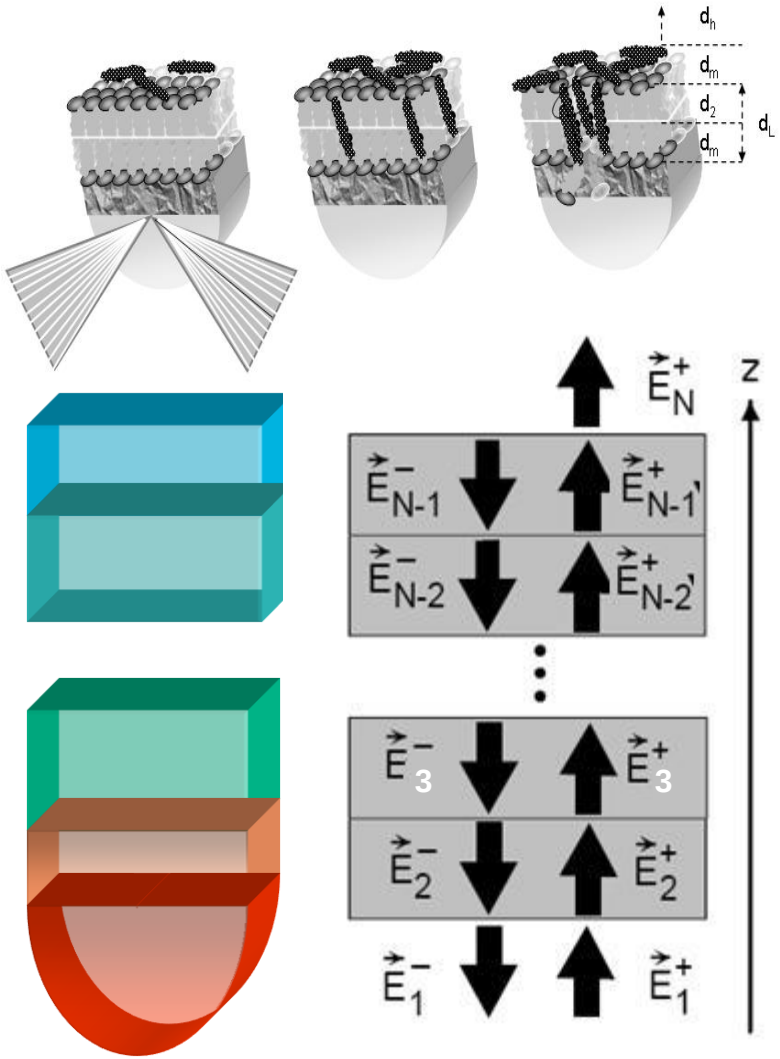
1. Asocierea M-L
2. Insertia M in membrana lipidca
3. Formarea Porilor

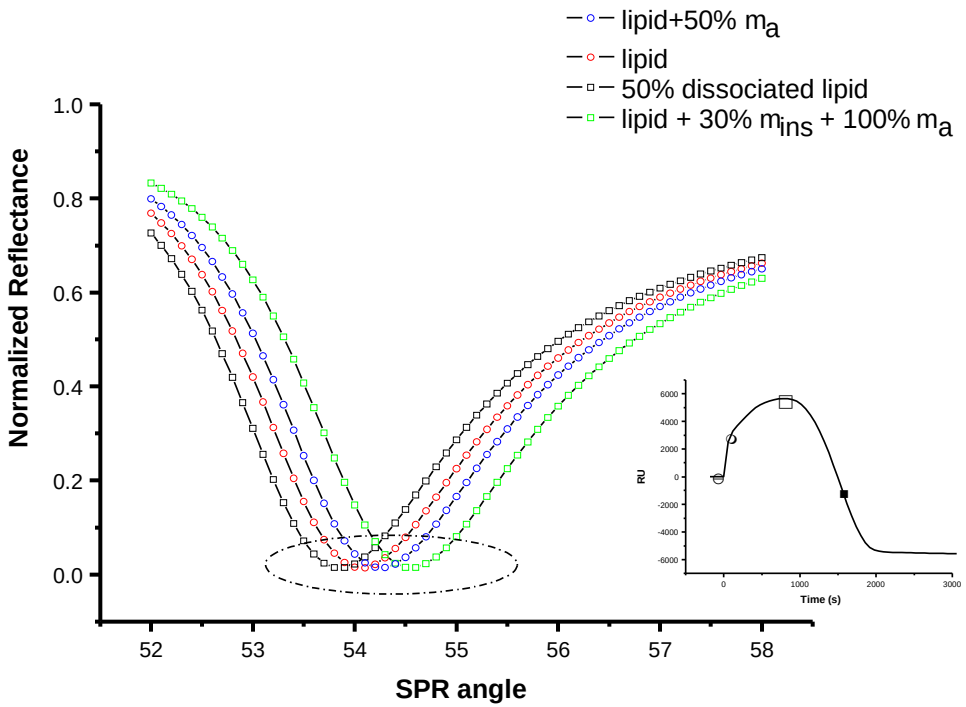
- **Pasii experimentali**

A – curatare suprafata senzor
B – formarea membranei lipidice (POPC)
C – indepartarea structurilor slab atasate
D – interactia melitinei cu membranele lipidice
E – regenerarea suprafetei senzorului

- Constante de asociere
- Constante de disociere
- Valori prag
- Rapoarte P:L

Determinarea reflectantei unui sistem multistratificat prin abordari de Matrice de Transfer



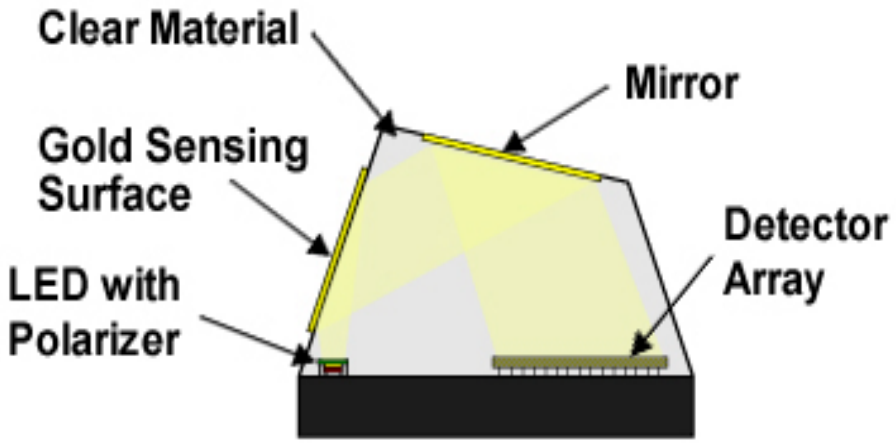


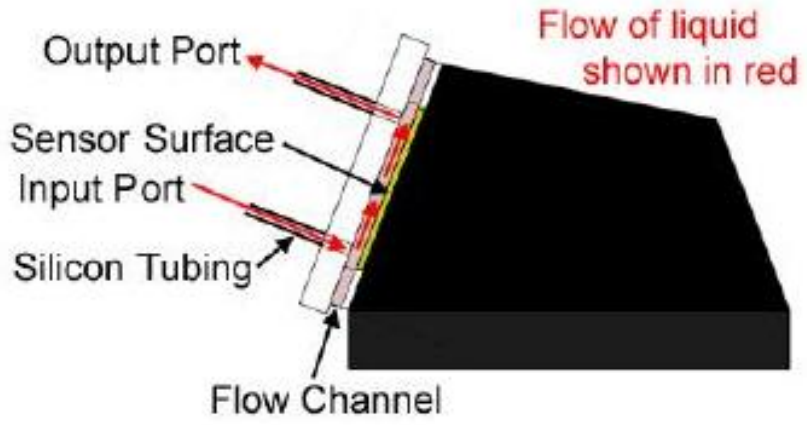
SPR signal of multiple dielectric/metal layers

(**2009**), J. Phys Chem B 113, 14369–14380

(**2009**), Biosens. Bioelectron. 24, 3517–3523

Spreeta

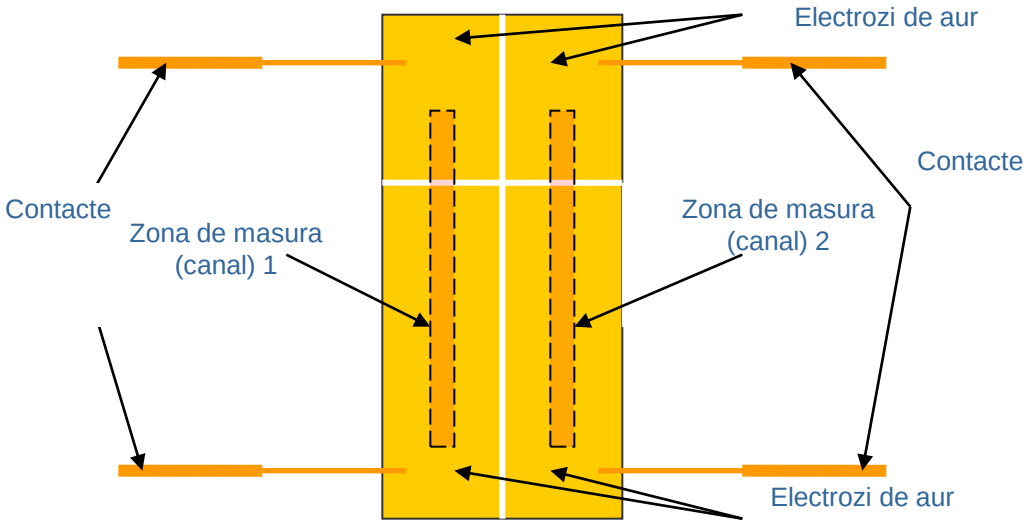


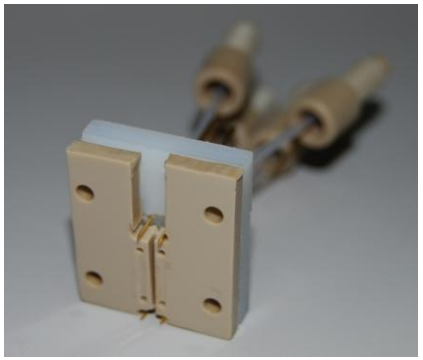


Caracteristicile senzorului SPREETA TSPR2K23

- Domeniu 1.320 – 1.368 RIU,
- Rezolutie $3x10^{-6}$ RIU
- Nr. detectori 128
- Lungime de unda 840 nm
- Nr. canale 3

Set-up combinat Electro-optic





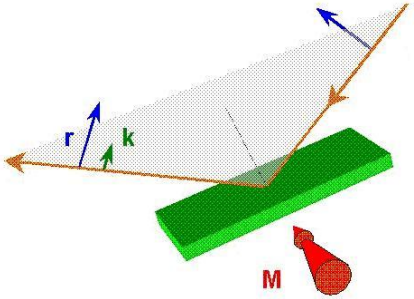
SPR/ impedanta
celule, proteine, analiti tinta
platforme de biorecunoastere cu aptameri si anticorpi

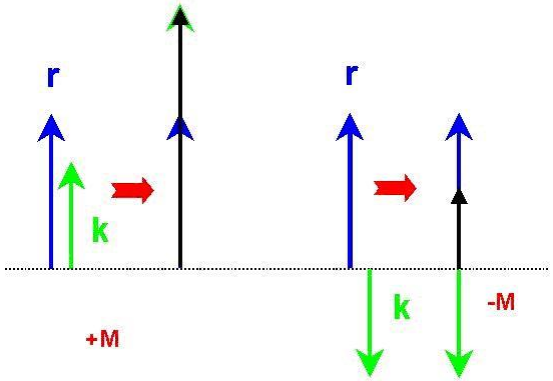
(2010) Talanta 80:2157-64

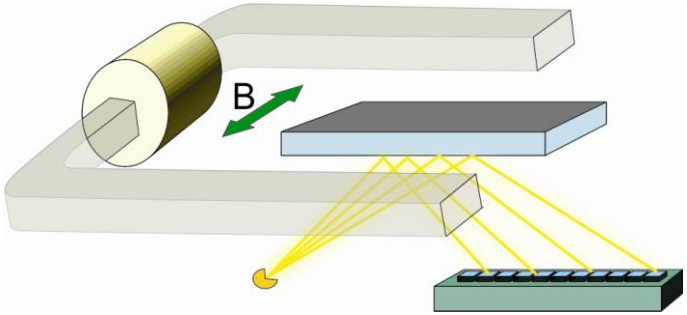
Set-up combinat Magneto-optic

- Efect Magneto-optic

Efect Kerr magneto –optic transversal



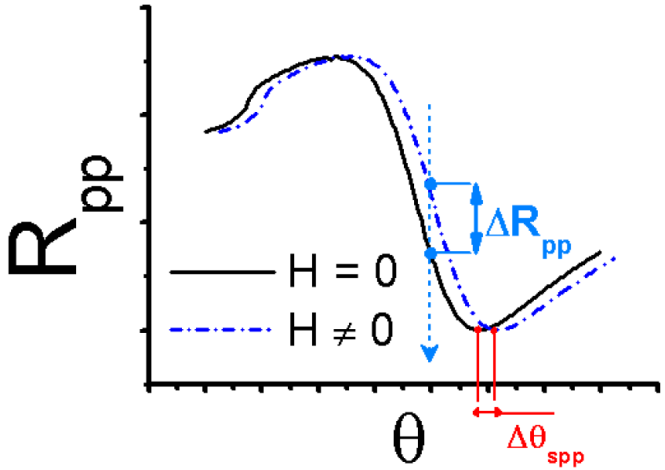


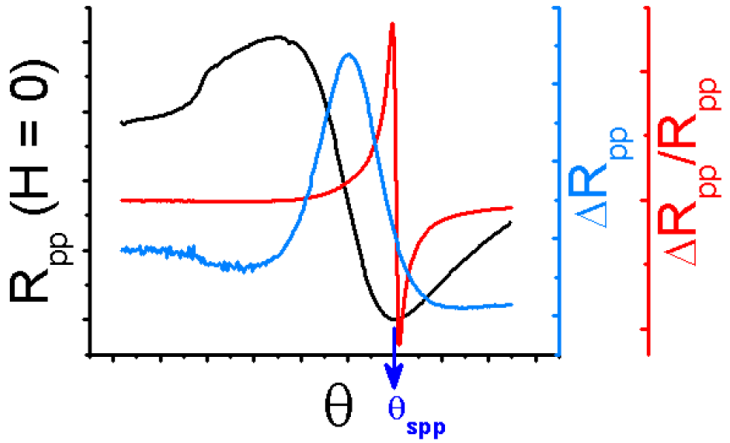


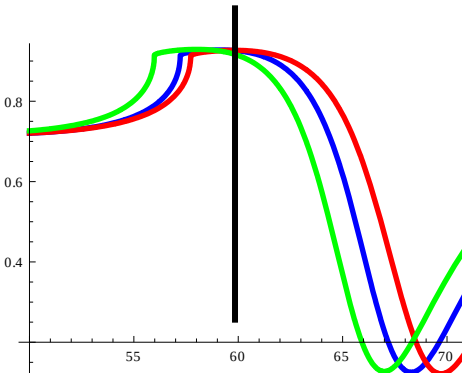
$$\frac{\Delta Rpp}{Rpp} = \frac{Rpp\left(M\right) - Rpp\left(-M\right)}{Rpp\left(0\right)}$$

- $R_{pp}(M)$ si $R_{pp}(-M)$ – valorile reflectivitatii cand magnetizarea este perpendiculara la planul de propagare a luminii p-polarizate incidente.
- $R_{pp}(0)$ reprezinta reflectivitatea in absenta magnetizarii

MOSPR







$$\frac{\Delta Rpp}{Rpp} = \frac{Rpp(M) - Rpp(-M)}{Rpp(0)}$$

$R_{pp}(0)$ (SPR) este dependent de indicele de refractie al straturilor componente ale sistemului de analiza.

Prin determinarea efectului magneto-optic (MOSPR) se vizeaza obtinerea unei sensibilitati crescute la variatiile indicelui de refractie.

Metoda Matricii de transfer

Metoda matricii de transfer permite calculul reflectivitatii ca functie de unghiul de incidenta θ al luminii p-polarizate pe baza considerarii distributiilor de camp, reflexiei si transmisiei in fiecare strat/interfata a sistemului multistratificat si caracterizat de o grosime d_i si o constanta dielectrica complexa ε_i^* .

$$\vec{P} = \varepsilon_0 (\overset{\text{t}}{\varepsilon} - 1)\vec{E} \quad \longleftrightarrow \quad \begin{pmatrix} P_x \\ P_y \\ P_z \end{pmatrix} = \varepsilon_0 \begin{pmatrix} \varepsilon_{xx} - 1 & \varepsilon_{xy} & \varepsilon_{xz} \\ \varepsilon_{yx} & \varepsilon_{yy} - 1 & \varepsilon_{yz} \\ \varepsilon_{zx} & \varepsilon_{zy} & \varepsilon_{zz} - 1 \end{pmatrix} \begin{pmatrix} E_x \\ E_y \\ 0 \end{pmatrix}$$

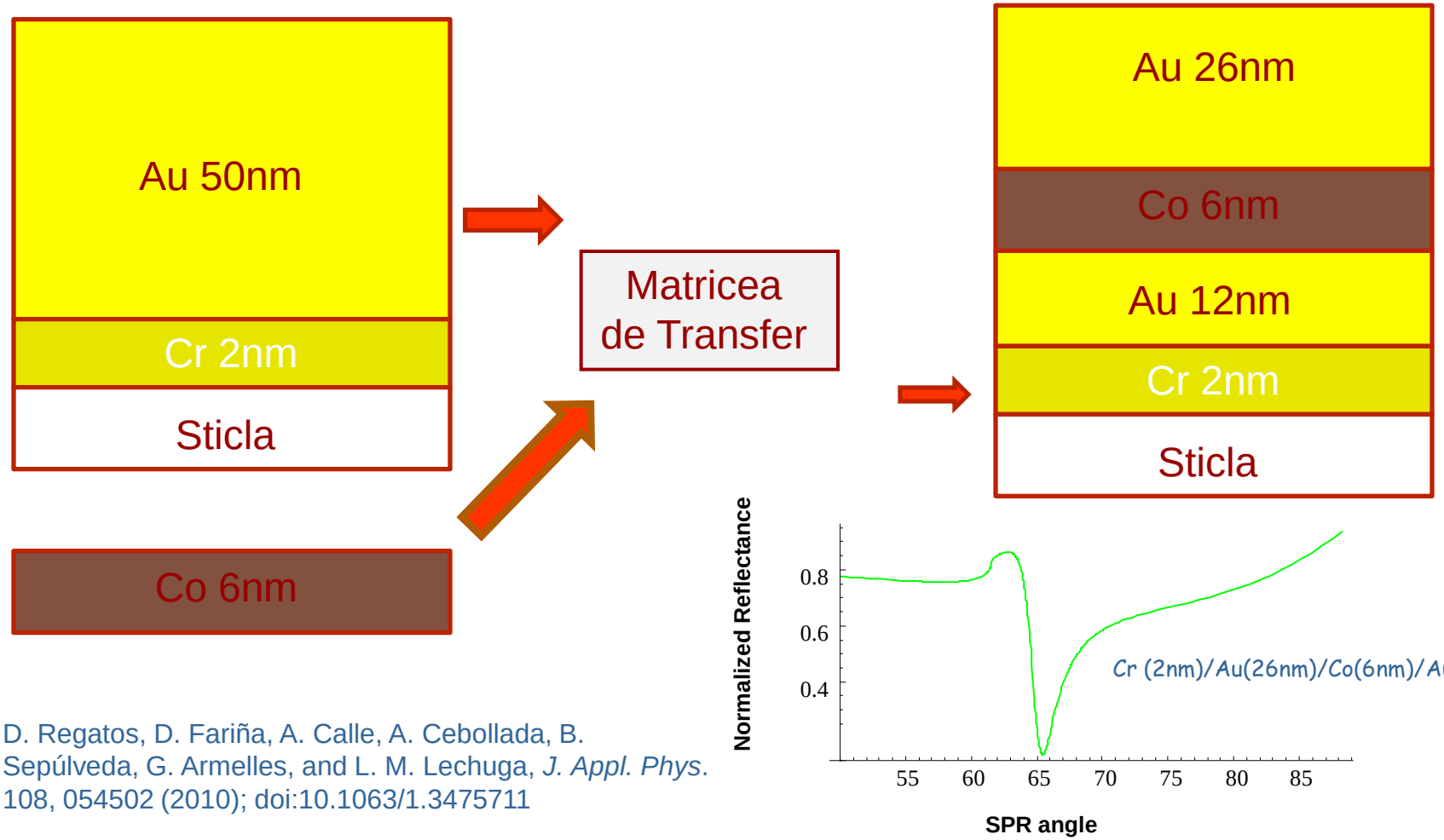
Tensorul dielectric pentru un material feromagnetic

$$\overset{\text{t}}{\varepsilon}_{ij}(\vec{B})$$

Q este constanta magneto optica, parametrul Voigt

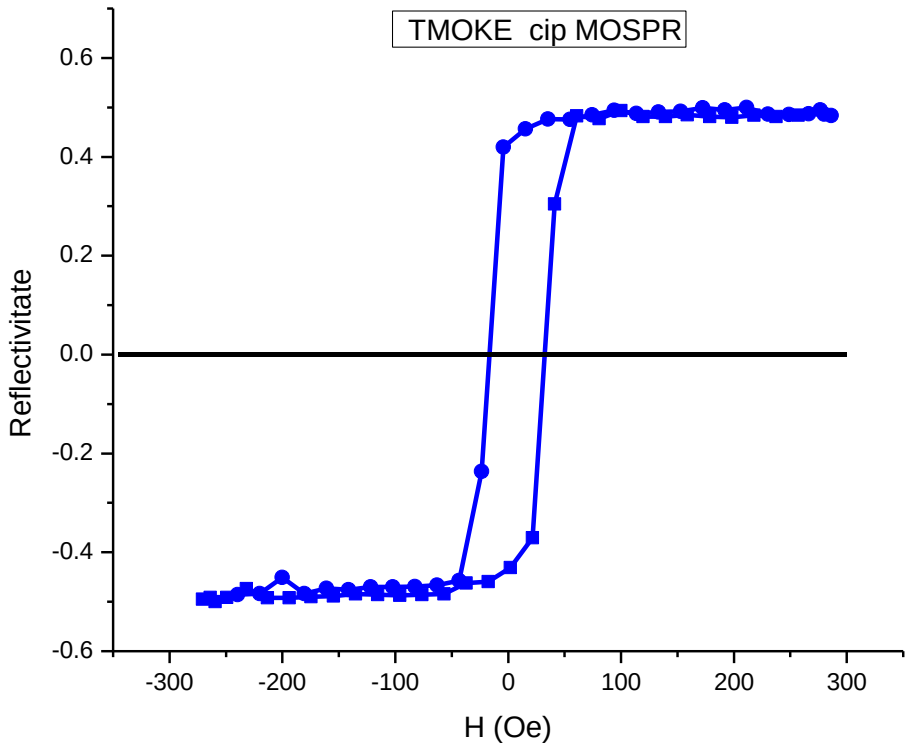
$$\hat{\varepsilon} = \varepsilon \begin{pmatrix} 1 & iQm_z & -iQm_y \\ -iQm_z & 1 & iQm_x \\ iQm_y & -iQm_x & 1 \end{pmatrix}$$

Cipul MOSPR



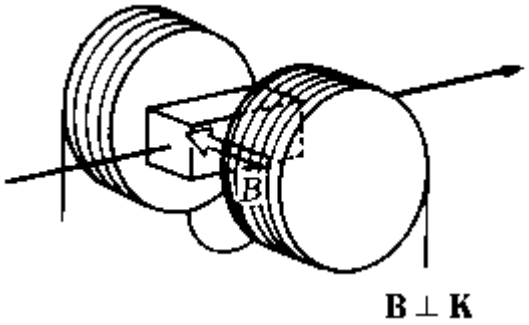
D. Regatos, D. Fariña, A. Calle, A. Cebollada, B. Sepúlveda, G. Armelles, and L. M. Lechuga, *J. Appl. Phys.* 108, 054502 (2010); doi:10.1063/1.3475711

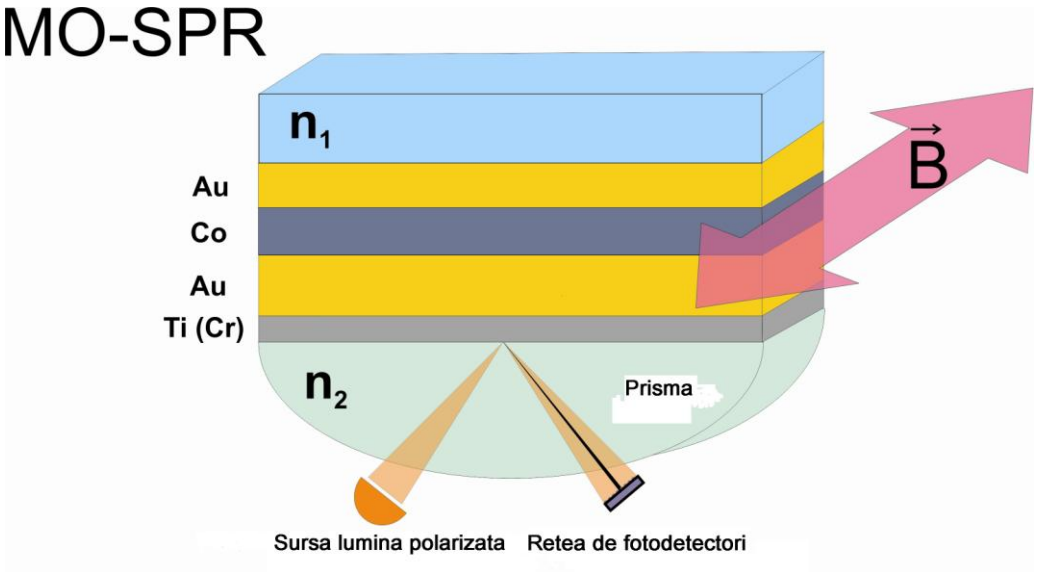
Comportarea Magnetica a Cipului MOSPR

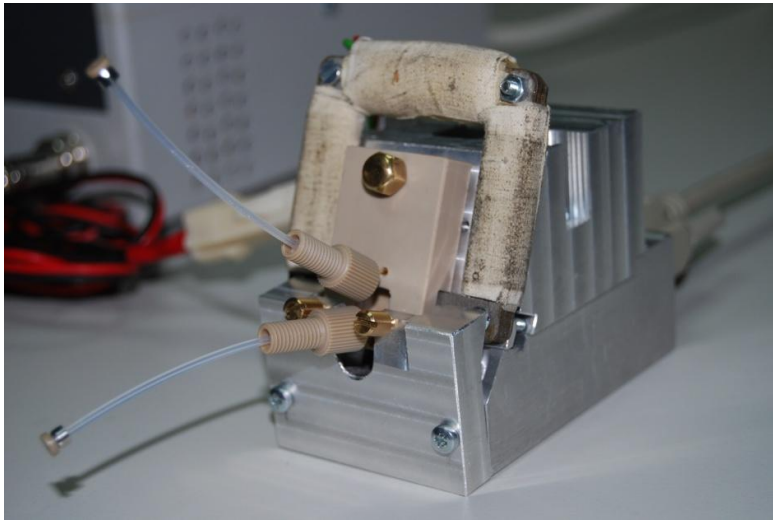


Dispozitiv MOSPR

- Senzor SPR – compact cu unitate de control
- Cip MOSPR compatibil
- Celula flux
- Electromagnet

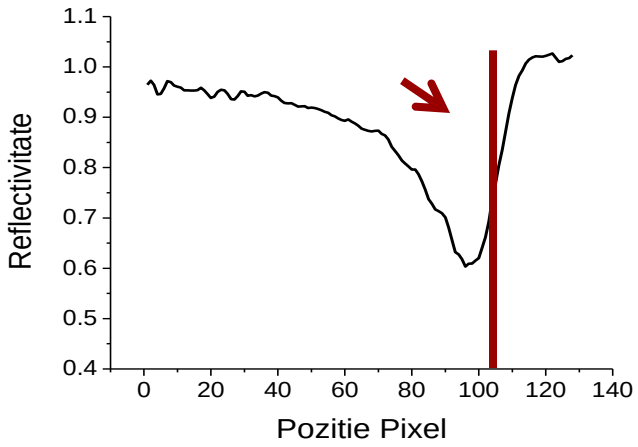


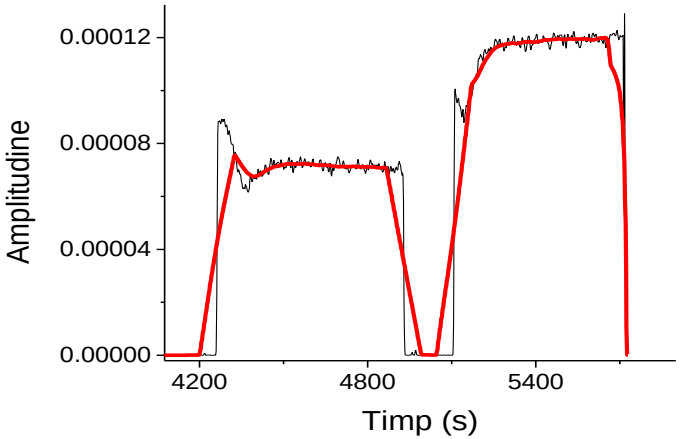




Analiza semnalului MOSPR

Reflectivitatea pentru Fotodioda #105





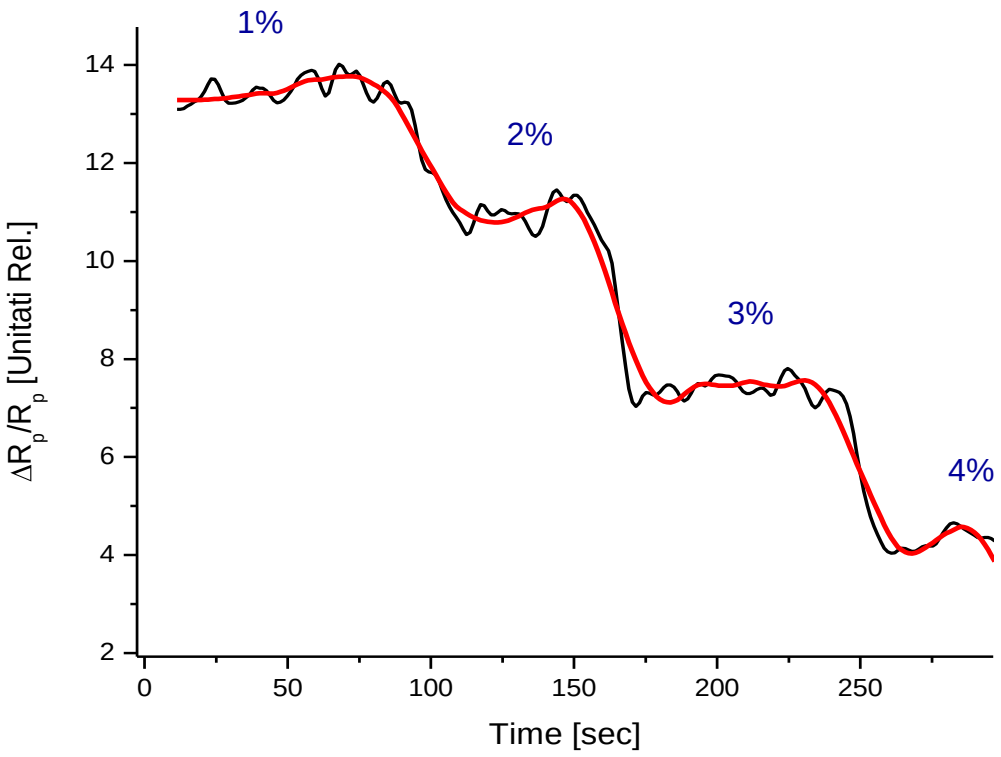
ΔR/R=Amplitudinea Sinusoidei/offset

FFT

Filtru trece banda (digital)

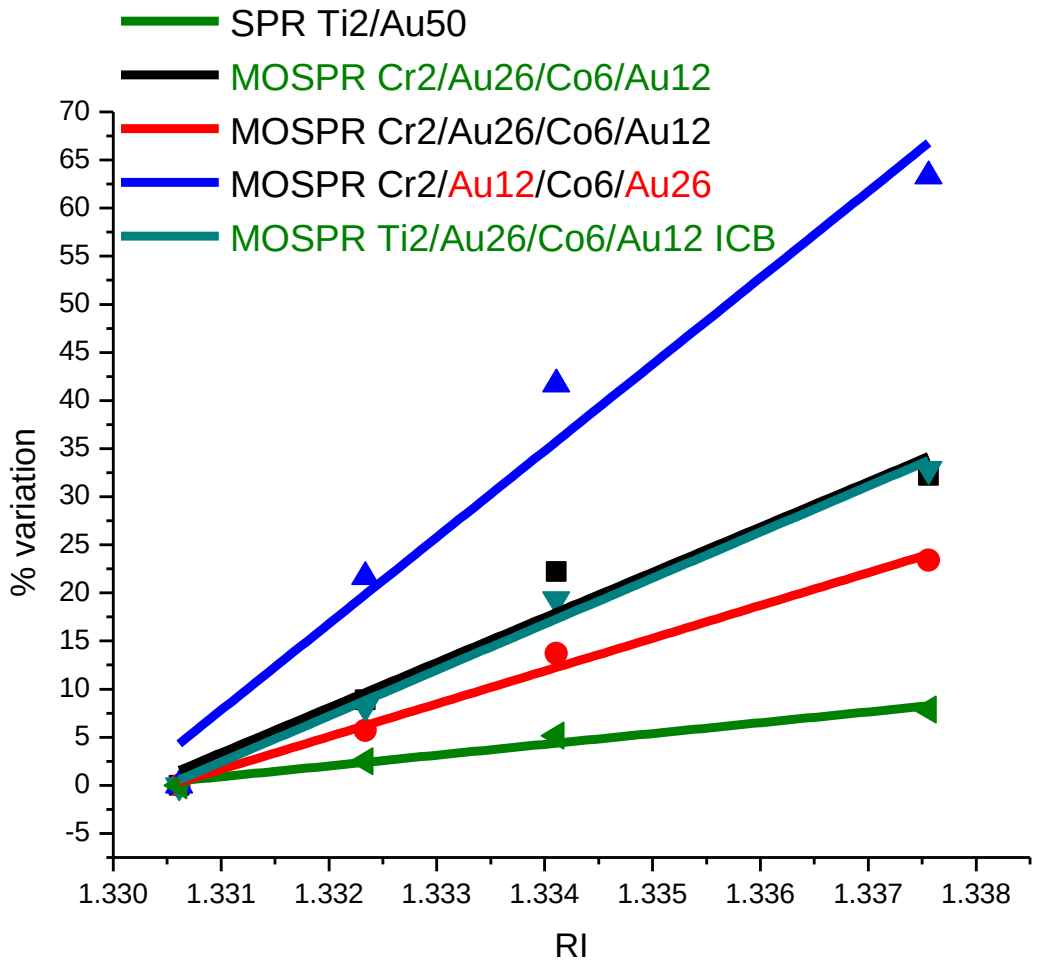
- Semnal reconstruit (sinusoida)
- Offset

Rezultate MOSPR

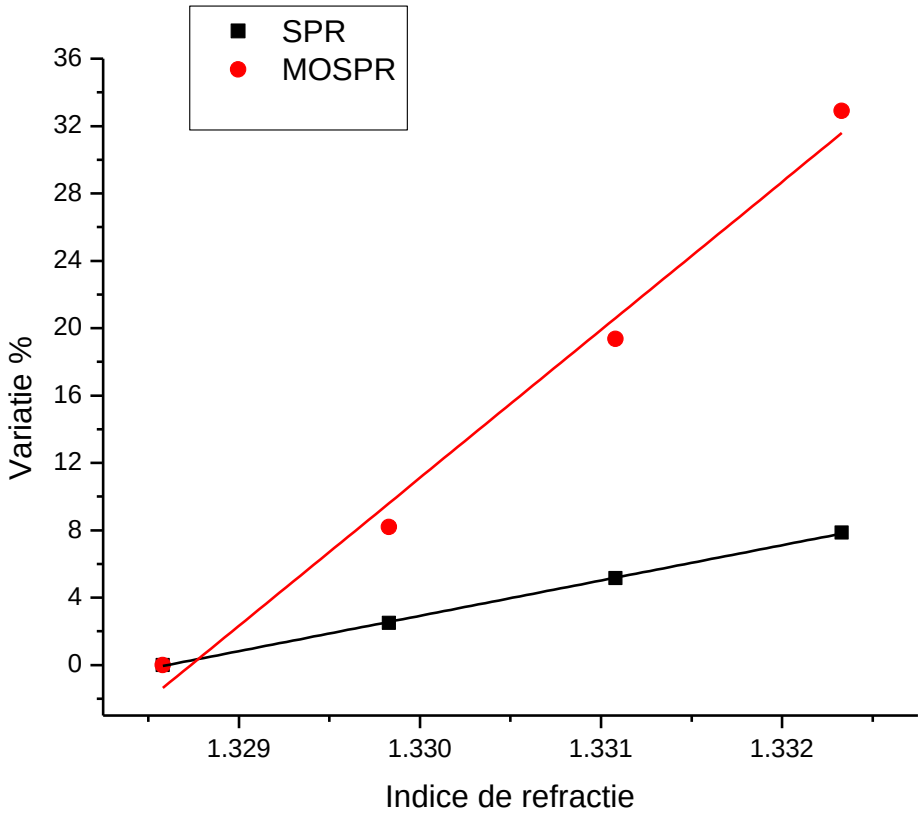


Variatia semnalului in relatie cu modificarea indicelui de refractie al mediului

Rezultate MOSPR

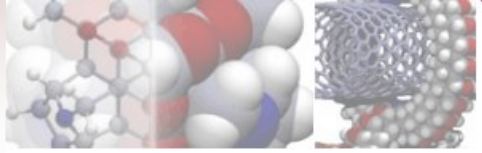


Rezultate MOSPR



Curbe de calibrare pentru SPR si MOSPR

Concluzii



- Dezvoltarea de echipamente
- Abordari analitice novatoare
- Granita intre …tehnologie si viu

- Suportul financiar al proiectelor NANOMAGMA FP7-214107-2, RoNanomagma # 25EU/2009 si ELBIOARCH # 12-121/2008