Fisica Medica a CNR II

Dan Cojoc

Istituto Officina dei Materiali, CNR

(ex INFM, Nat. Lab. TASC, Trieste)

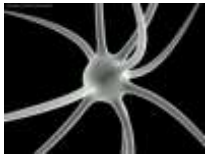
Primo Incontro AIFM sulla Ricerca
Roma, 8 Ottobre 2012

RICERCA IN FISICA MEDICA NEL CNR

Target: organi e distretti corporei

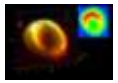
Tecniche avanzate di microscopia e spettroscopia (ottica non-lineare, fluorescenza, AFM, TEM, ultramicroscopia, …)





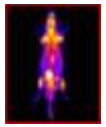
nm

µm



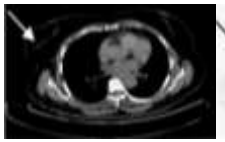

Nanotecnologie

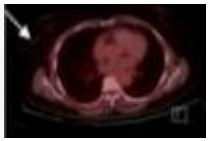
Tecniche cliniche imaging in vivo/terapia




mm

cm





Target: componenti delle cellule, cellule e tessuti

CNR Institutes considered :

INO, IOM, IFAC, ICIB, ISM, IMEM, IPCF, NANO

INO – Istituto Nazionale di Ottica

IOM – Istituto Officina dei Materiali

IFAC – Istituto di Fisica Applicata *Nello Carrara*

ICIB – Istituto di Cibernetica

ISM - Istituto di Struttura della Materia

IMEM - Istituto dei Materiali per l' Elettronica ed il Magnetismo

IPCF- Istituto per i Processi Chimico-Fisici

NANO- Istituto di Nanoscienze

Received about 50 projects

Bio-nano-fisica-tecnologia

(diagnostica, terapia, prevenzione)

Examples of projects

INO
ISTITUTO NAZIONALE
DI OTTICA

Application of 2-photon microscopy to human bladder tissue imaging and characterization

Riccardo Cicchi, Francesco S. Pavone

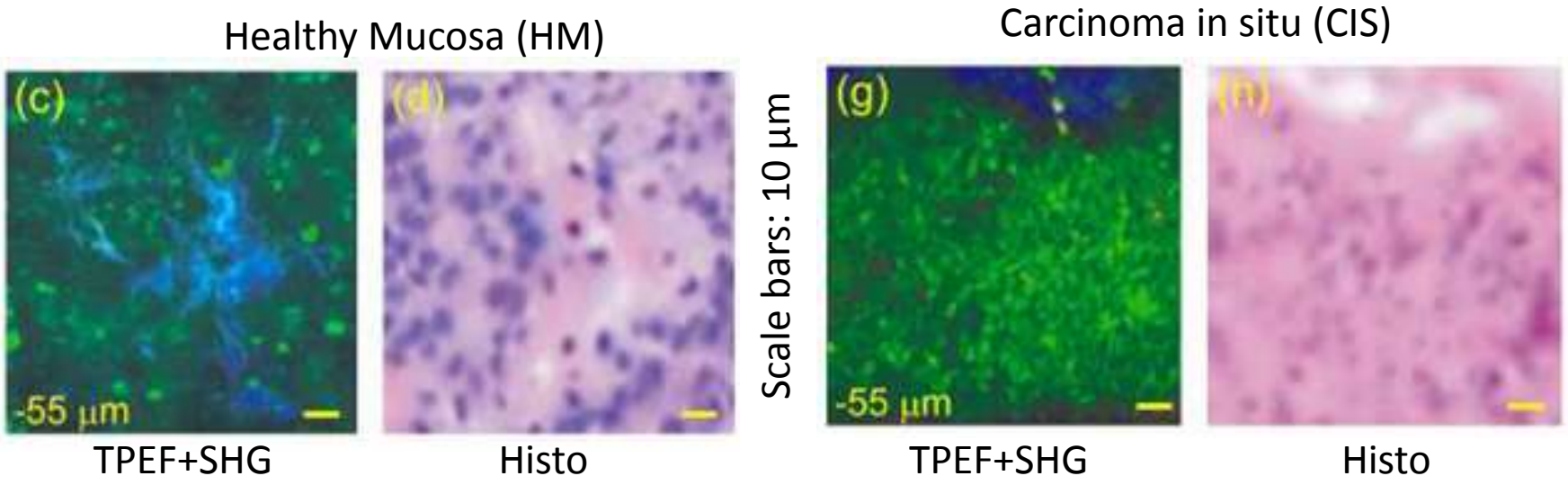
Problematic:

Early detection of bladder cancer (bladder cancer is the fifth most common cancer in U.S)

What's New:

Combined non-linear imaging techniques (2-photon excited fluorescence (TPEF) and second-harmonic generation (SHG)) to deeply image human *ex-vivo fresh biopsies of bladder as well as to discriminate* between healthy bladder mucosa and carcinoma in situ.

This method may represent a promising tool to be used in a multi-photon endoscope, in a confocal endoscope or in a spectroscopic probe for *in-vivo optical diagnosis of bladder cancer.*



Combined TPEF (green-coded) and SHG (blue-coded) images taken from human exvivo fresh biopsies of bladder and the corresponding histological images taken after H&E staining of the same sample.

Left: an optical section of healthy mucosa acquired at 55 µm depth (c) and the corresponding histological image (d).

Right: an optical section of CIS acquired at 55 µm depth (g) and the corresponding histological image (h).

R. Cicchi *et al* Optics Express 18, 3840 (2010)

Collaborations:

University of Florence Medical School, Department of Surgical and Medical Critical Area
Division of Urology, Department of Surgical and Medical Critical Area, Univ Florence

INO
ISTITUTO NAZIONALE
DI OTTICA

Confocal light sheet microscopy (LSM): micron-scale neuroanatomy of the entire mouse brain

L. Silvestri, L. Sacconi, F.S. Pavone

Problematic:

Elucidating the neural pathways that underlie brain function –
great challenge in neuroscience

What's New:

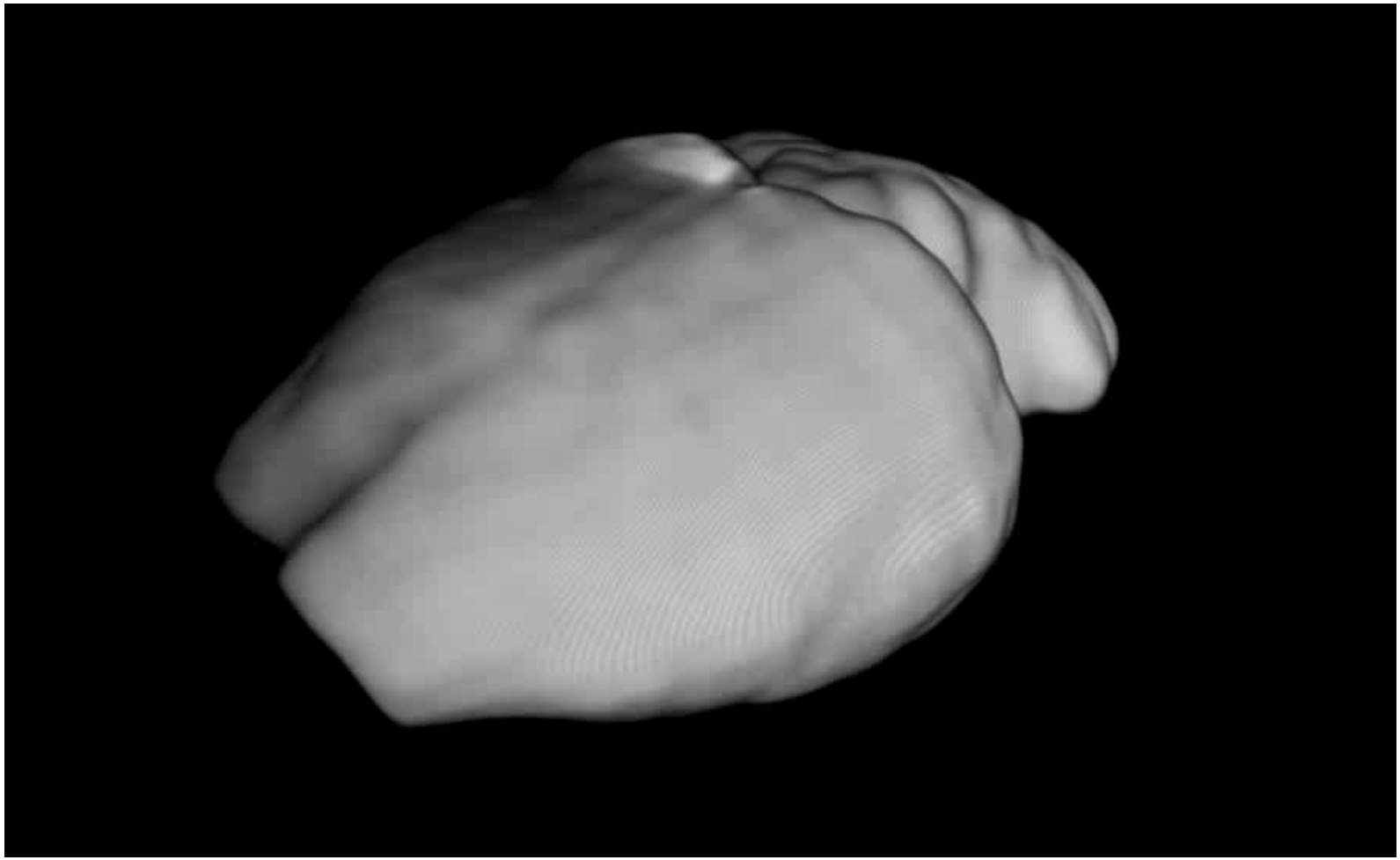
LSM allows mapping the cerabral circuitry through optical sectioning of cleared mouse brains. Confocal slit detection is added to LSM to increase image contrast. CLSM allows reconstructiong macroscopic brain volumes with sub-cellular resolution.

The whole-brain high-resolution fluorescence imaging assured by CLSM may represent a powerful tool to navigate the brain through neuronal pathways

Collaboration/support

EU FP7 Programme under grant agreement n. 228334.
The Human Frontier Science Program research grant (RGP0027/2009)
MIUR - the Flagship Project NANOMAX
ICON foundation supported by "Ente Cassa di Risparmio di Firenze".

The optical tomography of a whole thy1-GFP-M mouse brain (total volume ≈223 mm3)



L. Silvestri *et al ,* OPTICS EXPRESS 20, 20582 (2012)

Toward fast detection of Malaria

D. Cojoc, S. Finaurini

Problematic: Malaria is an old disease but still provokes almost a million deaths every year (mostly of African children); The gold standard for diagnosis remains the microscopy of a stained blood film (Giemsa) which is accurate and sensitive, but time consuming (8-10 h), considerable cost and difficult to apply in remote regions.

World Health Organization (WHO) goal diagnosis of malaria must be rapid, accurate, simple to use, portable and low cost

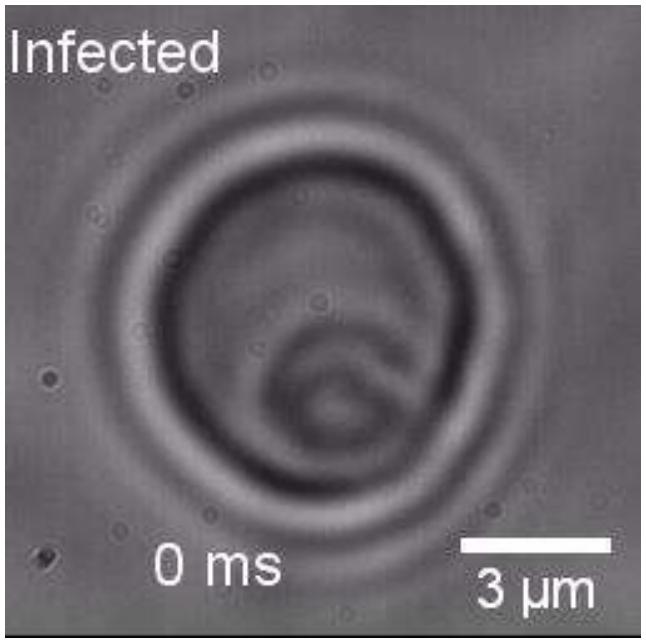
What's new: we developed a new technique called speckle sensing microscopy to detect malaria in half an hour by analysis of a drop of blood in situ.

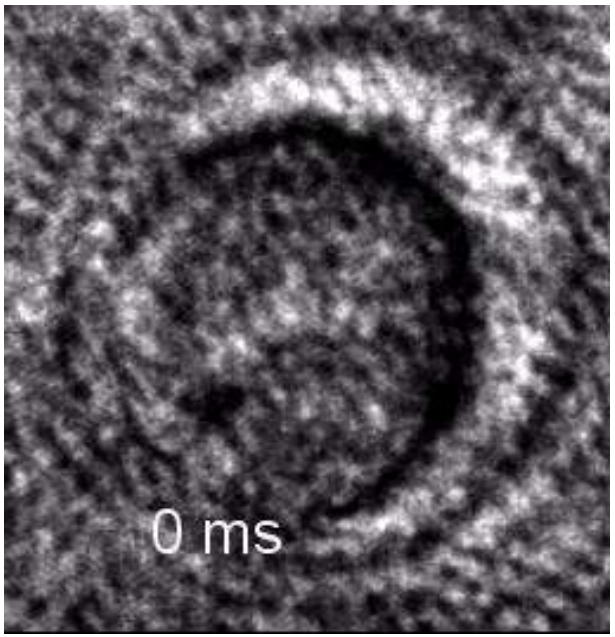
International collaboration: IOM-CNR; Bar Ilan University, Israel (Z. Zalevsky); University of Valencia, Spain (V. Mico) , AOU Ospedali Riuniti di Trieste (E. Bevilacqua, L. Mascaretti , Univ. Milano (D. Taramelli)

Red Blood Cell (RBC) thermal vibration sampling by SSM

- speckles formed at several microns from RBC are recorded at 2 KHz

- data processing involves correlation between the speckle patterns of successive frames; a set of statistical time varying parameters are extracted to characterize the RBC and discriminate infected from non-infected cells





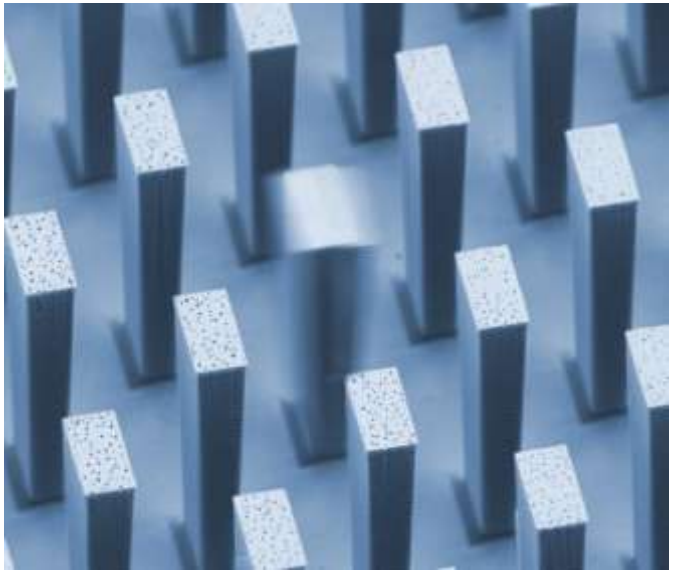
Cojoc *et al* (2012) *Biomedical Optics Express* **3**, 991

MEMS sensors for early cancer diagnostic

M. Lazzarino

Problematic: Cancer is the first cause of death in developed countries. The most effective way to fight it is early diagnosis. Monitoring the individual protein markers fingerprint would drastically improve the early diagnosis efficiency but, to this goal, small, cheap, sensitive and parallel sensing is required.

What's new: we developed a new sensor, based on microeletromechanical technology, able to detect in parallel tens of protein markers, in real time at picomolar concentration and in solution.



SEM image of the oscillating vertical MEMS used in the project

Collaborations: this activity is funded by an AIRC 5x1000 project and FIRB project. main partners involved are CRO-Aviano, UniTS, UniPD, UniUd and UniVR.

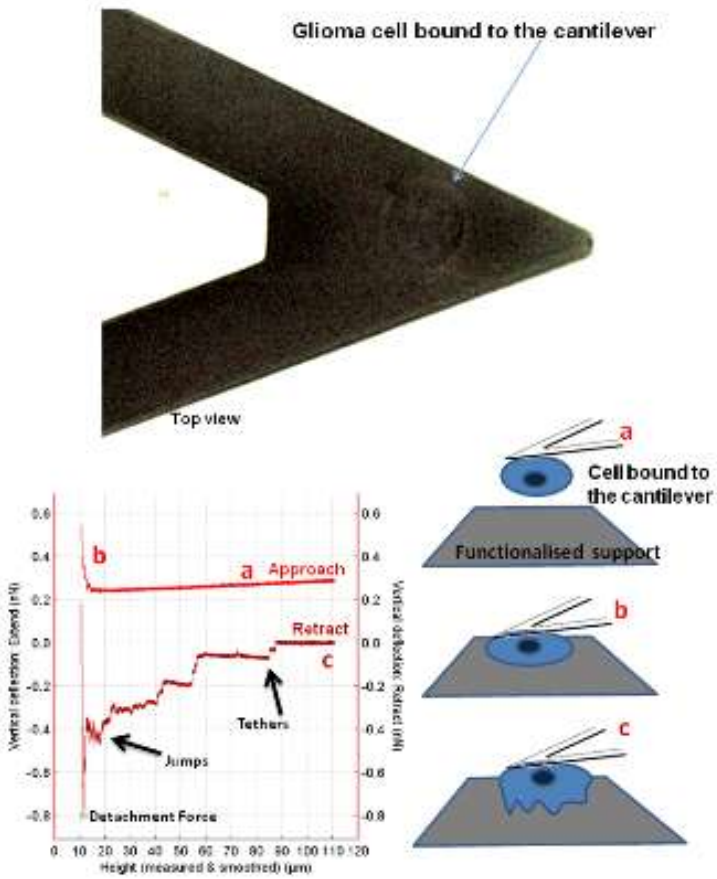
Single cell force spectroscopy

M. Lazzarino, D. Cojoc

Problematic: Glioblastoma are brain invasive tumors that, in their aggressive form, spread across the whole brain with a fast and lethal prognosis. The migration mechanism is still not understood but it can be related to intracellular adhesion mechanisms.

What's new: starting from primary culture from glioblastoma patients we use single cell force spectroscopy to investigate the peculiar adhesion mechanisms involved in this kind of tumor.

Collaborations: D. Cesselli and A. Beltrami at University of Udine.



Scheme of a single cell force spectroscopy measurement

Istitute of Applied Physics
Nello Carrara

Roberto Pini

Thermal Transitions of Fibrillar Collagen Unveiled by Second-Harmonic Generation Microscopy of Corneal Stroma

P. Matteini,† R. Cicchi,‡§ F. Ratto,† D. Kapsokalyvas, § F. Rossi,† M. de Angelis,

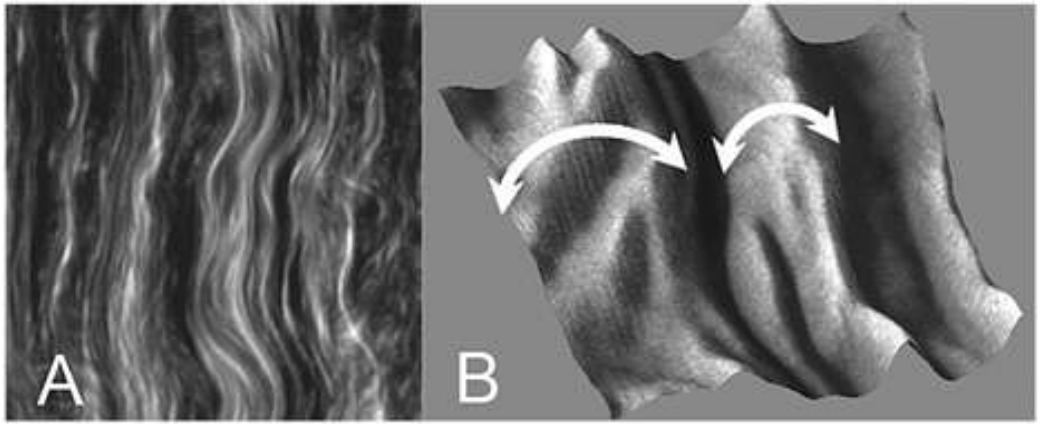
† F. S. Pavone,§ and Roberto Pini†*

†Institute of Applied Physics ‘‘Nello Carrara’’, National Research Council, Sesto Fiorentino

‡National Institute of Optics, National, Research Council, Florence

§LENS, European Laboratory for Non-Linear Spectroscopy, Sesto Fiorentino

Biophysical Journal 103, 1179 (2012)



(A) Example SHG image of a control corneal sample (50 50 um2) showing 0.5-um collagen bundles running parallel within superstructures, which are ascribed to stromal lamellae with fibrils laying in and out of the image plane, as evidenced in

(A) the three-dimensional rendering of a selected 5 x 5 um2 area.

Biophysical Journal 103, 1179 (2012)

Istituto di Struttura della Materia

The how, when, and why of the aging signals appearing on the human erythrocyte membrane: an atomic force microscopy study of surface roughness

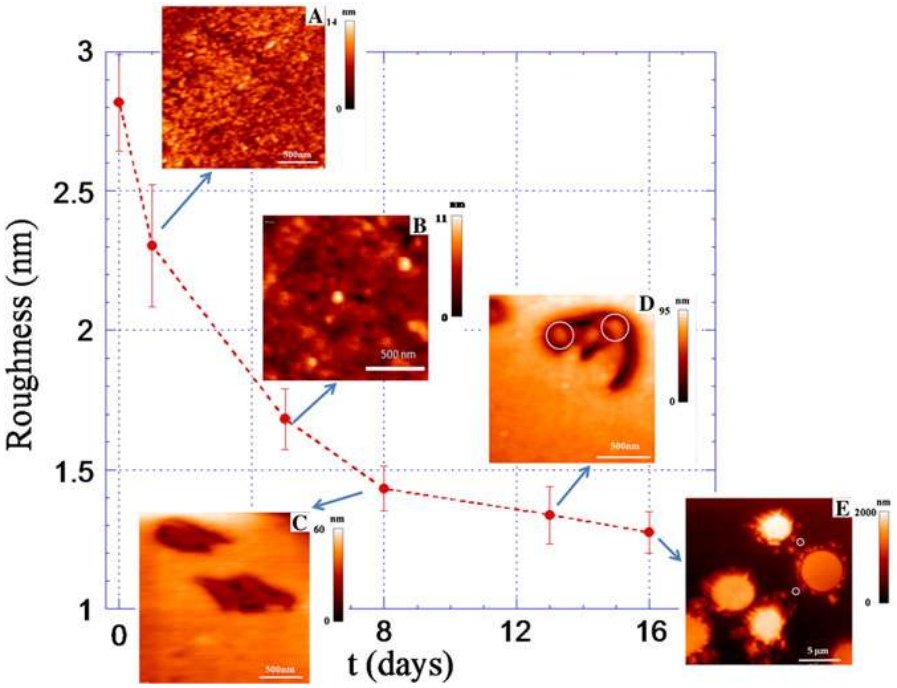
M. Girasole, G. Pompeo, A. Cricenti, G. Longo, G. Boumis, A. Bellelli, S. Amiconi

An Atomic Force Microscopy-based protocol that uses the roughness of plasma membrane of erythrocytes as a morphological parameter to investigate membrane-skeleton integrity .

The authors demonstrate that aging causes a decrease of the measured roughness, correlating with a progressive, ATP-dependent alteration of membrane-skeleton properties.

Istituto di Struttura della Materia – CNR, Rome, Italy
Dipartimento di Scienze Biochimiche “A. Rossi-Fanelli” – Università “La Sapienza,” Rome,
Klinik für Anästhesiologie, Operative Intensivmedizin und Schmerztherapie – Krankenhaus München-Schwabing, München, Germany

Nanomedicine: Nanotechnology, Biology, and Medicine 6 (2010) 760–768



Cell roughness versus cell aging

Trend of the mean roughness value as function of the aging time measured in starvation conditions. A progressive decrease of this parameter, which is sensitive to the aggregation of the membrane skeleton, runs parallel to the occurrence and evolution of microscopic aging markers on the plasma membrane of red blood cells shown in the insets (A) to (E).

Nanomedicine: Nanotechnology, Biology, and Medicine 6 (2010) 760–768

Istituto dei Materiali per
l' Elettronica ed il Magnetismo

Nanomedicina: sintesi, sviluppo e studio di nanoparticelle, nanosistemi e funzionamenti per drug delivery, terapia fotodinamica, ipertermia

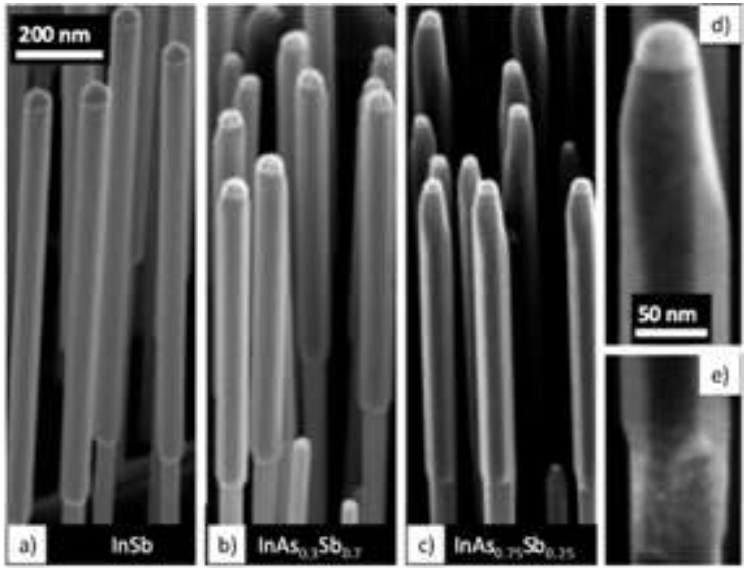
Giancarlo Salviati

Growth of InAs/InAsSb heterostructured nanowires

D. Ercolani 1, M. Gemmi 2, L. Nasi 3, F. Rossi3, M. Pea 1, Ang Li 1, G. Salviati 3,
F. Beltram 1 and L. Sorba 1

Nanotechnology 23 (2012) 115606 (9pp

1 NEST, Scuola Normale Superiore and Istituto NANOscienze—CNR, Pisa, Italy
2 Center for Nanotechnology Innovation @ NEST, Istituto Italiano di Tecnologia, Pisa, Italy
3 CNR-IMEM, Parma, Italy



Tilted SEM images of InAs/InAs1 xSbx NWs. (a) InAs/InSb NWs (R D 1, x 1). (b) Sample E (R D 0:9, x 0:70). (c) Sample C (R D 0:65, x 0:25). (a)–(c) have the same magnification. (d), (e) are magnified views of the tip and the InAs/InAsSb interface of sample C, showing the details of the faceted morphology, sharing the scale bar indicated in (d).

Istituto per i Processi Chimico-Fisici

Adesione e nanomeccanica di proteine extracellulari all'interfaccia con materiali sintetici,

Norberto Micali, Bruno Zappone

Istituto per i Processi Chimico-Fisici

Reading of Protein Surfaces in the Native State at Micromolar Concentrations by a Chirogenetic Porphyrin Probe

N. Micali, V. Villari, M. G. Donato , P. Mineo*,, and E. Scamporrino *
* Università di Catania

The recognition of some globular proteins was carried out in aqueous solution, at micromolar concentrations, by using an uncharged symmetrical cobalt–porphyrin (Co–P).

In particular, spectroscopic evidence showed the formation of supramolecular complexes without disruption of the native structure of.

Can used as a highly sensitive analytical tool for protein recognition.

Chem. Eur. J. 2012, 18, 12452 – 12457

About 50 projects

(diagnostica, terapia, prevenzione ?)

Bio-nano-fisica-tecnologia

Fisica Medica

Fisica in/alla Medicina ?

come educazione/programma