29.11

MA DAI! MATERIALI DA INNOVAZIONE
è un progetto del Corso di Laurea in SCIENZA E TECNOLOGIA DEI MATERIALI

AULA INTERATTIVA
Dipartimento di Fisica

Chemistry and Physics at Work for Life Science

	PRESENTER	TITLE
9.00	Dror Fixler	Implementing biological logic gates using fluorescence lifetime imaging
9.25		Time for Q&A
9.30	Cinzia Giannini	Supra and sub molecular investigation of pathologic tissues by X-ray scanning microscopy: the aneurism case
9.45		Time for Q&A
9.50	Gaetano Scamarcio	Detection of single biomarkers by electrolyte gated thin-film transistors
10.05		Time for Q&A
10.10	Nicola Cioffi	Stainless-steel assisted synthesis of nanocolloids
10.25		Time for Q&A
10.30	Lucia Curri	Multifunctional colloidal nanostructures: new opportunities for life science applications
10.45		Time for Q&A
	GET TOGETHER TIME	Caffeine, carboidrates, glucose and theine half-a-way boost
11.20	Andrea Cafarelli	Controlled ultrasound exposure for innovative therapeutic applications
11.45		Time for Q&A
11.50	Annalisa Volpe	Development of polymeric lab-on-chip exploiting femtosecond laser technology
12.05		Time for Q&A
12.10	Sebino Stramaglia	Information theory in robotics and calcium imaging from cells
12.25		Time for Q&A
12.30	Fabio Mavelli	Bottom-up approach to synthetic biology: the case of autotrophic simplified artificial protocells
12.45		Time for Q&A
12.50	Giuseppe Gonnella	Active brownian particles and fluids for biological matter
13.05		Time for Q&A
13.10	Sonia Tangaro	Quantitative approaches for classification of brain images to study neurological desease
13.25		Time for Q&A
	TALK TOGETHER TIME	Healthy pasta and salads at Vergnano

chaired by ***Maurizio Dabbicco***

Implementing biological logic gates using fluorescence lifetime imaging

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There is a paradigm shift in modern medicine from general to personalized treatments. One approach toward this personalized medicine is biological logic gates, which are able to identify and possibly even treat underlying conditions by inherently reacting to patient-specific biological stimuli. Here, we describe recent research in which we explored biologically relevant logic gates using gold nanoparticles (GNPs) conjugated to fluorophores and tracing the results remotely by time-domain fluorescence lifetime imaging microscopy (FLIM). GNPs have a well-known effect on nearby fluorophores in terms of their fluorescence intensity (FI) as well as fluorescence lifetime (FLT). We have designed a few bio-switch systems in which the FLIM detected fluorescence varies after biologically relevant stimulation. Some of our tools include Oregon Green which can be activated by either calcium ions or pH, peptide chains cleavable by the enzymes trypsin and caspase 3, and the polymer polyacrylic acid which varies in size based on surrounding pH. After conjugating GNPs to chosen fluorophores, we have successfully demonstrated the logic gates of NOT, AND, OR, NAND, NOR, and XOR by imaging different stages of activation. These logic gates have been demonstrated both in solutions as well as within cultured cells, thereby possibly opening the door for nanoparticulate in vivo smart detection. While these initial probes are mainly tools for intelligent detection systems, they lay the foundation for logic gates functioning in conjunction so as to lead to a form of in vivo biological computing, where the system would be able to release proper treatment options in specific situations without external influence.

Supra and sub molecular investigation of pathologic tissues by X-ray scanning microscopy: the aneurism case

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Microcalcifications are important pathological markers of several pathologies. Thus, it is relevant to study the occurring crystalline phases, their formation mechanisms, and the correlations between their structure and pathologic modifications of the human tissue.
Combining scanning X-ray micro-diffraction and small-angle scattering allows to reveal the crystalline phases of microcalcifications and the abundance and orientation of collocated fibrous tissues (elastin, collagen, myofilament), here spatially resolved over abdominal aortic and popliteal artery tissues.

Detection of single biomarkers by electrolyte gated thin-film transistors

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Conceptualizing cells' structure of highly-packed recognition elements, a field-effect-transistor is used to selectively detect ultra-low concentrations of bio-markers down to the single molecule limit. The gate is bio-functionalized with a self-assembled-monolayer of capturing antibodies. The sensing mechanism involves the amplification of the work-function change triggered by the affinity binding through an hydrogen-bonding network. The proposed immunoassay promises a revolutionary approach to protein detection for medical diagnostics.

Stainless-steel assisted synthesis of nanocolloids

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Gold nanoparticles (AuNPs) are one of the most popular nanosized material, rising attention in several fields, such as biomedicine, sensors and spectroscopy, just to cite a few. Among the methods for AuNPs preparation, the chemical reduction of gold(III) species is widely applied, based on the use of tetra chloroauric acid (HAuCl4) as precursor and sodium citrate or thiols as reducing and/or stabilizing agents. Using this procedure, byproducts and adsorbates that may affect negatively the quality of the colloid are often present in the final product. Recently, few research groups have proposed the use of a solid reductant to assist the synthesis of AuNPs. In this novel approach, stainless steel can be used as removable reducing substrate, in the aqueous preparation of gold nano colloids. This innovative bottom-up method is very easy, quick and cost-effective, allowing the synthesis of highly stable NPs without any additional organic capping agent. However, the mechanisms behind this reaction are not yet fully understood. Very recently, we evaluated the effects of several synthesis parameters (e.g. reaction time, precursor concentration, ionic strength, steel composition, etc.). In this presentation, an overview of the results obtained in the last two years will be presented. Applications of these AuNPs will be discussed, as well.

Multifunctional colloidal nanostructures: new opportunities for life science applications

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In the last years the extraordinary advances in the field of material science and, in particular, in nanomaterial synthesis have resulted in a great potential for biomedical applications.
A variety of preparative and post-preparative colloidal routes have demonstrated able to obtain a wide choice of inorganic nanoparticles (NPs) and nanocrystals (NCs), with different compositions, that can be achieved with a high control on size, shape and surface chemistry, ultimately tailoring their electronic, optical, magnetic, thermal and chemical size dependent properties. Functionalization strategies allowing to surface engineer NPs and NCs and to tune their specific chemical reactivity towards the surrounding environment, have enabled their conjugation and combination with biologically relevant entities, thus producing advanced materials for diagnostics and therapy.
The design and fabrication of specialized nanomaterials ingeniously combining suitably functionalized NPs and NCs, such as semiconductors, plasmonic and magnetic nanostructures, with peptides, drugs and other relevant biological systems will be presented and their potential for diagnosis and treatment of different diseases, including cancer and neurodegenerative diseases will be illustrated. In particular, examples of drug delivery, labelling and theragnostic multifunctional systems, based on NIR photoactive nanomaterials, plasmonic nanostructures and magnetic NPs will be reported.

Controlled ultrasound exposure for innovative therapeutic applications

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While several medical applications of therapeutic US have been clinically demonstrated, the underlying mechanisms of the interaction between US and cells, US and tissues and US and materials are often not well understood, yet. The talk will be about recent developments of ultrasound-based systems for therapeutic purposes: high intensity ultrasound for cancer surgery, low intensity ultrasound for regenerative medicine and mediated drug delivery.

Development of polymeric Lab on a Chip exploiting femtosecond laser technology

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A Lab on a Chip (LoC) is a device for controlling and manipulating fluid flows with length scales less than a millimeter. In recent years, LoCs are gaining an increasing interest in the scientific community, since the idea of integrating in small and compact platforms the capabilities of a standard biological laboratory is extremely promising.

Among all the available materials for LoCs production, polymeric materials are considered the best choice. They are low cost, bio-compatible, non toxic, transparent, permeable to oxygen and gas. Furthermore, quick fabrication processes for polymeric LoC are available.

Micromachining with ultrashort pulsed lasers is, nowadays, one of the most promising contact-free fabrication technologies for micro structuring on a wide variety of materials, such as metals and polymers, allowing to achieve high quality and precision of the micromachined features.

Here, the development of three innovative polymeric microfluidic devices exploiting femtosecond laser technology will be presented. In particular, (i) an optofluidic stretcher, (ii) a flow cytometer and (iii) a size-based cell sorter will be shown. For the fabrication of these devices, the fs-laser technology have been exploited either for direct micromachining of polymeric substrates (rapid prototyping) or in combination with microinjection molding (μIM), ensuring reliability and reduced costs for large scale production.

Information theory in robotics and calcium imaging from cells

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Abstract: Transfer entropy measures the amount of information which is exchanged among the components of a complex system. Based on information theory, evaluation of the transfer entropy requires the simultaneous recording from all the components of the system under study; it constitutes a major approach to causality analysis, aiming at a description of complex systems which goes beyond the correlational analysis. Transfer entropy has found applications in neuroscience, physiology, econometrics, climatology, fluid dynamics, and many others. I will describe some applications which can be interesting for the topic of the meeting, i.e. applications in Robotics and Calcium Imaging from Cells.

Bottom-up approach to synthetic biology: the case of autotrophic simplified artificial protocells

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In this contribution we discuss the possible strategies to synthesize photo-autotrophic artificial protocells starting from scratch, following the semi-synthetic bottom up approach. The main aim is to build up artificial compartmentalized systems able to mimic living cell behavior in the transduction of light energy in chemical energy. Some preliminary results and future perspective are presented and discussed.

Active brownian particles and fluids for biological matter

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We briefly discuss two important classes of models for active matter. Soft matter is called active when some of the constituents of the system consume internal energy sources to move or make work on the environment. Active systems are solutions of cellular material, e.g. microtubules with molecular motors, or bacterial suspensions. The dynamics of these systems can be described in the continuum to take into account hydrodynamical effects, or at level of single units by Brownian particle models. I will briefly discuss the results obtained by our group in this context (superfluidic behavior, motility induced phase separation, etc) mentioning also possible applications.

Quantitative approaches for classification of brain images to study neurological disease

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Topological features of brain networks can be used as reliable markers for characterizing cognitive states, aging and diseases. In this light, statistical techniques to infer significant differences among clinical populations have been specifically developed.
Complex Network methods and Machine learning models have been adopted to automatically extract high-dimensional personalized patterns from large neuroimaging datasets. These patterns are used for diagnostic and clinical purposes. Multivariate predictive models are used to simultaneously evaluate sets of features to discriminate patients from controls. This allows to study the areas of the brain affected by the disease and the mechanisms underlying it.

If does not exist, you can invent it.

Aim
Chemistry and Physics at Work for Life Science *is not intended to be a sort of conference. Aim of this meeting is not presentation, rather communication among colleagues involved in the Master courses of the Chemistry and Physics departments of the University of Bari whose research interest is also related to biological/life science.*
Targeted audience will mainly consist of the presenters themselves. PhD students, Masters' students and some other colleagues are likely to participate as well.

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