TIME TABLE

Registration on Monday at 8.30

TIME	Monday July 20	Tuesday July 21	Wednesday July 22	Thursday July 23	Friday July 24
9.00 - 9.45	Yarin	Zussman	Zussman	De Clerck	Lauricella
9.45 - 10.30	Yarin	Zussman	Zussman	De Clerck	Lauricella
11.00 - 11.45	Pierini	Pisignano	Lauricella	Lauricella	De Clerck
11.45 - 12.30	Pierini	Pisignano	Lauricella	Lauricella	De Clerck
14.00 - 14.45	Zussman	Pierini	Yarin	Pierini	Discussion
14.45 - 15.30	Zussman	Pierini	Yarin	Pierini	Discussion
16.00 - 16.45	Pisignano	Yarin	Pisignano	Kowalewski	
16.45 - 17.30	Pisignano	Yarin	Pisignano	Kowalewski	
18.00	Welcome Aperitif				

ADMISSION AND ACCOMMODATION

The registration fee is 600.00 Euro + VAT*, where applicable (bank charges are not included). The registration fee includes a complimentary bag, four fixed menu buffet lunches (on Friday upon request), hot beverages, downloadable lecture notes and wi-fi internet access.

Applicants must apply at least one month before the beginning of the course. Application forms should be sent on-line through the following web site: http://www.cism.it. A message of confirmation will be sent to accepted participants. Applicants requiring assistance with the registration should contact the secretariat at the following email address: cism@cism.it.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email to cism@cism.it) no later than two weeks prior to the start of the course.

Cancellation requests received during the two weeks prior to the start of the course will be charged a 50.00 Euro handling fee. Incorrect payments are also subject to a 50.00 Euro handling fee.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered lodging and/or board, if available, in a reasonably priced hotel or student guest house.

Requests should be sent to CISM Secretariat by **May 20, 2020** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on the web site www.cism.it, or can be mailed upon request.

* Italian VAT is 22%.

For further information please contact:
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ACADEMIC YEAR 2020
The Erwin Stein Session

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

CISM

MATERIALS, ELECTRO-MECHANICAL AND BIOMEDICAL DEVICES BASED ON NANOFIBERS

Advanced School
coordinated by

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IPPT-PAN
Warsaw, Poland

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University of Illinois
Chicago, USA

Udine *July 20 - 24* 2020

MATERIALS, ELECTRO-MECHANICAL AND BIOMEDICAL DEVICES BASED ON NANOFIBERS

Recently, there has been a strong interest in the development of new micro- and nanomaterials, in particular, nanofibers (NFs), for biomedical applications. The aim of this course is to provide state-of-the-art information on the development of nanofiber-based materials and devices for advanced biomedical purposes. With this objective, the course aims at covering the design of fibrous nanomaterials at the forefront of biomedical sciences reviewing the most important areas from fiber fabrication modeling to their final application.

Core-shell fibers with healing agents are key element for self-healing vascular composite materials used to sustain mechanical properties and for corrosion protection. Sustainable NF-based triboelectric nanogenerators comprised of biopolymers will also be discussed. Soft thermo-pneumatic artificial muscles and actuators with the embedded NFs impregnated with ethanol and blister-like thermo-pneumatic soft actuators, which deflect in response to heat supplied to their bottom are an important step toward NF-based soft robotics. Metallized NFs are electrically conductive and highly transparent materials, which hold great promise as three-dimensional heaters, sensors, and treatment of aneurysmal subarachnoid hemorrhage.

Optical, electronic, and photonic properties of NFs can also be highly important for electro-mechanical and biomedical devices. Based on a variety of functional compounds such as conjugated polymers, organic light-emitting molecules, dyes, piezo-polymers, etc., NFs can be used as building blocks of miniaturized dielectric waveguides, optical amplifiers, solid-state lasers, active fiber optics, and surface-coating elements of great relevance for lab-on-chip architectures, electro-mechanical devices, wearable and implantable technologies.

Electrostatic interactions between polyelectrolytes and increased entropy resulting from counter-ion release are the main driving forces for polyelectrolyte complexation. We discuss formation of NFs from polyelectrolyte complexes as a function of polymer molecular weight and concentration, and solution ionic strength and pH. The applications of polyelectrolyte complex fibers for actuation and drug release will be discussed. We will show several approaches of modeling hydrodynamic transport of nanofibrous suspensions and experimental methods used for evaluating their interactions in micro and nanoscale environment. We will also discuss properties of materials for cancer treatment developed over the past few decades.

NFs are used for developing new composite materials. They have proven to be one of the most effective ways to improve toughness of matrix polymer and the delamination resistance of structural composites. It is hence important to understand the mechanics of NFs and their related materials.

This course is directed towards senior year undergraduate students, graduate students, researchers, engineers and practitioners in industry. It will be of special importance for those interested to develop novel devices and models based on nanofibers from the in-depth and comprehensive exposition of physical foundations of such devices and related phenomena.

PRELIMINARY SUGGESTED READINGS

A.L. Yarin et al. Fundamentals and Applications of Micro- and Nanofibers. Cambridge University Press, 2014.

A. L. Yarin et al. Self-Healing Nanotextured Vascular Engineering Materials. Springer Nature, Switzerland AG, 2019.

S. An et al. Blister-like soft nano-textured thermo-pneumatic actuator as an artificial muscle. Nanoscale 10, 16591 (2018).

M.-W. Kim et al. Packing of metalized polymer nanofibers for aneurysm embolization. Nanoscale 10, 6589 (2018).

M. Boas et al. Electrospinning polyelectrolyte complexes: pH responsive fibers. Soft Matter 11, 1739 (2015).

L. Daelemans et al. Damage-resistant composites using electrospun nanofibers: a multiscale analysis of the toughening mechanisms. ACS Applied Materials & Interfaces 8, 11806 (2016).

D. Pisignano, Polymer Nanofibers, Royal Society of Chemistry (RSC), Cambridge 2013.

M. Gaio et al. A nanophotonic laser on a graph. Nature Communications, 10, 226 (2019).

F. Di Benedetto et al. Patterning of light emitting conjugated polymer nanofibers. Nature Nanotechnology, 3, 614 (2008).

F. Pierini et al. Polymer-based nanomaterials for photothermal therapy: From light-responsive to multifunctional nanoplatforms for synergistically combined technologies. Biomacromolecules, 19, 4147 (2018).

S. Pawłowska et al. Fibrous polymer nanomaterials for biomedical applications and their transport by fluids: an overview. Soft Matter, 14, 8421 (2018).

P. Nakielski and F. Pierini. Blood interactions with nano- and microfibers: recent advances, challenges and applications in nano- and microfibrous hemostatic agents, Acta Biomaterialia, 84, 63 (2019).

L. Daelemans et al. Excellent nanofiber adhesion for hybrid polymer materials with high toughness based on matrix interdiffusion chemical conversion. Advanced Functional Materials, 29(8). (2019).

INVITED LECTURERS

Karen De Clerck - Ghent University, Belgium
4 lectures on:
Thermo-mechanical analysis of electrospun fibers, fibrous assemblies and nanocomposite films enhanced with nanofibers, composites enhanced with electrospun fibers: failure mechanisms and micromechanical mechanisms of nanofibers, composites enhanced with electrospun fibers: from delamination lab-testing to realistic composites.

Tomasz A. Kowalewski & Filippo Pierini - IPPT-PAN, Warsaw, Poland
8 lectures on:
Hydrogels: mechanical properties, transport properties of particles, droplets, filaments, hydrogels for drug delivery and tissue recovery, electrically conductive network polymer nanomaterials, stimuli-responsive nanomaterials for biomedical application, nanofibrous hemostatic agents: blood-nanofiber interactions.

Marco Lauricella - CNR, IAC "Mauro Picone", Rome, Italy
6 lectures on:
Electrospinning of polymer solution, electrical and rheological properties of charged polymer jets, formation of the precursor of electrospun jets, driven bending instability, modeling the electrospinning process: numerical approaches, alignment of electrospun nanofibers.

Dario Pisignano - Pisa University, Italy
6 lectures on:
Organic light-emitting materials, organic and plastic devices: sensing, biosensing, microfluidics; wetting of nanofibrous materials, photonics based on polymer NFs, piezoelectric NFs: interplay with light-emitting materials, NFs for biomedicine and cell cultures.

Alexander L. Yarin - University of Illinois at Chicago, USA
6 lectures on:
Self-healing vascular nano-textured materials, biopolymer nanofibers and their applications, soft robots and actuators based on nanofibers, sustainable biopolymer nanofiber-based triboelectric nanogenerators, metallized nanofibers, nanofiber-based heaters and sensors.

Eyal Zussman - Technion, Haifa, Israel
6 lectures on:
Polyelectrolytes-based nanofibers, polyelectrolytes complex nanofibers, actuation based on polyelectrolytes complex nanofibers, drug release based on polyelectrolytes complex nanofibers.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from the CISM web site. Instructions will be sent to accepted participants.