UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

DII NFORMA

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NEWSLETTER DEL DIPARTIMENTO DI INGEGNERIA INDUSTRIALE
DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA

Cover story

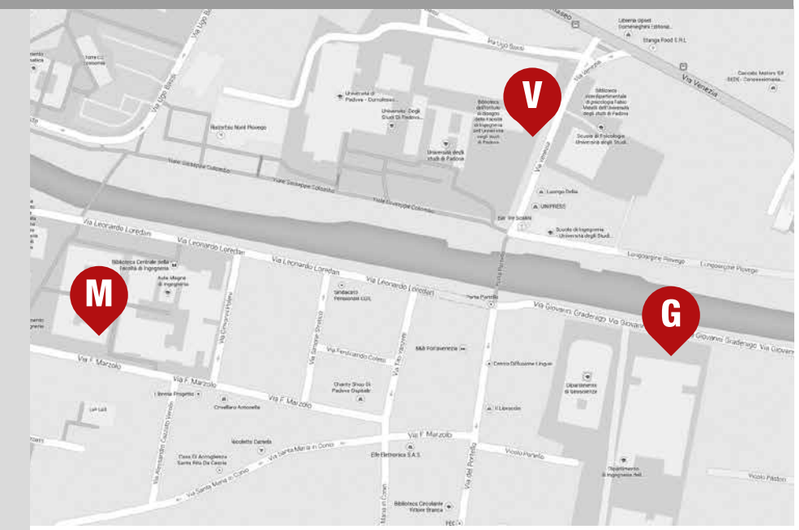
Analisi sperimentale della rottura delle fibre di rinforzo nella fase di plastificazione del processo di stampaggio ad iniezione

Il laboratorio di Polymer Processing del Precision Manufacturing Engineering Group è attivo nello studio dei processi per la fabbricazione, delle prestazioni meccaniche e funzionali dei prodotti in materiale polimerico. Si occupa di microstampaggio ad iniezione di componenti per applicazioni biomedicali e di stampaggio ad iniezione di materiali fibro-rinforzati. Le principali attività sono rivolte allo studio degli effetti della variazione rapida della temperatura stampo nella replicazione di cavità microlavorate e nanostrutturate, allo studio degli effetti del processo sulla rottura delle fibre di rinforzo e allo studio dello stampaggio ad iniezione di componenti ibridi a matrice termoplastica.

Ing. Ruggero Giusti

Nato a Rimini, il 01/08/1987. Dottorando in ingegneria industriale XXIX ciclo. Dopo aver conseguito la laurea triennale in ingegneria meccanica presso l'Università di Bologna, ha approfondito l'interesse per le tecnologie per la lavorazione dei materiali polimerici conseguendo in aprile 2013 la laurea magistrale in ingegneria meccanica presso l'Università di Padova. Ho iniziato nel 2014 la sua attività di ricerca presso il laboratorio Te.Si. di Rovigo come dottorando. I suoi interessi di ricerca riguardano principalmente l'analisi della resistenza della saldatura in componenti ibridi ottenuti mediante sovrastampaggio ad iniezione di laminati a matrice termoplastica e lo studio degli effetti del processo sulle proprietà del componente.
P.S: La figura presentata è un mancato riconoscimento, da parte di un programma per l'analisi di immagini, delle fibre di rinforzo estratte dalla matrice polimerica. Tale immagine non ha una rilevanza scientifica ma è frutto di uno step intermedio che ha poi portato all'ottimizzazione del riconoscimento automatico della lunghezza in pixel dei frammenti di fibra.

SEDI



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UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

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DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

Andrea Stella

Direttore del DII

Editoriale/Editorial

Viene oggi pubblicato il secondo numero della newsletter DIInforma, strumento di comunicazione e informazione ritenuto necessario per favorire la conoscenza e la collaborazione reciproca all'interno di un grande Dipartimento come è il Dipartimento di Ingegneria Industriale (DII); infatti nel Dipartimento, nato il 1° gennaio 2012 dalla fusione di sei preesistenti Dipartimenti, spesso poco comunicanti tra loro, operano oggi circa 450 persone, considerando i docenti, gli studenti di dottorato, gli assegnisti, i borsisti di ricerca e il personale tecnico e amministrativo. Ma scopo della newsletter è anche quello far conoscere all'esterno l'estesa attività e le potenzialità del Dipartimento che, sino dalla sua fondazione, ha puntato decisamente a obiettivi e risultati di elevata qualità nel campo della ricerca e della formazione e a rafforzare, al tempo stesso, le proprie attività di terza missione.

Dopo quasi quattro anni di intensa attività, il Dipartimento si caratterizza sempre più come polo multidisciplinare per la ricerca e la formazione in estesissime aree dell'Ingegneria, ha progressivamente assunto maggiore consapevolezza delle proprie potenzialità e opportunità e ha sviluppato via via un crescente numero di collaborazioni scientifiche di alto livello, nazionali e internazionali, attraverso i suoi ricercatori.

Questo secondo numero di DIInforama prosegue nella linea già tracciata nel primo numero, pubblicato lo scorso marzo; otto pagine sono qui dedicate ad una sintetica presentazione di altrettanti ulteriori temi di ricerca sviluppati presso il DII, riguardanti la bioingegnaria, l'energia, i sistemi elettrici, i sistemi meccanici, i materiali avanzati, la mobilità sicura e sostenibile, lo sviluppo di farmaci antitumorali e l'ambiente. Le due pagine successive sono dedicate alla presentazione del corso di Laurea in Ingegneria Chimica e dei Materiali e del corso di Laurea Magistrale in Ingegneria Energetica. Viene poi presentato un evento relativo alla Formula 1, organizzato dal DII, che grandissimo interesse ha suscitato tra gli studenti, per finire con la Cover Story, che ha per protagonista uno studente di dottorato di ricerca del Dipartimento.

The one published today is the second issue of the DIInforma newsletter, a communication and information tool, deemed necessary to promote mutual knowledge and cooperation within a large Department such as the Department of Industrial Engineering (DII).
As a matter of fact, about 450 people, including professors, Ph.D. students, research fellows, technical and administrative staff, operate today in the Department, created on January 1st, 2012 from the merging of six pre-existing Departments, often in limited communication with each other.
But the purpose of the present newsletter is also to communicate and disseminate the wide range of activities and the potential of the Department, that, since its very foundation, has decisively aimed for top quality objectives and results in the fields of research and education, and, at the same time, for the strengthening of its third mission activities.

After nearly four years of intense activity, the Department characterizes itself more and more as a multidisciplinary research and higher education centre in various Engineering areas, and has become increasingly aware of its potential and opportunities, counting on a growing number of high level national and international scientific collaborations developed by its researchers.

This second issue of DIInforma goes on with the line already drawn in the first issue, published last March.
Eight pages are here devoted to a brief presentation of just as many research topics developed at DII, relating to Bioengineering, Energy, Electrical Systems, Mechanical Systems, Advanced Materials, safe and sustainable mobility, the development of anti-cancer drugs, and the Environment.
The next two pages are devoted to the presentation of the Bachelor's Degree Programme in Chemical and Materials Engineering and of the Master's Degree Programme in Energy Engineering.
Then, a Formula 1 event organized by DII will be illustrated, having raised deep interest among students, and finally you will find a cover story, where the protagonist is a Ph.D. student of the Department.

Bioingegneria, biotecnologia e tecnologie per la salute
Bioengineering

BioERA Lab: Biological engineering research and application

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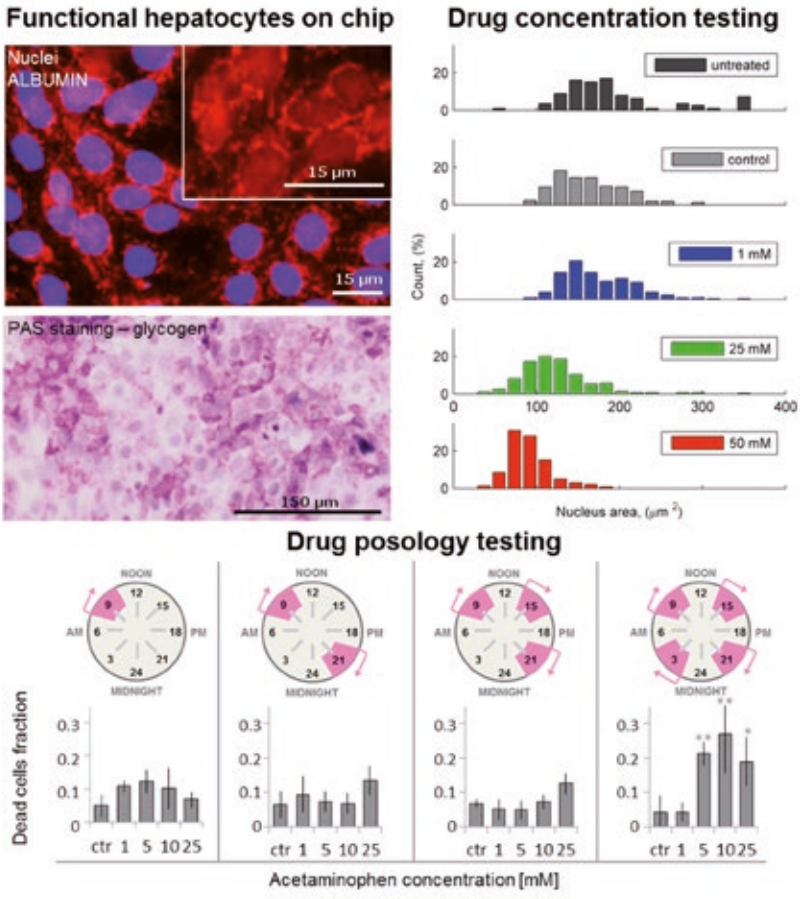
BIOERA
biological engineering research and application

Main research topics:

- Human stem cell engineering
- Microfluidic technology for bioengineering applications
- Biomimetic material design for mechanotransduction studies
- Lab on a chip for tissue development, disease model and functional assay
- Micro and nano-structured electrochemical biosensor design and development

Human organs on chip: in vitro models for patient-specific therapy development

The percentage of failure in the drug discovery pipeline is still very high, especially at late stages, and research expenses are not compensated by yielding new products. More predictive models and assays are necessary to increase the success rate, anticipating the failure of bad lead compounds before clinical trials. Multiple governmental authorities are thus opening to innovative tools for drug screening, in particular to in vitro cell-based or tissue-based models reproducing human physiology and, in perspective, pathophysiology.
Within BioERA lab, we work on development of organ-on-chip systems that integrate microfluidic technology and human living cells. Their small scale enables precise control of culture conditions and high-throughput experiments, both not pursuable at a macroscopic level.
Given the necessary scarce availability of human biopsies, as a cell source for on-chip integration we use embryonic-like stem cells, called human induced pluripotent stem cells (hiPSC), that we are able to derive from a skin biopsy. These cells have two main advantages: they preserve the genetics of the patient donor, paving the way for personalized medicine applications, and can be differentiated into all cell types of the human body.
We recently developed a robust multi-stage method for differentiating hiPSCs into hepatic and cardiac organs on chip. We characterized the cells obtained to show that they are fully functional on chip and that can be used for toxicological studies. Taking advantage of microfluidics precision in generating dynamic perturbations, we also showed the importance of drug administration posology by performing repeated perturbations in a 24-hour time span.



Giobbe GG, Michielin F, Luni C, Giulitti S, Martewicz S, Dupont S, Floreani A, Elvassore N. 2015. Functional differentiation of human pluripotent stem cells on a chip. **Nat Methods**. 12:637–640.

Dynamic simulations for the optimum management of HVAC and DHW system in a multifamily building

Aim of the present work was the analysis of an integrated system for the heating and the DHW production for 30 apartments. The system consists of a gas modulating condensing boiler (220 kW) for heating and DHW, a heat pump (130 kW), and 18 evacuated tube solar thermal collectors. Solar energy contribution is used both for heating and for DHW generation. Three thermal storage tanks are installed: a puffer for the heating demand (800 l) and the other two (2000 l each) dedicated to DHW production. The aim of the analysis is to evaluate the optimum design of the plant and of the management system, in order to maximize the exploitation of the solar energy, to increase the load factor of the heat pump and to manage the boiler operation for achieving the highest efficiency at partial loads.
Dynamic simulations have been run first to analyze the management of the solar system, and subsequently to evaluate the overall efficiency of the plant, as it has been managed with different set of controls and different priorities among devices, and the operation of the boiler has been split into two modules dedicated respectively to heating and to the DHW generation.
To identify the best configuration of the solar system, acting on the solar circuit flow management, it was investigated how to divide the total flow among the three storage tanks to optimizing the energy contribution provided by the solar collectors. A small contribution was found with respect to the heating demand and it has questioned whether to maintain or not this connection. However, the overall performance analysis on the system showed a solar contribution of about 23% of the total energy demand, due to the contribution to DHW production, always greater than the 50% required by Italian regulation. Compared to a traditional system(only condensing boiler) the analyzed solution provides a primary energy saving of 36%. The split management of the boilers allows a further saving of 6% of primary energy [Tab.1].

	BOILER	HP	SOLAR SYSTEM	TOTAL INPUT
	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]	Thermal energy [MWh] Primary energy [toe]
Integrated system unique boiler	45.4 3.9	16.1 3.0	30.3 -	91.8 6.9
Integrated system split boilers	34.3 2.9	18.8 3.5	30.3 -	83.4 6.4
Traditional system only boiler	126.0 10.8	- -	- -	126.0 10.8

Energia
Energy

Energetica degli edifici

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Main research topics:

- Performance analysis of HVAC system by the means of experimental measures and dynamic simulations
- Analysis of indoor environmental quality (thermal comfort and air quality)
- Modeling and analysis of heating radiant system
- Natural and mechanical ventilation
- Geothermal heat pumps
- Screen walls and efficient enclosures
- Energy and temperature analyzes in large environments
- Energy and plant consulting
- Study and optimization of the interventions for the renovation of existing buildings
- Fluid dynamic simulations
- Thermo graphic surveys
- Detailed thermal analysis of thermal bridges
- Measurements of air permeability of building envelopes
- Hygrothermal behavior of the envelope components

Ingegneria dei sistemi elettrici
Electric systems

DII research group
Power System Group

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Assisted by
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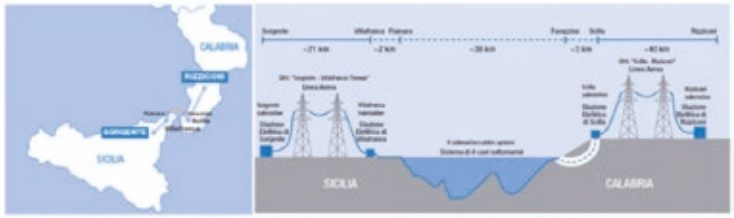
Dr. Riccardo De Zan,
Dr. Maria Rosaria Guarniere,
Dr. Paolo Sylos Labini and
Dr. Giuseppe Lavecchia
with Terna Rete Italia, Rome.

Main research topics:

- Smart grids: the operation and control of active networks.
- Voltage regulation in the distribution network with high penetration of distributed generation
- Large-scale energy storage in the network
- EHV/HV dc and ac innovative transmission lines e.g. insulated cables and gas insulated lines;
- Synergy between railway and highway infrastructures and insulated cables
- Multiconductor cell analysis (MCA) of asymmetric systems by means of self-implemented matrix procedures (insulated cables with screens and armours, gas insulated lines with enclosures, overhead lines with one or more earth wires)

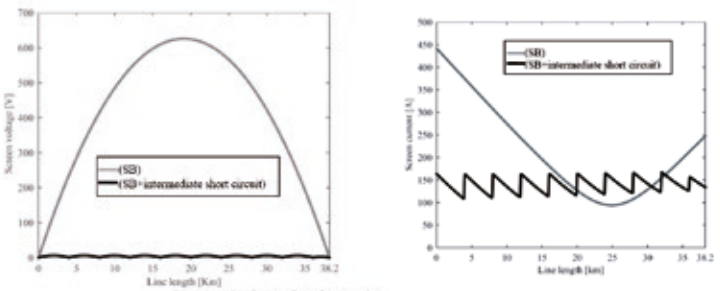
Sorgente-Rizziconi (Sicily-Calabria) 43 km Double-Circuit AC 380 kV Submarine-Land Cables

The Power System Group has investigated and deeply contributed in the analysis and in the planning choices of the future extra-high voltage (EHV) double-circuit cable line between Sicily and Calabria which is a reinforcement of the Italian southern transmission grid. This will be one of the longest AC submarine link in the world. The multiconductor cell analysis (with acronym MCA: software devised and entirely developed by the Group) of these land-submarine double-circuit single-core cables has been compared with an Electro Magnetic Transient Program (EMTP-RV) model with a very good agreement. The different choices of bonding systems implemented in the real Italian installation have been theoretically justified by means of the two software comparison. It is worth remembering that the first link between Sicily and Italy mainland is dated 1955 and was a 220 kV double-circuit overhead line with a crossing span of 3.65 km. In 1981 these overhead lines were dismantled and substituted by a very challenging submarine 400 kV single-circuit cable installation in the difficult environmental conditions of the Messina Strait. More recently, the necessity of substituting this submarine oil-filled cable link and of strengthening the Italian southern EHV grid have brought to the planning and installation of a very long AC double-circuit single-core cable line chiefly constituted of a submarine armoured cable system (38 km long) and of two land parts (wholly about 5 km long) in Sicily and in Calabria Regions. This link with different cable types presents both the most important bondings of cable screens i.e. solid-bonding and cross-bonding. In the submarine part, the cable is armoured and the screen and armour of each single-core cable are bonded together every 4 km. At both ends of the submarine part, all the screens and armours are solid-bonded. The land part is cross-bonded in order to have negligible induced currents in the screens. Therefore, in the submarine part, only solid-bonding is possible: this implies induced currents and voltages in the screens and armours which have been computed. The Group has also demonstrated that in order to keep the screen induced voltages sufficiently low it is necessary to bond them together with armours at given intervals along the submarine part: the evaluation of this length interval has been given by means of MCA. The Group has also clearly shown that the stray current in the sea is practically negligible and the additional losses of solid-bonding armours are very low so giving a very environmental-friendly installation



The "Sorgente-Rizziconi" overhead – land-submarine-land cable – overhead line

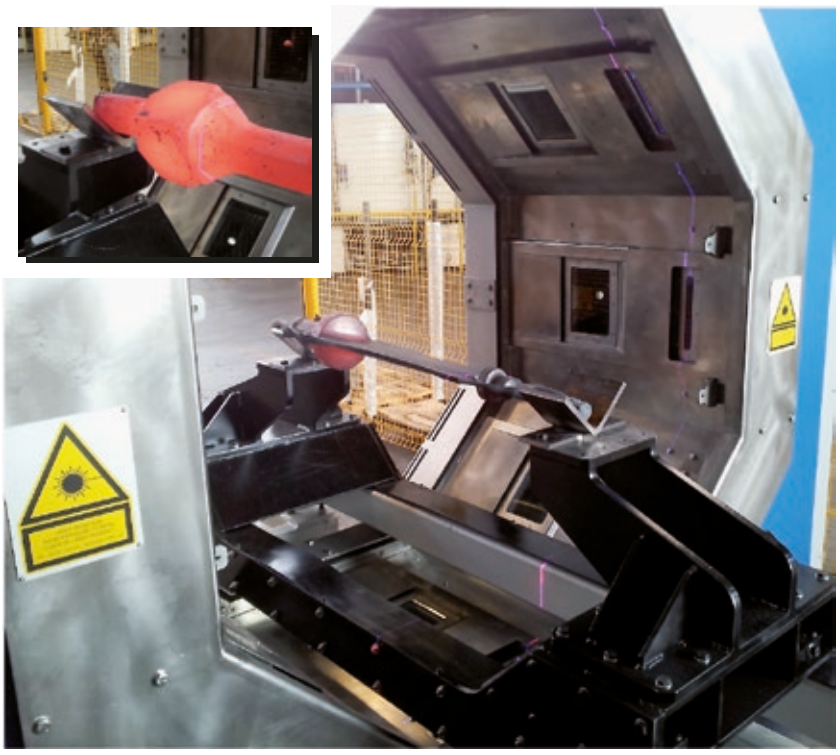
From left: Cable drum in the cable laying ship Giulio Verne; an installation phase of the submarine laying; an impressive view into the vertical tunnel



Screen induced voltage and current magnitudes

HOTGAUGE – Measurement of complex and freeform shaped parts at elevated temperature

Geometrical distortions due to inappropriate setting of process parameters are one of the main causes of variability in manufacturing high-valued hot forged thin freeform parts e.g. turbine blades. Their identification and quantification at the earliest steps of the process chain may permit well-timed setting of the process parameters, with significant benefit in case of small batch production. DII and partners of the international research project HOTGAUGE developed and tested an innovative Coordinate Measuring System (CMS) for fast inspection of freeform parts at elevated temperatures through high-speed laser triangulation, using multiple sensors and intelligent data fusion and illustrated in the figure below. The system can scan the entire geometry of a hot part a frequency of 320 Hz, thus generating 10^6 points/s for a 800 mm long blade in less than 8 sec. Due to the harsh environment conditions, laser triangulations sensors where placed inside a shielded and isolated housing (2.6 x 2.5 x 1 m), where the temperature is kept steady at 20±1°C while a part at 800 °C is moved through. Additionally, two pyrometers are installed in the top of the housing in order to acquire part surface temperature. Main error sources were identified and minimized using appropriate techniques, including a new method for the correction of systematic errors due to imperfect laser planes alignment. A new procedure for testing the prototype CMS in hot conditions was also developed. The procedure uses glass-ceramic plates, featuring nearly zero Coefficient of Thermal Expansion (CTE), mounted on a fixture over a hot billet. Test results demonstrate that the prototype CMS, after more than one hour of operation in hot conditions, is measuring with bidirectional length measurement errors in the order of 0.05 mm.
The prototype was extensively tested in the forging plant of an Italian manufacturer of turbine blades and demonstrated to be an effective tool for reductions of wastes in small batch production of high-valued hot forged thin freeform parts.



Ingegneria dei sistemi meccanici
Mechanical systems

DII research group
Precision manufacturing engineering

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Project:
HOTGAUGE - Measurement of complex and freeform shaped parts at elevated temperature (E!6692), funded by the Eurostars Programme, 2011-2014.

Partners:
DII, Università di Padova, Italy
Zumbach Electronic AG, Switzerland (Coordinator)
NTB Interstate University of Applied Sciences of Technology Buchs, Switzerland
Pietro Rosa TBM srl, Maniago (PN), Italy

DII team:
Prof. Enrico Savio (Project leader)
Prof. Paolo F. Bariani (Group coordinator)
Prof.ssa Stefania Bruschi
Prof. Simone Carmignato
Prof. Andrea Ghiotti
Prof. Giovanni Lucchetta

Main research topics:
- Manufacturing systems and processes
- Micro-technologies and precision technologies
- Shaping of metallic materials
- Processing of polymeric materials
- Geometric metrology

Materiali avanzati
Advanced Materials

DII research group
Nanoengineering group

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Investigation conducted in collaboration with Prof. Fiorenzo Omenetto and Dr. Giovanni Perotto at Tufts University - Boston.

Main research topics:

- Nanoparticles and nanopowders for functional applications.
- Functional and structural thin coatings via wet chemistry.
- Ceramic based nanocomposites.
- Nanostructured materials for gas sensors

Functional biomaterial based on silk fibroin-titanate nanocomposites

After being used for millennia as a luxury fabric, silk, and in particular silk fibroin, the protein extracted from the silk fibers is experienced a second youth thanks to outstanding applications as a biomaterial.
Thanks to its high transparency, mild processing conditions and pushed by the development of several fabrication and nanofabrication methods, silk fibroin has been proposed as a platform for biocompatible optics, high tech application like resorbable electronics, and implantable and biofunctional optical devices.
To enhance the performances of silk as a material for optics a strategy to increase its refractive index while preserving all the properties of silk is needed. We developed a new nanocomposite made of silk and titanate nanosheets (TNSs). TNSs are 2D layered materials made of nano sheets with a $Ti_{(1-x)}O_2^{4x-}$ composition that are one unit cell thick and 3-5 nm wide (see figure 1a). TNSs have small size, high refractive index and are easily synthesized via sol gel chemistry. They are also water-soluble which makes the integration with the silk processing very easy to implement. TNSs have been homogenously dispersed in silk (see figure 1b) obtaining both unsupported flexible thick film (see figure 1c) or thin film supported on proper substrate, with refractive index varying from 1.45 to up 2.00 depending on the concentration of TSNs.
A wide variety of fabrication techniques were developed to create optical devices and interfaces with silk: e-beam lithography to make photonic structures, photolithography, thin coatings, inkjet printing. The high refractive index TNSs/silk nanocomposite was successfully processed with all these fabrication techniques.
In Figure 2a a thin film of 75% TNSs 25% silk patterned with e-beam lithography is shown. 270 nm holes with 700 nm lattice constant were successfully written. TNSs:silk nanocomposite was used as a resist for UV lithography. Figure 2b shows a pattern of 400 µm wide features that were made by UV exposure of a 300 nm TNSs:silk coating made with 80% TNSs and 20% silk. High refractive index silk solution was successfully used as a functional ink for inkjet printing as reported in figure 2c.

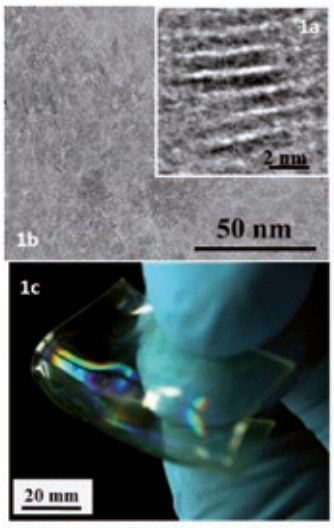


Figure 1. a) TEM picture of a single TNS particle made of 6 nanosheets. b) TEM picture of TNSs silk-TNSs composite, TNSs are evenly dispersed in the silk matrix. c) a freestanding film made flexible by simple hydration with water

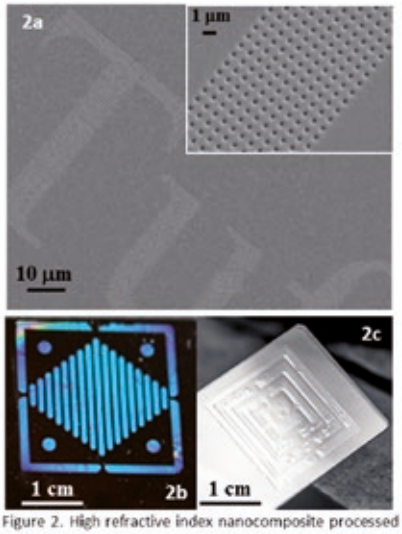


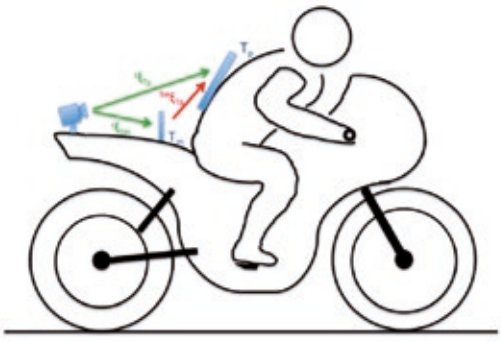
Figure 2. High refractive index nanocomposite processed with different techniques. a) SEM picture of 270 nm holes e-beam lithographed on a 300 nm film. The inset shows a higher magnification picture. b) film patterned using UV lithography; lines are 400 µm in width. c) ink jet printed solution on a glass slide

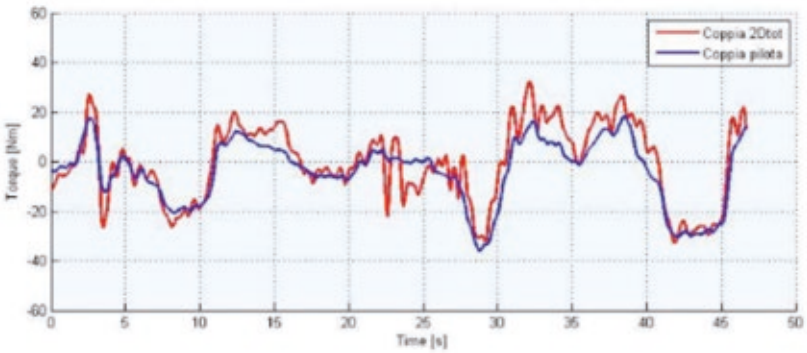
Motorcycle's driver pose estimation using an action camera

The aim of this work is the development of a system to investigate how the driver interacts with the motorcycle. An apparatus and algorithm was developed to measure the pilot's position with respect to the vehicle, while driving normally on the street or on the track. A single camera records the movements of the pilot, then processing the recorded video it's possible to estimate the position (6 DOF) of the rider's body.

Since nowadays affordable technological instruments are available with great accuracy, the use of commercial apparel combined with the calculation power of a laptop pc can provide results that a decade ago would have required great efforts. The principle to use a single camera to measure pilot's behavior has been recently adopted as in [1] and [2] but it is still requiring a specif apparel and accurate mounting of the camera on the vehicle. In order to exclude errors due to inaccurate hardware setup, and allow fast mounting on every vehicle, an innovative procedure was developed in which is useless to know the position of the camera on the vehicle, and moreover accidental movements of the camera and low frequency vibrations becomes irrelevant for the measure.

As result in field tests is presented a comparison among the developed system and a traditional instrumented motorcycle. The motorcycle is equipped with sensors in order to measure the torque exerted by the pilot on the vehicle along the rolling direction. Sensors includes an instrumented handlebar, pedals and saddle, which are considered the contact points of the human body with the motorcycle.
The same torque was calculated using a simple human model as described above.





Mobilità sicura e sostenibile
Safe mobility

DII research group
MDRG Motorcycle
Dynamics Research Group

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Main research topics

- Dynamics of two-wheeled vehicles
- Dynamics and control of the vehicle
- Identification of the mechanical properties of vehicle components
- Development of driving simulators
- Modelling of active and passive behaviour of the pilot of two-wheeled vehicles

Processi, prodotti e servizi
Processes, products and services

DII research group
TCMET

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The research in the field has been started and successfully carried out by Prof. Rino Michelin, recently passed: it was our deepest privilege to have worked with him.
The research is ongoing and carried out in collaboration with Cristina Marzano and Valentina Gandin (Department of Pharmaceutical Sciences, UNIPD) as for the biological and cytotoxic activity, Alessandro Dolmella (DFS) as for X ray structural determinations and Alfonso Venzo (CNR) as for NMR characterization. Other relevant collaborations: Armando Pombeiro, IST, Lisbon and Tamas Kiss, University of Szeged (HU).

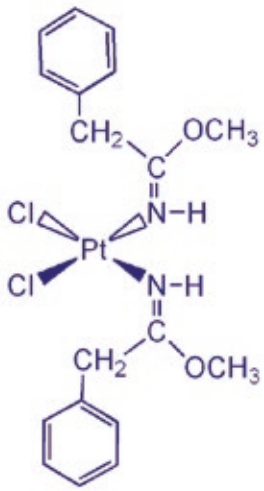
Main research topics:

- Design, synthesis and characterization of organometallic compouds of transition metals
- Design, synthesis and study of catalytic activity of new green catalytic systems
- Design, preparation and characterization of metal nanoparticles
- Preparation of nanocomposites with improved designed and tuned properties
- Supramolecular chemistry
- Supramolecular polymers
- Study of new approaches in environmental cleaning processes: application of photocatalysis
- Evaluation of chemical bases of technologies and proposal of innovative solutions

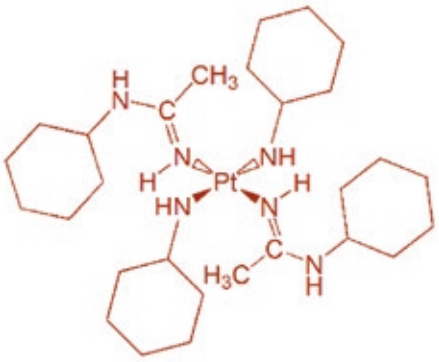
Neutral and cationic platinum amidine and iminoether complexes: new classes of potential antitumor drugs

Platinum complexes are routinely used in clinical practice for the treatment of solid tumors. Unfortunately, the therapeutic outcome of platinum-based chemotherapy is massively impaired by severe side effects and intrinsic or acquired resistance.
Platinum amidine and iminoether complexes represent new classes of potential antitumor drugs which contain the imino moiety HN=C(sp^2) bonded to the platinum center.
The iminoether complex *cis*-[$PtCl_2${E-N(H)=C(OMe)CH_2Ph}$_2$] (1) showed to be significantly more potent than cisplatin (the reference drug) against some tumor cell lines and able to overcome cisplatin resistance (Table 1).
In vivo studies on two transplantable tumor models (L1210 leukemia and Lewis lung carcinoma) showed that 1 induced a remarkable antitumor activity, as measured by prolonged survival and reduced tumor mass compared to control. The water soluble complex *trans*-[$Pt(NH_2Cy)_2${N(H)=C(NHCy)CH_3}$_2$](Cl)$_2$, (2) distinguished itself as the most promising derivative among a series of dicationic bis-amidine *trans*-Pt^{II} complexes: using PEG400 as a solvent, it showed to be able to overcome both cisplatin and MDR resistance, inducing cancer cell death through p53-mediated apoptosis. *In vivo* studies on C57BC mice bearing Lewis lung carcinoma highlighted a significant and dose-dependent tumor growth inhibition without adverse side effects.

Complex 1



Complex 2



Complex	Hela	MCF-7	A375	A549	Caco-2	Hep-42	HL60
1	3.01±0.4	19.11±1.3	9.15±1.2	2.33±1.7	5.37±1.4	7.05±1.2	5.59±2.7
cisplatin	11.75±1.5	30.18±1.5	20.28±1.3	39.27±1.9	35.37±1.4	21.54±1.3	18.35±1.6
	2008	C13*	RH4	LoVo	LoVo MDR	A2780	A2780 ADR
2	6.30±2.06	5.22±1.45	13.24±2.05	11.01±2.43	15.02±1.58	9.43±2.52	9.35±1.53
cisplatin	12.69±1.73	89.18±1.54	26.76±1.75	1.43±0.20	44.87±3.13	1.91±1.54	27.32±1.61

Integrated water resources management to reconcile agriculture with environment in dry coastal areas

Conflicting water uses in coastal zones demand integrated approaches to achieve sustainable water resources management, protecting water quality while allowing those human activities which rely upon aquatic ecosystem services to thrive. The Vallevecchia wetland system (Fig. 1) is based on a reclaimed 900 ha-large drainage basin located along the coast of the NW Adriatic Sea near Caorle, Northern Italy, where droughts recently impacted agricultural activities causing water scarcity and saltwater intrusion. Vallevecchia is a multipurpose experimental system with the pioneering goal of allowing agricultural practices close to the sea. Rainwater and drained water are recirculated inside the system (where no significant internal freshwater sources exist) to limit saltwater intrusion, provide water for irrigation during dry periods and reduce the nonpoint pollution of agricultural origin, i.e. the nutrient loads discharged into the bordering sea. The staff of LASA has been monitoring the surface water quality of Vallevecchia since 2003; results show that the groundwater is saline and about 1 m deep, but sometimes it can even reach the ground surface where salt crusts can occasionally be noticed. There are two hydraulic pathways in the system. One runs across the Sbregavalle channel: water flows from secondary channels, which run across the fields and collect their surface runoff, into the Sbregavalle channel, then to a gated spillway, and finally to a pumping station which pumps water out of the system. Regulating gates are found at the beginning and at the end of the secondary channels, and when they are closed the water level inside these channels increases and consequently water is distributed in the fields. In this manner the groundwater table is raised up uniformly, thus benefiting agricultural activities and possibly reducing saltwater intrusion. In the second pathway, water from the Sbregavalle channel is pumped into a storage basin and then the water is recirculated back into the system for irrigation in dry periods. In the framework of the LIFE+ project WSTORE2, started on November 2012, LASA is carrying out extensive water quality monitoring inside Vallevecchia. Monitoring aims to provide a knowledge base to better manage the hydraulic structures in the system; management is also assisted by the recently implemented automation of all the gates, located at the end of every channel that flows across the agricultural fields, which are operated with the goal of storing rainwater (to stop saltwater infiltration) and permitting the outflow of good quality water coming from the drainage of agricultural soils. The clearly positive outcome of the activities of WSTORE2 is highlighted by the monitoring data collected over the first two project years, which show a much better water quality than the data we had collected before the project start (Fig. 2).

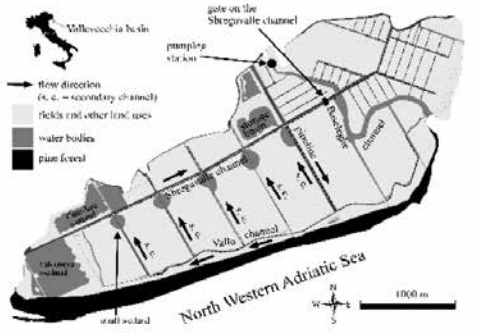


Figure 1. Hydraulic network and land use in the Vallevecchia wetland system

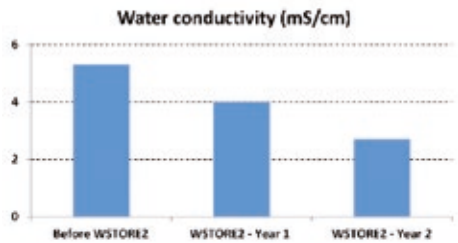


Figure 2. Mean water conductivity across the Sbregavalle channel

Ambiente
Environment

DII research group
LASA

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WSTORE2 is a LIFE+ project, which started in November 2012 and will end on October 2015. The goal of the project is to implement and demonstrate the efficacy of an innovative management process designed to maximize and optimize the use of available rainfall water in rural coastal areas.

Main research topics:

- Surface water quality
- Point and diffuse pollution of water bodies
- Aquatic ecosystem monitoring and modeling
- Water treatment wetlands
- Ecotoxicology
- Air quality and odor dispersion models

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Corso di laurea triennale in Ingegneria Chimica e dei Materiali

Obiettivi formativi

Il Corso di Laurea in Ingegneria Chimica e dei Materiali ha come obiettivo formare un ingegnere che sappia gestire i processi di trasformazione della materia e dell'energia (tipici per esempio dell'industria chimica, petrolchimica, farmaceutica, alimentare, biotecnologica), scegliere i materiali adatti per particolari condizioni di impiego, e mettere a punto nuovi materiali, estendendo prestazioni e settori di impiego di quelli convenzionali. L'Ingegnere Chimico e dei Materiali sa progettare e gestire le trasformazioni di materia e di energia necessarie alla produzione sostenibile di quei beni materiali che concorrono a determinare la qualità della nostra vita (per esempio prodotti chimici, carburanti, materie plastiche, vetri e materiali ceramici, farmaci, prodotti alimentari, detergenti, prodotti per l'igiene personale).

Cosa si studia

Il corso ha l'obiettivo di formare una figura professionale con una solida preparazione tecnica di base, basata sui seguenti punti chiave comuni :

- base scientifica (matematica, fisica, chimica…) —> strumenti per comprendere e descrivere la realtà tecnologica
- fenomeni fondamentali (termodinamici, cinetici, chimici) delle trasformazioni della materia e dell'energia
- struttura della materia (meccanica dei solidi e scienza dei materiali)
- fenomeni di trasporto di materia e di energia —> la base dei processi industriali dell'industria chimica, farmaceutica, alimentare e dei processi industriali in generale
- selezione e dimensionamento di apparecchiature dell'industria di processo
- tecnologie di produzione e utilizzo dei materiali

e su formazioni aggiuntive a scelta dello studente sui seguenti punti:

- processi per la produzione industriale di sostanze chimiche
- strumentazione di processo
- trattamento degli inquinanti liquidi

e su formazioni aggiuntive a scelta dello studente sui seguenti punti:

- metallurgia
- caratterizzazione dei materiali

Prospettive post-corso

Il Corso di Laurea ha carattere prevalentemente formativo e quindi si presume che lo studente completi la formazione con una specializzazione nelle lauree magistrali collegate (Ingegneria Chimica e dei Processi Industriali e Ingegneria dei Materiali), progettate per essere complementari ai due indirizzi di questo Corso di Laurea. In alternativa, la formazione potrebbe completarsi in altri corsi di Laurea Magistrale affini (ad esempio Ingegneria dell'Energia o Ingegneria Meccanica), purché il curriculum precedente soddisfi ai requisiti minimi previsti dal regolamento.

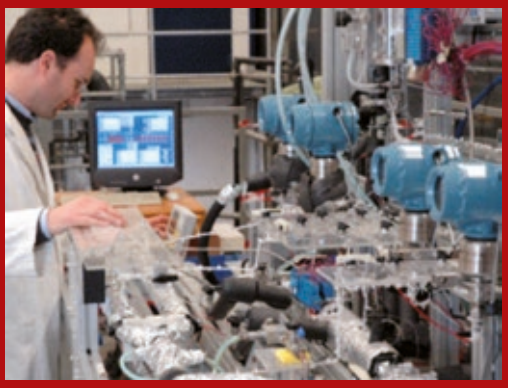
Gli sbocchi professionali sono possibili anche senza Laurea Magistrale, e comprendono l'impiego nelle industrie di trasformazione di materie prime, nelle attività di trasformazione dell'energia, negli enti operanti nel settore del trattamento dei rifiuti solidi, liquidi ed aeriformi. In ogni singolo caso il laureato avrà gli strumenti per acquisire rapidamente le competenze tecniche specifiche richieste dalla professione scelta.

Corso di laurea magistrale in Ingegneria Energetica

Obiettivi formativi
Obiettivo principale del corso di laurea magistrale in Ingegneria energetica è formare un ingegnere capace di operare con funzioni direttive o di ricerca e sviluppo nell'ambito della produzione, distribuzione ed utilizzazione dell'energia nelle sue diverse forme (meccanica, elettrica, termica, chimica), valutandone le interazioni con gli aspetti ambientali, economici e normativi. Il percorso formativo prevede l'approfondimento delle conoscenze teoriche ed applicative relative all'energetica, alla termofluidodinamica, alla trasmissione del calore, ai sistemi di produzione energetica, ai sistemi elettrici per l'energia, all'economia dell'energia, alle misure e strumentazioni industriali, alle energie rinnovabili. Sono previsti, poi, degli esami specifici (tra cui lo studente può scegliere), per la preparazione più specifica di competenti figure professionali rivolte a precisi ambiti di impiego, tutti di grande interesse nell'attuale panorama energetico. Essi approfondiscono, ad esempio, aspetti relativi alle macchine e agli impianti che utilizzano fonti rinnovabili, le conoscenze in tema di impianti combinati, cogenerativi e nucleari (a fusione e a fissione), le applicazioni civili ed industriali, entrando nel dettaglio dell'energetica degli edifici e degli impianti termici e frigoriferi. Durante gli insegnamenti, gli studenti verranno posti davanti a problemi concreti, anche complessi, ai quali verrà chiesto loro, con l'aiuto del docente ed utilizzando diversi strumenti (libri di testo specialistici, avanzati codici di calcolo, informazioni raccolte da svariate fonti), di trovare una soluzione possibile.

Cosa si studia
Il manifesto degli studi mette in evidenza le caratteristiche del curriculum di questo corso di laurea magistrale. Sono approfonditi i settori delle fonti energetiche rinnovabili e non rinnovabili, della combustione, della termofluidodinamica, delle misure, dei controlli, dell'impiantistica energetica (termica, meccanica, elettrica), dei sistemi energetici. Gli esami a scelta consentono agli allievi di focalizzare l'interesse su specifici aspetti.
Gli studenti che intendano iscriversi al corso di laurea magistrale in Ingegneria Energetica devono essere in possesso di un diploma di laurea o di altro titolo conseguito all'estero, riconosciuto idoneo in base alla normativa vigente, e con un voto minimo indicato nel regolamento didattico del corso di studio. La laurea triennale in Ingegneria dell'Energia, conseguita presso l'Università di Padova (e organizzata dal DII) rappresenta l'ideale, ma non l'unico, punto di partenza per la formazione magistrale. Il regolamento didattico del corso di studio indica i requisiti curriculari richiesti per l'accesso (espressi mediante valori minimi di cfu in settori o in gruppi di settori scientifico disciplinari) e prevede le modalità di verifica della personale preparazione.

Prospettive post-corso
Il laureato in Ingegneria Energetica trova impiego:
• nelle aziende di produzione e distribuzione di energia (energia elettrica, gas naturale, prodotti petroliferi)
• negli studi professionali che si occupano di impiantistica civile e industriale (idraulica, termica, elettrica) o di valutazioni di impatto ambientale
• nelle aziende municipalizzate, nelle aziende industriali che siano autoproduttrici di energia o che abbiano rilevanti consumi energetici (figura dell'energy manager) nelle aziende produttrici di apparecchiature per l'utilizzo del calore e del freddo o per la conversione energetica (pompe, turbine, motori endotermici, caldaie, scambiatori di calore, sistemi frigoriferi, apparecchiature elettriche, ecc.).
Gli ambiti professionali sono analoghi a quelli del laureato triennale in Ingegneria dell'Energia, ma in realtà aziendali di maggiori dimensioni, tipicamente medie, grandi e multinazionali. Assai più concrete e più rapide sono le prospettive di carriera verso i livelli dirigenziali, con responsabilità di coordinamento e di indirizzo strategico.



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Achievements

Il Team Red Bull al Dipartimento di Ingegneria Industriale

Il 22 aprile 2015 alle ore 16.15, il Team Toro Rosso/Red Bull di Formula 1 ha presentato agli studenti di ingegneria del Dipartimento di Ingegneria Industriale (DII) alcuni aspetti della propria attività tecnologico-sportiva, nell'ambito di un evento indirizzato particolarmente agli studenti dei corsi magistrali e triennali di ingegneria aerospaziale e ingegneria meccanica. Francesco Pancrazi (Senior Control Systems Engineer del Dipartimento Elettronico) ha tenuto una relazione sul tema "Controlli elettronici in una vettura di F1", con ottima partecipazione degli studenti (testimoniata dal rapido esaurimento dei posti disponibili). La conferenza è stata accompagnata dall'esposizione di un'auto della scuderia Toro Rosso nel cortile del DII in via Venezia 1.

Per ulteriori informazioni rivolgersi al Prof. Ugo Galvanetto (049 8276817, ugo.galvanetto@unipd.it)

RaceUP Team presenta MG X.15

Venerdì 3 luglio presso il Palazzo Bo è stata presentata alle Autorità Accademiche, agli Sponsor e alla Stampa la nuova vettura MG X.15 con la quale il RaceUP Team dell'Università di Padova parteciperà alle prossime competizioni internazionali del circuito Formula SAE, che si terranno presso il circuito di Hockenheim (Germania) nel mese di agosto e presso il circuito di Varano de' Melegari (Parma) nel mese di settembre.

Per ulteriori informazioni rivolgersi al Prof. Giovanni Meneghetti (049 8276751, giovanni.meneghetti@unipd.it)

www.raceup.it/

Novel routes for open cell geopolymer components

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1. Motivation

The aim of this work was to fabricate highly porous, open cell geopolymer components by two routes: a) foaming by *in situ* formation of surfactants (saponification reaction of a vegetable oil in an alkaline medium); b) negative replica of 3D printed PLA sacrificial structures with various geometries.

2. Introduction

Porous components based on geopolymers are typically produced employing procedures used in the cement industry, i.e. the addition to an aqueous geopolymer slurry of components, such as silica fume or Al powder, capable of generating *in situ* gaseous H_2 by the reaction occurring with metallic Si or Al in a highly alkaline medium. Another route that has been proposed is the addition of peroxides, which decompose into water and oxygen due to the high pH, generating gas. These approaches provide a suitable way of fabricating highly porous components, but when these processing routes are used the cells are typically closed, i.e., the interconnection among adjacent cells are not present, thereby greatly limiting the functional properties of the component, such as the permeability to liquids or gases. Despite all these studies, little work has been devoted to the production of porous geopolymer components using alternative approaches.
We employed two alternative routes to obtain open cell structures:

1) Saponification, which generates carboxylate surfactants (soap molecules) *in situ* through the hydrolysis reaction of the triglycerides found in oils or fats occurring in the highly alkaline environment of the geopolymer slurry.
2) Negative replica, in which the geopolymer slurry is poured into 3D printed PLA structures with various geometries; the sacrificial templates are decomposed through heat treatment after geopolymerization.

3. Materials and Methods

Porous geopolymers were prepared from metakaolin, fly ash class F, potassium silicate and potassium hydroxide, respecting the oxide molar ratios as follows: SiO_2/Al_2O_3 = 4, K_2O/SiO_2 = 0.25 and H_2O/K_2O = 15.19.
Figure 1 reports the flowcharts for a) geopolymer slurry preparation, b) the saponification route and c) the negative replica route. A commercial sunflower oil, with saponification index (SI) of 190, was used for the saponification route; whereas 3D printed PLA structures were used to be replicated.

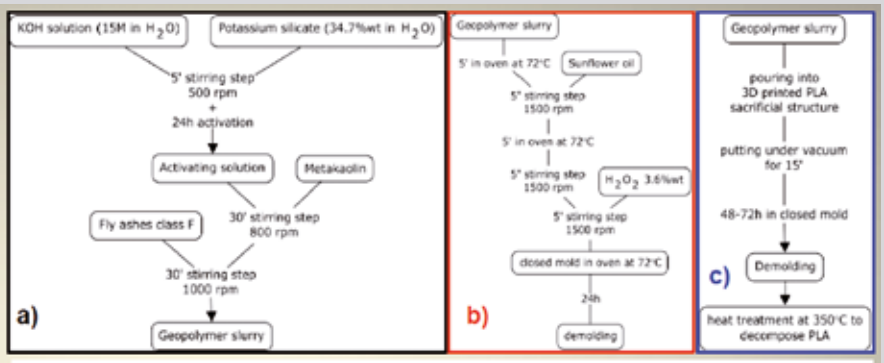

Figure 1. Schematic diagram for the a) preparation of the geopolymer slurry and its application in the b) saponification and c) negative replica route.

4. Results

For the saponification route, it was possible to produce foams with a total pore volume as high as ~85 vol%, with an amount of open porosity as high as ~70 vol%.
Besides that, stereomicroscopy and SEM investigations showed a regular distribution of open and interconnected cells with dense struts (see Figure 2).

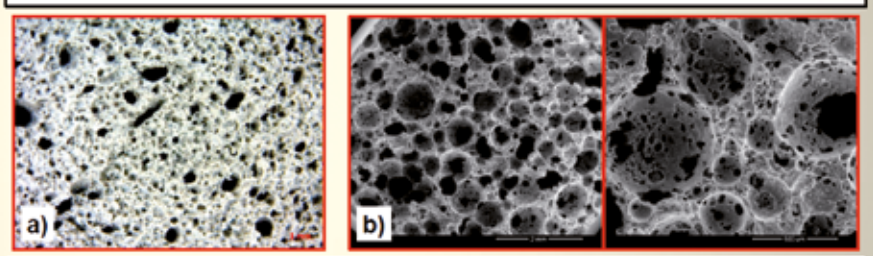

Figure 2. Morphology of various geopolymer foams obtained by saponification: a) stereomicroscopy and b) SEM images

Following the negative replica route, complex geometries with a pattern specifically designed for filtration and adsorption purposes were produced; from the decomposition of the PLA sacrificial structure derives an open porosity of 35-40 vol%.

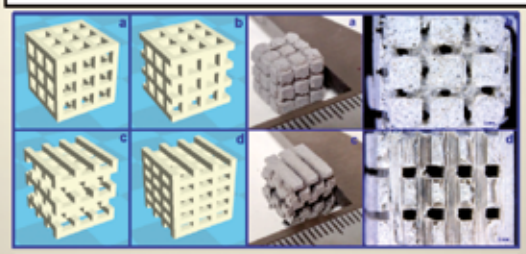

Figure 3. 3D rendering (left) and negative replica (right) of various sacrificial templates

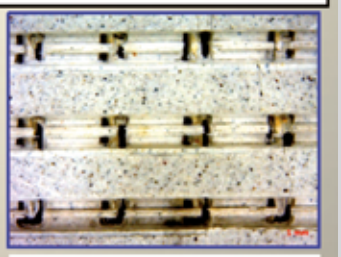

Figure 4. Morphology of a filter for water treatment

5. Conclusions

These preliminary results suggest the suitability of these routes in order to obtain highly porous geopolymer components with interconnected porosity. Further studies, concerning different process conditions (type of vegetable oil, stirring velocity for the saponification route; impregnation processes, PLA decomposition processes, geometry for negative replica) are currently being carried out to further improve the morphology of the porous components and the amount of open porosity, as well as permeability and adsorption properties.

Reference: M. Strozi Cilla, P. Colombob, M. Raymundo Morelli, "Geopolymer foams by gelcasting," *Ceram. Intern.*, in press (doi: dx.doi.org/10.1016/j.ceramint.2013.11.011)
Acknowledgments: São Paulo Research Foundation (FAPESP)

Best poster award at:
«Workshop: How to exploit the porosity of geopolymers?»
October 2, 2014 - CNR ISTEC, Faenza (RA)

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