ICMATE
Istituto di Chimica della Materia Condensata
e di Tecnologie per l'Energia

Conferenza di Istituto 2019

PROGRAM & BOOK OF ABSTRACTS

Padova – Area della Ricerca, CNR

May 21-22, 2019

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2019 - ICMATE CONFERENCE

The *2019-ICMATE Conference* will take place from May 21st to 22nd, 2019, in Padova.

The conference will be held in the *Aula Blu* room at *Edificio Servizi Generali*, *CNR-Area della Ricerca di Padova*.

The meeting is aimed to promote the exchange of knowledge between researchers, by presenting their research activities in order to share skills and techniques.

The objectives are:

- to point out and enhance instrumental resources and individual skills;

- to foster partnerships and collaborations;

- to share initiatives for promoting research outcomes at a national- and international-level, in order to participate to European, National and Regional calls.

SCHEDULE

	Tuesday 21	*Wednesday 22*	
		Oral session	8:30-10:50
		Coffee break	10:50-11:10
11:00-11:40	Opening	Oral session / Meeting Admistrative-Technical staff	11:10-13:10
11:40-13:40	Oral session		
		Lunch	13:10-14:10
13:40-14:30	Lunch		
		Oral session	14:10-15:50
14:30-16:30	Oral session		
		Closing remarks	15:50-16:00
16:30-17:00	Coffee break		
17:00-19:00	Oral session		
19:00-20:30	Poster session with buffet		

Tuesday, May 21st

		Opening
11:00		L. Armelao – ICMATE Director M. Peruzzini – DSCTM Director
		Morning session – Chair: A. Vittadini
11:40	TU01	D. Ripamonti, Milano **Dust in fusion devices: characterization, mobilization and adhesion features**
12:00	TU02	G. Angella, Milano **Materials science for a new classification approach of conventional and advanced spheroidal cast irons**
12:20	TU03	L. Nodari, Padova **In situ external reflection infrared spectroscopy as contactless tool to investigate artistic materials**
12:40	TU04	C. A. Biffi, Lecco **Selective laser melting: an advanced method for manufacturing metallic alloys**
13:00	TU05	F. Cirisano, Genova **Non-contact 3D optical profilometer for advanced surface characterization**
13:20	TU06	L. Garavaglia, Lecco **Method to monitor the metallic material characteristics evolution during the shape setting treatment**
13:40-14:30		**Lunch**
		Afternoon session 1 – Chair: F. Passaretti
14:30	TU07	F. Migliorini, Milano **Laser-induced incandescence technique: current applications and future prospects**
14:45	TU08	S. De Iuliis, Milano **Flame spray pyrolysis for nanoparticles synthesis**
15:00	TU09	P. Stagnaro, ISMAC Genova **Research activities on macromolecules and polymeric materials**

		J. Fiocchi, Lecco
15:30	TU10	**Biodegradable iron based alloys: synthesis and characterization**
		A. Galenda, Padova
15:50	TU11	**T.A.R.A.N.T.O. project: supported TiO_2 MOCVD thin films and doped TiO_2 powders for photocatalytic water remediation**
		S. Pittaccio, Lecco
16:10	TU12	**Multimaterials and metamaterials for wearable applications**
16:30-17:00		**Coffe break**
		Afternoon session 2 – Chair: F. Tisato
		C. Fanciulli, Lecco
17:00	TU13	**Growth of a compact thermoelectric generator based on multi-disciplinary approach**
		R. Seraglia, Padova
17:20	TU14	**Overview on mass spectrometry: description and applications**
		S. Deambrosis, Padova
17:40	TU15	**HiPIMS: the advantages of a high ionization plasma PVD technology**
		S. Bogialli, Padova
18:00	TU16	**Targeted and non-targeted analysis of organic compounds by high resolution mass spectrometry**
		F. Valenza, Genova
18:20	TU17	**Wetting and interfacial phenomena in relation to joining of advanced ceramics**
		M. Natali, Padova
18:40	TU18	**Development of prefabricated panels for energy efficiency of buildings within the InnoWEE project**
19:00-20:30		**Poster session with buffet**

Wednesday, May 22nd

		Morning session 1 – Chair: V. Buscaglia
8:30	WE19	D. Barreca, Padova **Multi-functional metal oxide nanomaterials for sustainable technologies, energy and environmental applications**
8:50	WE20	C. Mortalò, Padova **$BaCe_{0.65}Zr_{0.20}Y_{0.15}O_{3-\delta}$-$Ce_{0.85}Gd_{0.15}O_{2-\delta}$ composite MIEC membrane for H_2 purification**
9:10	WE21	D. Giuranno, Genova **Horizon 2020-MSCA co-funded projects: a valuable opportunity to enhance the creative and innovative potential within and beyond Europe**
9:30	WE22	A. Glisenti, Padova **Improving catalytic and electro-catalytic functionality in perovskites. Can noble metals be avoided?**
9:50	WE23	N. Comisso, Padova **Preparation of electrocatalysts via oxide-oxide galvanic exchange reactions. New evidences on the reaction mechanism**
10:10	WE24	S. Schiavon, Padova **The commissioned research contract**
10:30	WE25	A. Volpi, Bruxelles **Towards Horizon Europe: the new Frame Program for European Research**

10:50-11:10 Coffee break

		Morning session 2 – Chair: G. Angella
11:10	WE26	E. Santini, Genova **The laboratory of tensiometry: where emulsions and foams are shaping up**
11:30	WE27	R. Donnini, Milano **Experimental methods for the determination of macro- and micro-structural properties on materials for industrial applications**
11:50	WE28	L. Mattarozzi, Padova **Porous metal electrodes prepared by electrodeposition with simultaneous hydrogen evolution**
12:10	WE29	P. Bassani, Lecco **Understanding the behavior of high performance aluminum alloys: the importance of multiscale analyses**

		G. Canu, Genova
12:30	WE30	**Hydrothermal synthesis: a natural process exploited for the synthesis of compounds with controlled size and morphology**
		E. Villa, Lecco
12:50	WE31	**Thermo-mechanical analysis: from calorimetric measurements to dynamic thermo-mechanical characterization for a complete investigation of microstructure and functional properties of materials**
13:10-14:10		**Lunch**
		Afternoon session – Chair: M. Fabrizio
		G. Riva, Milano
14:10	WE32	**Gasdynamics of Propulsion Systems Lab**
		S. Tamburini, Padova
14:30	WE33	**Nuclear magnetic resonance, a versatile and powerful spectroscopy**
		D. Forrer, Padova
14:50	WE34	**Studying and developing inorganic and organic materials and their interfaces by computational methods**
		F. Agresti, Padova
15:10	WE35	**Phase change materials emulsions for heat transfer and storage applications**
		D. Zannoni, Padova
15:30	WE36	**Heavy metals and radionuclides presence and mobility in food and environment: some recent research activities**
15:50		**Closing remarks**

ORAL CONTRIBUTIONS

Dust in Fusion Devices: Characterization, Mobilization and Adhesion Features

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Dust in fusion devices, produced by plasma–surface interactions, can cause safety and operational concerns. In the frame of EuroFUSION, a work has been done to describe the nature of the dust present in fusion devices and to understand its mobilization and adhesion features. On the one hand, dust was collected in actual pilot plants to analyze compositions and morphology of particles [1]; on the other hand, experiments on deposited particles were performed in order to study the effect of exposure to plasma (mobilization, melting) [2]. Tungsten is the most studied materials because it is used in PFCs (Plasma Facing Components), but other materials have been investigated [3].
To quantify and model the adhesion forces, an experimental setup was developed to electrostatically remove of tungsten spherical particles from tungsten surfaces (Fig. 1) [4].

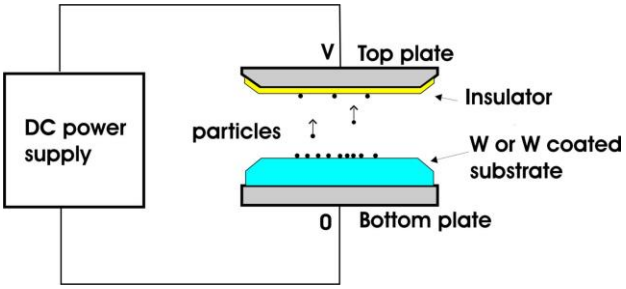

Fig. 1: Schematic of the high-voltage system for particles removal.

[1] M. De Angeli *et al.*, Nucl. Fusion 55 (2015), 123005.
[2] S. Ratynskaia *et al.*, Nucl. Mat. En. 12 (2017), 569-574.
[3] S. Ratynskaia *et al.*, Nucl. Mat. En. 17 (2018), 222-227.
[4] P. Tolias *et al.*, Nucl. Mat. En. 18 (2019), 18-22.

Materials Science for a New Classification Approach of Conventional and Advanced Spheroidal Cast Irons

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The current classifications of conventional spheroidal cast irons are based on a single production process, while high-silicon alloying and thermal treatments with salt bath quenching allow the production of advanced spheroidal cast irons characterized by outstanding mechanical properties [1]. It is therefore necessary to review the normative approach based on the minimum tensile mechanical properties, so that the new classification should be related to the new production routes, such as Si content and heat treatments [2]. Modelling tensile flow curves by physical based constitutive equations has been proved to be useful for this new regulatory approach, providing diagrams capable of identifying classes of spheroidal cast irons for Si content and productive heat treatments [3,4]. The desirable economic impact of this work is the spread on the market of the new generations of advanced cast irons, which today encounters obstacles because of engineering design based on empirical criteria derived from a long experience on widely known materials, such as steels and conventional spheroidal cast irons.

[1] Górny M., Angella G., Tyrała E., Kawalec M., Paź S. and Kmita A., Met. Mat. Int. (2019) in press.
[2] Zanardi F., Bonollo F., Bonora N., Ruggiero E. and Angella G., Int. J. Metalcasting 11 (2017) 136–147.
[3] Donnini R., Zanardi F., Vettore F. and Angella G., Mat. Sci. Forum, 925 (2018) 342-349.
[4] Angella G., Zanardi F., *Proc. 73rd World Foundry Congress "Creative Foundry"* (2018) 265-266.

In situ External Reflection Infrared Spectroscopy as contactless tool to investigate artistic materials

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Infrared spectroscopy (FTIR) is a well-established and widely used analytical technique in the heritage science field. In the last two decades, the development of portable and contactless FTIR spectrometers, operating in external reflection (ER-FTIR), has allowed the beginning of non-invasive mid-infrared spectroscopy analyses on cultural heritage materials [1]. The results here presented aim to illustrate the potentialities and the drawbacks of ERFTIR in the characterization of artistic materials. As cases of study the characterization of pigments and binders in illuminated manuscripts [2, 3] and the understanding of alteration processes in modern and contemporary artworks [4] will be presented.

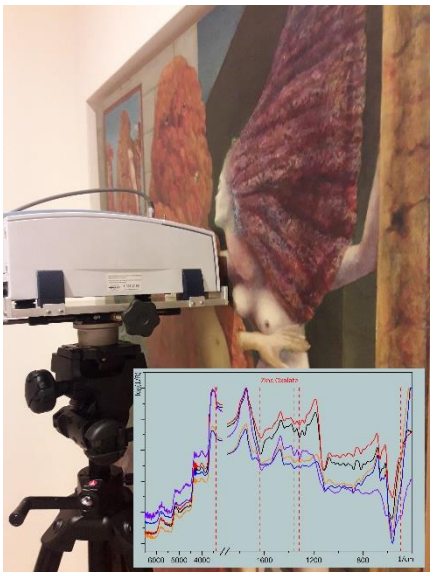

Fig. 1: *In situ* ERFTIR measurements performed on the "Attirement of the Bride" by Max Ernst (1936, Peggy Guggenheim Collection (VE) and relative spectra.

[1] Miliani C., Rosi F., Daveri A. and Brunetti B.G., Appl Phys A-Mater. 106 (2012) 295-307.
[2] Legrand S., Ricciardi P., Nodari L. and Janssens K., Microchem J. 138 (2018) 162-172.
[3] L. Nodari L. and Ricciardi P., Herit Sci. 2019, 7:7.
[4] L. Nodari, Tresin L., Benedetti A., Tufano M. K. and Tomasin P., J Cult Her. 35 (2019) 288-296.

Selective Laser Melting: an Advanced Method for Manufacturing Metallic Alloys

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Among several advanced manufacturing processes, Selective Laser Melting (SLM) is a challenging method used for the realization of 3D complex parts, starting from a micrometric powder. In this technique the scanning of a laser beam is used for melting the powder for realizing the part with a layer by layer building strategy (see Fig. 1a). Thanks to the limited size of the single liquid pool, cooling rates are high enough to induce microstructures significantly finer than the ones achievable with conventional casting methods, (see Fig. 1b) [1]. SLM process permits to manufacture parts with high complexity levels, like lattice structures (see Fig. 1c), which can be used for producing light elements with controlled porosities. Finally, some representative results regarding researches, performed at the laboratories of CNR ICMATE@Lecco, on this topic will be reported [1-3].

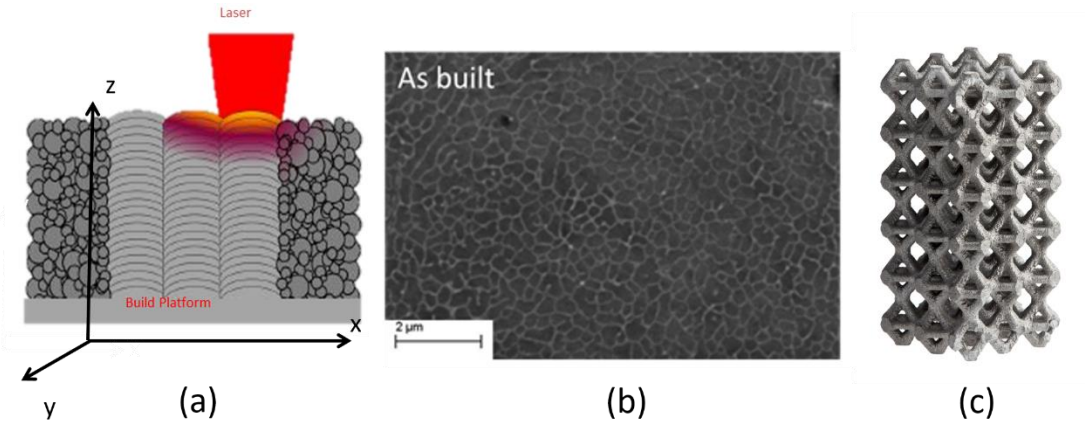

Fig. 1: Schematic of the SLM process (a); cellular microstructure of an Al-Si alloy produced by SLM (b); an example of lattice structure (c).

[1] Fiocchi J., Tuissi A., Bassani P., Biffi C.A., J. Alloys Compd. 695 (2017) 3402–3409.
[2] Biffi C.A., Fiocchi J., Bassani P., Tuissi A., Addit. Manuf. 24 (2018) 639–646.
[3] Biffi C.A., Fiocchi J., Tuissi A., J. Alloys Compd. 755 (2018) 100–107.

Non-contact 3D optical profilometer for advanced surface characterization

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Non-contact 3D optical profilometer in Genoa laboratory is used for non-destructive advanced characterization of different solid surfaces. The instrument combines the confocal, interferometry and focus variation techniques to characterize materials with different dimensions (um to cm), thicknesses and surface features. This profilometer allows to get fast surface scans with lateral and vertical resolutions ranging from few nm to several mm. The instrument is used in different research fields such as coatings preparation, corrosion analysis, surface analysis for technological applications (e.g. brazing) (Fig. 1) and cell biology due to the numerous surface parameters, classic and advanced, that are possible to obtain. Thanks to this technique is possible to confirm or find a correlation between surface morphology and surface behavior.

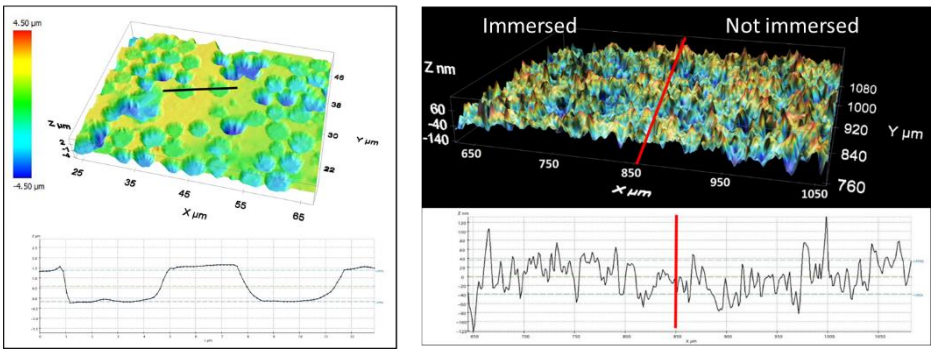

Fig. 1: Examples of profilometer measurements for surface analysis on different samples: a) SiC/SiC composite after surface modification in view of brazing process [1], b) Superhydrophobic coating after 40 days of immersion [2]

[1] Valenza F., Casalegno V., Gambaro S., Muolo M.L., Passerone A., Salvo M. and Ferraris M., Int. J. Appl. Ceram. Techn. 14(3) (2017) 287-294.

[2] Cirisano F., Benedetti A., Liggieri L., Ravera F., Santini E., Ferrari M. Colloids Surfaces A Physicochem. Eng. Asp. 505 (2016) 158–164.

Method to monitor the metallic material characteristics evolution during the shape setting treatment

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Shape setting is one of the most important aspects of Shape Memory Alloy (SMA) processing. Different strategies have been devised to adjust treatment parameters and optimise material characteristics. We present a method to monitor the advancement of shape setting non-destructively in the furnace during the whole process. The data obtained were repeatable and it has been possible to correlate consistently relative voltage values with mechanical performance and structural evolution in the material. Furthermore, it was possible to predict the type of pseudoelasticity of the annealed wire from the point along the electric resistance curve where the heat treatment was stopped. This method is being tested on more complex NiTi structures with favourable preliminary results and could be applied to other materials which require annealing or ageing treatments.

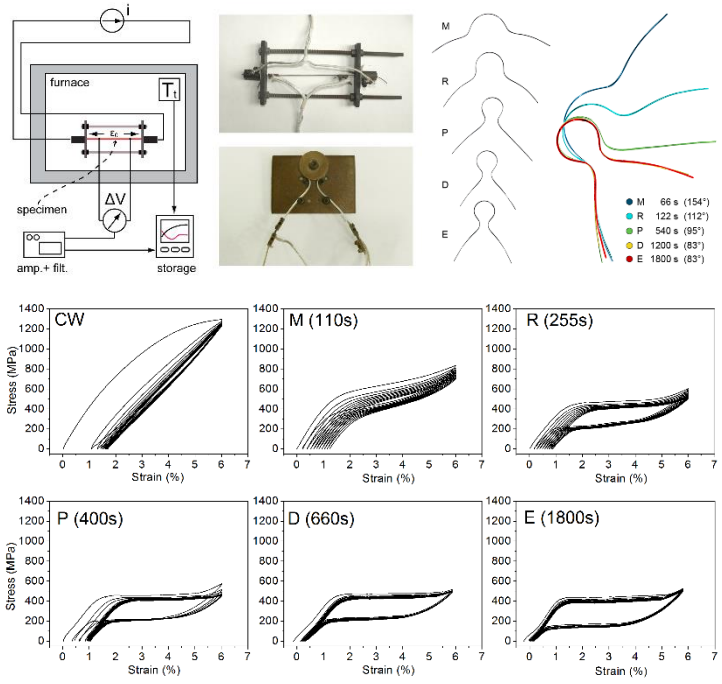

Fig. 1: *Top left,* experimental set up to monitor the shape setting of straight wire and Omega-shape geometry. *Top right,* evidences of different shape-setting durations related to the final shape. *Bottom*, corresponding mechanical properties obtained at different latencies.

[1] S.Pittaccio, L. Garavaglia, Mat. Science and Eng. A 599 (2014) 92-104.
[2] J.Pilch., L. Heller, P. Sittner., ESOMAT 2009 (2009) 05024.

Laser-induced incandescence technique: current application and future prospects

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Laser-Induced Incandescence technique is used worldwide to evaluate concentration and particle size of combustion-generated nanoparticles [1-2]. The technique involves heating the particles to the incandescence temperature, using a high-power, pulsed laser. In our lab, we have designed and developed a portable high-sensitivity instrument based on this technique and here we present an overview of the most recent applications of the instrument in field campaign for Black Carbon monitoring. Moreover, due to the growing interest on combustion-generated nanoparticles as a cost-effective material for a large variety of optical and electronic applications [3], the laser-irradiation process at the basis of the technique has been recently tested as a tool for tailoring the optical properties of such particles. The first promising results in this field will be briefly presented.

[1] H. A. Michelsen, C. Schulz, G. J. Smallwood and S. Will, Prog. Energy Combust. Sci .51 (2015) 2-48.
[2] F. Migliorini, S. De Iuliis, S. Maffi and G. Zizak, Appl. Phys. B 112 (2013) 433-440.
[3] A. Bruno, M. Commodo, S. A. Haque, P. Minutolo, Carbon 94 (2015) 955-961.

Flame Spray Pyrolysis for Nanoparticles Synthesis

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Flame Spray Pyrolysis is a widely used technology for a massive production of oxide nanoparticles with a continuous process and no need of sample post-treatment. The apparatus available in ICMATE laboratories (unit of Milan) allows the production of nanoparticles in powder as well as directly deposited on different supports, which are of wide interest in several applications, e.g. air and water treatment. By changing the experimental flame conditions, nanoparticles of different size, composition and phases can be produced.
For in-situ synthesis monitoring, different diagnostics are implemented. Laser-Induced Incandescence allows obtaining information on nanoparticles size. Flame emission intensity allows retrieving nanoparticles temperature. Fluorescence measurements are under study to discriminate nanoparticles phase (e.g. anatase /rutile in Titania nanoparticles synthesis).

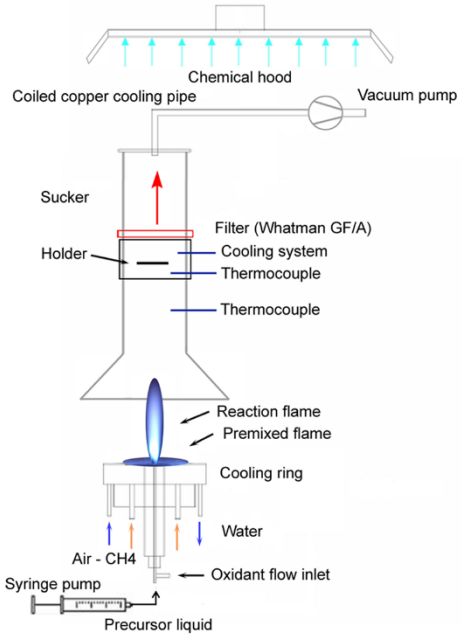

Fig. 1: Flame Spray Pyrolysis Apparatus

Research Activities on Macromolecules and Polymeric Materials

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The research activity of the ISMAC Section of Genoa is focused on: i) design, formulation, characterization and development of advanced polymeric materials (multicomponent, micro-, nanostructured) addressing process-structure-morphology-properties correlations to achieve functional and/or structural plastic materials with optimized performance for innovative applications and/or processes, e.g., food packaging [1], energy storage [2], automotive [3] (Fig. 1a) and shipbuilding [4] industry, rotational molding [5]; ii) chemico-physical characterization of biopolymers (nucleic acids, proteins, peptides) to study their interactions with different ligands (Fig. 1b), such as bioinspired nutraceuticals and drugs [6], toxic substances and pollutants [7] in various environments for applications in human health (multifactorial and degenerative diseases) and environmental monitoring.

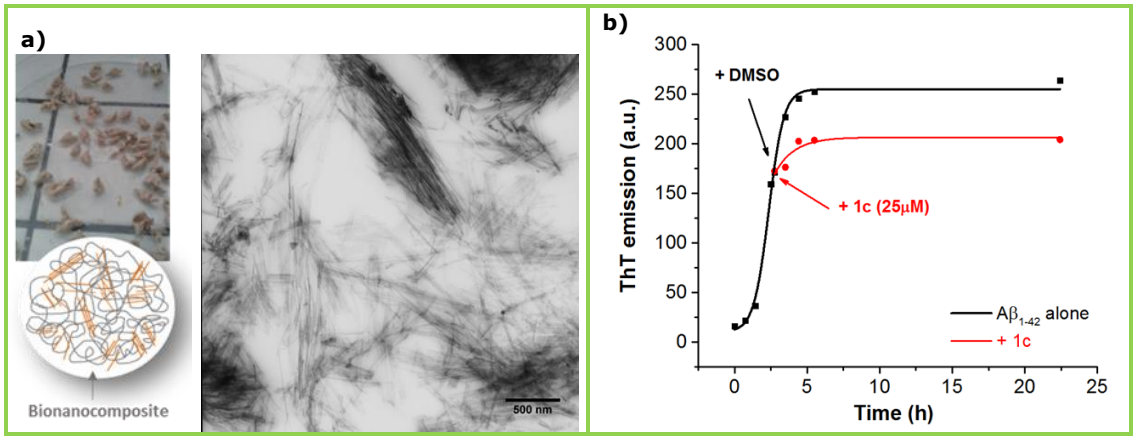

Fig. 1: a) TEM image of a sepiolite/natural rubber bionanocomposite obtained after a green flocculation process (ref. 3); b) inhibition activity of peptide-mimetics on beta-amyloid oligomerization to prevent Alzheimer disease (ref. 6).

[1] S. Losio, I. Tritto, L. Boggioni, G. Mancini, G. Luciano, L. Tofani, C. Viglianisi, S. Menichetti, M.C. Sacchi, P. Stagnaro, Polym. Degrad. Stab. 144 (2017) 167-175.
[2] E. Brunengo, L. Conzatti, I. Schizzi, C. Costa, M.T. Buscaglia, G. Canu, M. Castellano, V. Buscaglia, P. Stagnaro, AIP Conference Proceedings, Vol. 1981, 2018, Article number 020132, 9th International Conference on Times of Polymers and Composites: From aerospace to Nanotechnology; Ischia, Naples; Italy; 17-21 June 2018; Code 137840.
[3] B. Di Credico, I. Tagliaro, E. Cobani, L. Conzatti, M. D'Arienzo, L. Giannini, S. Mascotto, R. Scotti, P. Stagnaro, L. Tadiello, Nanomaterials 9 (2019) 46.
[4] G. Luciano, A. Brinkmann, S. Mahanty, M. Echeverria, Prog. Org. Coat. 110 (2017) 78-85.
[5] A. Vignali, S. Iannace, G. Falcone, R. Utzeri, P. Stagnaro, F. Bertini, Polymers 11 (2019) 624.
[6] C. Lambruschini, D. Galante, L. Moni, F. Ferraro, G. Gancia, R. Riva, A. Traverso, L. Banfi, C. D'Arrigo, Org. Biomol. Chem. 15 (2017) 9331-9351.
[7] P. Shrivastava, P.A. Mulay, P.K. Naoghare, P. Meshram, M. Farooqui, A. Bafana, P. Arrigo et al., Human Ecol. Risks Asses.: Intern. J. 23 (2017) 241-256.

Biodegradable iron based alloys: synthesis and characterization

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In recent years, biodegradable metals are gathering an increasing worldwide interest for developing temporary vascular and osteosynthesis devices. Among the studied alloys, also comprising magnesium and zinc, iron-based alloys are promising candidates, thanks to their high biocompatibility, good mechanical strength and acceptable corrosion rate. The present work briefly recollects the advances achieved in the synthesis and characterization of FeMn based alloys by the authors. Starting from the basic binary composition, ternary and quaternary Fe-Mn-x-y systems were explored in cooperation with SAES Getters (Lainate, Italy) and Laval University (Québec, Canada) in the framework of an industrial research project. The effect of alloying elements and synthesis route on microstructure, mechanical performance and degradation behavior was assessed.

[1] E. Mouzou, C. Paternoster, R. Tolouei, P. Chevallier, C. A. Biffi, A. Tuissi, D. Mantovani, Mater. Lett., 181 (2016) 362-366.

[2] B. Occhionero, C. Paternoster, C. A. Biffi, A. Tuissi, D. Mantovani, eCM Meeting Abstracts 2017 - Collection 4, 9th Symposium on Biodegradable Metals (2017)

T.A.R.A.N.T.O. project: supported TiO_2 MOCVD thin films and doped TiO_2 powders for photocatalytic water remediation

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T.A.R.A.N.TO research project (PON, ARS01_00637) aims to develop technologies suitable to generate renewable energy and the remediation of the polluted environmental compartments, thus favouring circular economy and decarbonisation practices. The proposed technologies intend to promote the transformation of wastes in renewable energy sources. ICMATE role is focused on the fabrication of supported photocatalysts based on TiO_2, both as thin films (anatase, MOCVD coatings [2]) on stainless steel micrometric nets and over-grafted modified TiO_2 nano-micro-powder (in anatase-rutile form [2]), Fig.1. This approach makes the whole support photo-active, thanks to the net MOCVD functionalisation and takes advantage from to the synergic action of the grafted powder, joined to a simplified catalyst management (easiness in placement-recovering).

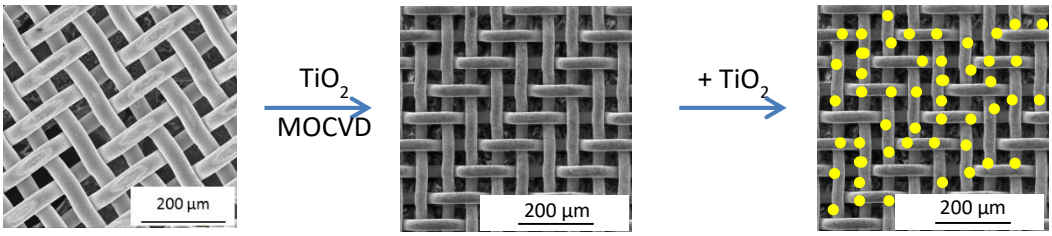

Fig. 1: Scheme of the functionalisation procedure.

[1] S. Murgolo, V. Yargeau, R. Gerbasi, F. Visentin, N. El Habra, G. Ricco, I. Iacchetti, M. Carere, M.L. Curri, G. Mascolo, Chem. Eng. J. 318 (2017) 103-111.
[2] A. Galenda, F. Visentin, R. Gerbasi, S. Battiston, N. El Habra, Water Air Soil Pollut. (2017) 228-416.

Multimaterials and metamaterials for wearable applications

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Innovative design of wearable devices for the biomedical, sports and wellness fields require new material constructs with spatially and dynamically changing characteristics, hybrid functional/structural properties, able to sense biosignals or application-related information. By a multidisciplinary approach including Materials Science, Biomechanics, Electronics and Automation, we are developing tools for the fabrication of multimaterials and metamaterials addressing said challenges. The talk will include computer-aided design techniques for complex metastructures, 3D printing of perfect-fit devices [1], assemblies of functional and sensing materials, as well as ideas for soft-robotic approaches in wearables. Alongside the devices implemented by the group, the results of collaborative work will be presented, especially in the biomedical upper-limb prosthetics and orthotics domains.

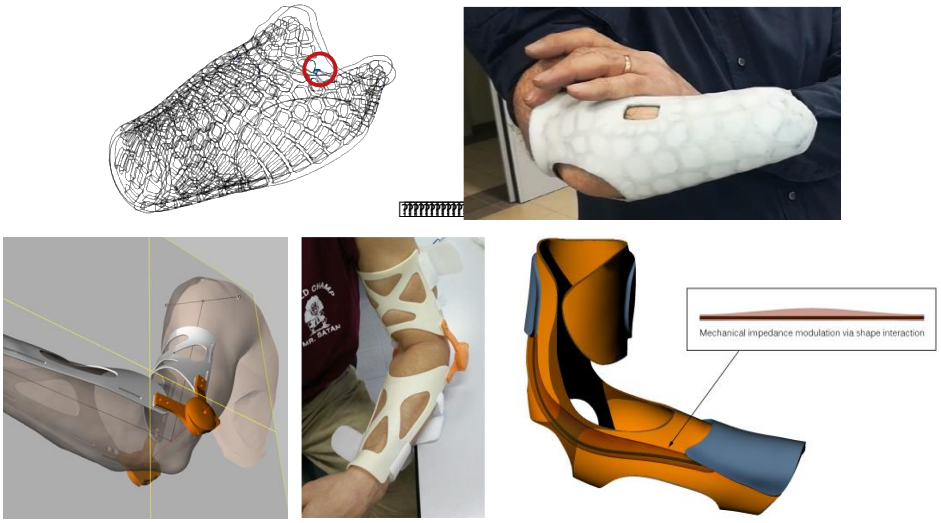

Fig. 1: *Top left*, Finite Element Analysis of an optimised anatomically-coherent metastructure for multimaterial upper-limb prosthetic sockets, showing region of possible plasticisation – open cells will receive functional materials; *Top right*, combined prosthesis metastructure and acrylic resin with thermal conductance improved by phase-change material additions; *Bottom left/centre*, virtual and 3D-printed prototype of a perfect-fit upper-limb orthosis with optimal alignment of hinges functionalised with pseudoelastic alloys; *Bottom right*: concept of shape modulation for integration of NiTi wires into a compliant orthosis.

[1] Jacopo Romanò, Lorenzo Garavaglia, Fabio Lazzari, and Simone Pittaccio, Virtual design method to exploit kinematic analysis in the making of 3d-printed upper-limb orthoses. *Proceedings of the ESB 2019 Congress,* Vienna, 7-10 July 2019 (accepted).

Growth of a compact thermoelectric generator based on multi-disciplinary approach

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Electrical power and device portability are two actual challenges of technological world. The capability of achieving a full connectivity and a smart interaction between environment and devices are two of the mainstream engines of actual technological development. Such a target requires a diffuse network of electrical power, able to support the battery needs related to mobile devices. This work wants to introduce the supply chain we are growing in the development of a novel device based on the combined action of thermoelectric effects, catalytic combustion and additive manufacturing. The device aims to support a distributed electrical low power production in a compact and light design, taking profit from the advantages offered by the embedded technologies and the expertise in processes analysis offered by the team involved in the development.

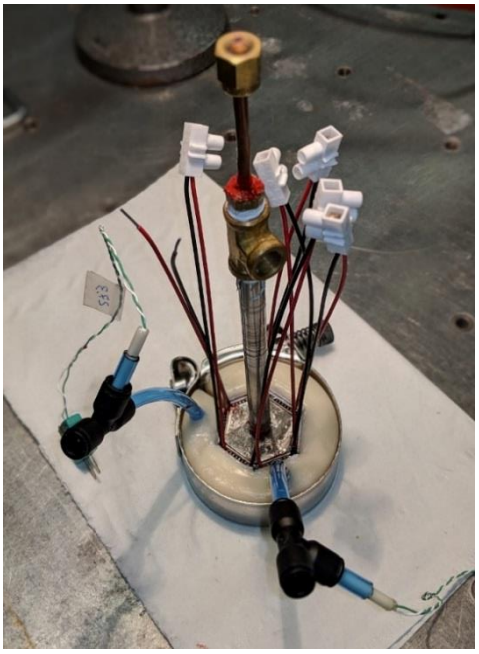

Fig. 1: The thermoelectric generator prototype ready for the characterization.

Overview on Mass Spectrometry: Description and Applications

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Mass spectrometry (MS) is an extremely sensitive and specific analytical technique, capable of providing qualitative and quantitative analytical data on nanomolar to attomolar amounts of analyte. It has been applied successfully to a very wide range of analytical problems in food and nutrition sciences, in organometallic and organic chemistry and in biomedical fields.
Among the different ionization techniques, the principles of electrospray (ES) and matrix-assisted laser desorption/ionization (MALDI) will be briefly explained and some examples of applications in food and organometallic chemistry will be illustrated to highlight the potential of this analytical technique.

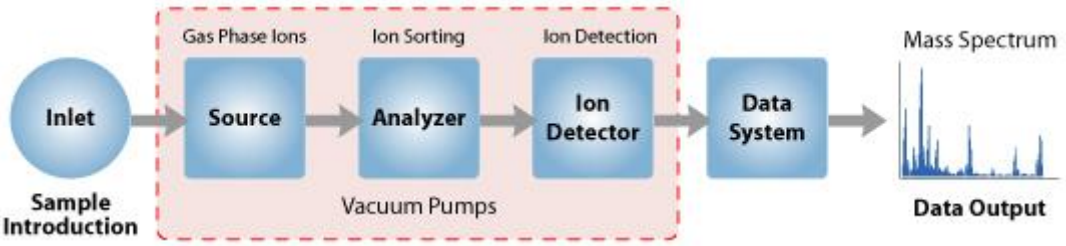

Fig. 1: Schematic of a mass spectrometer

HiPIMS: the advantages of a high ionization plasma PVD technology

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High Power Impulse Magnetron Sputtering (HiPIMS) is an advanced Physical Vapour Deposition (PVD) coating technology that combines magnetron sputtering with pulsed power concepts [1]. By applying high power pulses with low duty cycle, large fractions of sputtered atoms and near target gas particles are ionized producing an ultra-dense plasma. These features lead to high-density coatings with enhanced adhesion especially for complex-shaped surfaces, often improved toughness and reduced columnar structure. For example, it is possible to grow high hardness wear resistant coatings [2], films with improved oxidation and corrosion resistance [3], high-performance layers on temperature sensitive substrates [4], etc…This presentation is intended to clarify the potential of this technology using a few illustrative case studies.

Fig. 1: HiPIMS plasma at the Padova ICMATE laboratory

[1] Vladimir Kouznetsov, Karol Macak, Jochen M. Schneider, Ulf Helmersson, Ivan Petrov, Surf. Coat. Technol. 122 (1999) 290–293.

[2] Silvia M. Deambrosis, Francesco Montagner, Valentina Zin, Monica Fabrizio, Claudio Badini, Elisa Padovano, Marco Sebastiani, Edoardo Bemporad, Katia Brunelli, Enrico Miorin, Surf. Coat. Technol. 354 (2018) 56-65.

[3] Claudio Badini, Silvia M. Deambrosis, Oxana Ostrovskaya, Valentina Zin, Elisa Padovano, Enrico Miorin, Micaela Castellino, Sara Biamino, Ceramics International 43 (2017) 5417–5426.

[4] Valentina Zin, Enrico Miorin, Silvia M. Deambrosis, Francesco Montagner, Monica Fabrizio, Tribol. Int. 119 (2018) 72-380.

Targeted and non-targeted analysis of organic compounds by high resolution mass spectrometry

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The mass spectrometry lab of the Department of Chemical Sciences of the University of Padua is involved in numerous research projects concerning the development of new qualitative and quantitative analytical methods for monitoring organic compounds (pesticides, herbicides, drugs, metabolites and many others) in samples of environmental, food, cultural heritage and clinical origin.
In this presentation we will briefly describe one of the main research topics and potential collaborations with the CNR-ICMATE mass spectrometry laboratory. The main applications concern the identification of cyanotoxins in algae and water for human use and the development of novel mass spectrometry-based methods for the identification of protein and oil binders in paintings for cultural heritage.

Wetting and interfacial phenomena in relation to joining of advanced ceramics

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The full exploitation of advanced ceramics requires effective joining technologies for the integration of ceramic components into existing structures or for assembling them in complex shapes. When liquid media are used for joining, understanding how the liquid wets the adjoining surfaces and interfacial phenomena is essential [1]. This information must be related to the processing conditions and to the ultimate mechanical properties so as to provide the processing-microstructure-property relationships needed to optimize joining processes. In this talk, after a description of the theoretical and experimental aspects related to wetting of liquid metals, recent case studies [2-4] will be presented. The utilization of phase diagrams, as a powerful tool to design the best alloy compositions, and mechanical properties of brazed samples will be described and discussed as well.

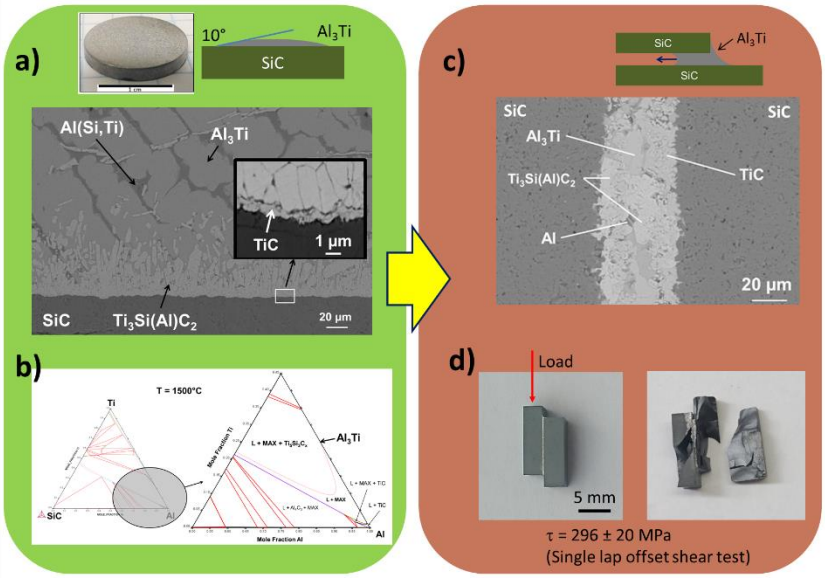

Fig. 1: Examples of the steps required for designing SiC to SiC joints: a) wetting tests; b) thermodynamic description; c) manufacturing of specimens; d) mechanical characterization

[1] A. Passerone, F. Valenza, M.L. Muolo, High temperature solid-liquid interactions in metal-ceramic brazing: a critical review. In: "Liquid metals and alloys: from structure to industrial applications" (L. Arnberg, F. Bonollo, R. Montanari eds.), Trans Tech pub. 884 (2017) 132-165.
[2] F. Valenza, S. Gambaro, M.L. Muolo, M. Salvo, V. Casalegno, J. Eur. Ceram. Soc. 38 (2018) 3727-3734.
[3] W. Fu, A. Passerone, H. Bian, S. Hu, Y. Zhao, X. Song, M. Wang, F. Valenza, J. Mater. Sci. 54(1) (2019) 812-822.
[4] S. Gambaro, F. Valenza, A. Passerone, G. Cacciamani, M.L. Muolo, J Eur. Ceram. Soc. 36 (16) (2016) 4185-4196.

Development of prefabricated panels for energy efficiency of buildings within the InnoWEE project

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Construction and Demolition waste (CDW) is one of the main sources of waste in Europe, with approximately one billion tons generated in the EU 27 every year. In this context, the H2020 project InnoWEE – Innovative pre-fabricated components including different Waste construction materials reducing building Energy and minimising Environmental impacts, started in 2016. The project is focussed on the development of prefabricated panels, made of geopolymer materials containing either inorganic or wood CDW, for the improvement of the energy efficiency of new and renovated buildings.

Fig. 1: ETICS-like (left) and ventilated façade (right) geopolymer panels, installed in the Padova demo-site

The geopolymer mixtures include 50% by weight of inorganic CDW, or either 40% or 50% of wood CDW according to their application (exterior or interior). First waste aggregates were extensively characterized to best exploit the properties of geopolymer binders. The binders were then optimized to meet the requirements of real-scale panels, such as robustness, absence of flaws, impact behaviour, etc., and were tuned to suit the needs of their upscaled production on a pilot plant, especially regarding open time and fluidity [1]. Four types of products are under development, namely ETICS-like panels for the exterior insulation of building walls, a ventilated façade panel, and two modular hydronic radiating panels for either ceiling or wall heating/cooling systems. The prototyping phase of the panels was concluded in March 2018, and the pilot production for the four demo sites located in Italy, Belgium, Greece and Romania, was concluded in March 2019. The installation in real buildings was preceded by a one-year environmental monitoring that will allow a direct comparison of the energetic performance before and after the installation.

[1] M. Panizza, M. Natali, E. Garbin, S. Tamburini, M. Secco, J. *Constr. Build. Mater.* 181 (2018) 119-133.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723916.

Multi-functional metal oxide nanomaterials for sustainable technologies, energy and environmental applications

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The controllable bottom-up preparation of multi-functional oxide nanomaterials provides a unique opportunity towards the development of innovative devices for emerging technologies. In this context, the present contribution will present a survey of selected representative results obtained in the chemical vapor deposition and/or plasma-assisted processing of transition metal oxide nanosystems. The tailoring of their characteristics underpinning advanced applications will be illustrated and discussed with particular regard to: a) Mn_3O_4 nanomaterials as solid state gas sensors for the detection of chemical warfare agents [1]; b) Fe_2O_3-TiO_2 nano-heterostructures for photoelectrochemical water splitting to yield molecular hydrogen, the prime artificial solar fuel [2], and for the sunlight-driven photocatalytic abatement of gaseous nitrogen oxides as atmospheric pollutants [3,4].

[1] Chiara Maccato, Lorenzo Bigiani, Giorgio Carraro, Alberto Gasparotto, Cinzia Sada, Elisabetta Comini and Davide Barreca, ACS Appl. Mater. Interfaces 10 (2018) 12305-12310.
[2] Davide Barreca, Giorgio Carraro, Alberto Gasparotto, Chiara Maccato, Michael E. A. Warwick , Kimmo Kaunisto, Cinzia Sada, Stuart Turner, Yakup Gönüllü, Tero-Petri Ruoko, Laura Borgese, Elza Bontempi, Gustaaf Van Tendeloo, Helge Lemmetyinen and Sanjay Mathur, Adv. Mater. Interfaces 2 (2015), 1500313.
[3] José Balbuena, Giorgio Carraro, Manuel Cruz, Alberto Gasparotto, Chiara Maccato, Adrián Pastor, Cinzia Sada, Davide Barreca and Luis Sánchez, RSC Adv. 6 (2016) 74878-74885.
[4] Giorgio Carraro, Alberto Gasparotto, Chiara Maccato, Elza Bontempi and Davide Barreca, Surf. Coat. Technol. 307 (2016) 352-358.

$BaCe_{0.65}Zr_{0.20}Y_{0.15}O_{3-\delta}$-$Ce_{0.85}Gd_{0.15}O_{2-\delta}$ composite MIEC membrane for H_2 purification

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Dense ceramic membranes based on mixed ionic-electronic conducting (MIEC) perovskites are currently attracting growing interest for their potential applications in H_2 separation membranes or in catalytic membrane reactors [1]. Indeed, in these materials a selective non-galvanic separation is allowed by incorporating H_2 in their crystal structure as charge protonic defects and electrons/holes that are transported to the opposite side of the membrane under a H_2 partial pressure gradient, *i.e.* without external power. Thanks to its good performances and suitable chemical stability under operational conditions, $BaCe_{0.65}Zr_{0.20}Y_{0.15}O_{3-\delta}$-$Ce_{0.85}Gd_{0.15}O_{2-\delta}$ (BCZ20Y15-GDC15) all-ceramic composite is considered one of the most promising MIEC-based membrane for H_2 separation at T > 600 °C [2-4].

This talk provides a comprehensive overview of the results reached by our group in such MIEC composite membrane: the preparation method, hydrogen permeability and chemical stability will be discussed.

[1] H. Wang, Et al., J. Ind. Eng. Chem.,60 (2018) 297.
[2] E. Rebollo, Et al., Energy Environ. Sci., 8 (2015) 3675.
[3] D. Montaleone, Et al., J. Mater. Chem. A, 6 (2018) 15718.
[2] C. Mortalò, Et al., J. Membr. Sci., 564 (2018) 123.

Horizon 2020-MSCA Co-funded projects: a valuable opportunity to enhance the creative and innovative potential within and beyond Europe

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Scientific research and innovation are among the most powerful forces driving economic development and social change. Yet while scientific research facilities become larger, more complex, and require more resources, funding trend for scientific research is often not increasing in many countries even as the timescale for projects. Facing with such "intimidating" technical and financial challenges, scientist can either abandon its exploratory spirit or adapt itself by fostering greater coordination and collaboration on a global scale for gaining access to complementary resources, equipment and knowledge, which fundamentally enhance the quality of their results and improve the efficiency of their work. In this context, the establishment and consolidation of cross-border new and already exhisting cooperations, within the EU and even across the globe, is one of the priority of EU research policy.
The talk aims to introduce the EU Research and innovation funding programme "Horizon 2020" for the Marie Skłodowska-Curie actions which was co-funding, by the National Science Center of Poland POLONEZ-3 call, the one-year "**SIC-WIN**: **R**eactivity of **SI**-alloy/**C**-material system: **W**etting vs **IN**filtration" Project. After a brief introduction of the project and of the Foundry Research Institute of krakow (Host Institution), the main outcomes will be pointed out mainly in terms of individual (i.e. scientific, career and personal) achievements and future perspectives of bilateral ICMATE-FRI interactions.

Acknowlegements
The authors wish to thank NCN-National Science Center, Poland for the financial support through POLONEZ project number UMO-2016/23/P/ST8/01916. This project is carried out under POLONEZ-3 program which has received funding from European Union's Horizon 2020 research and innovation program under Marie Skłodowska-Curie grant agreement. No 665778.

Improving catalytic and electro-catalytic functionality in perovskites. Can noble metals be avoided?

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Several materials exhibit high performance (particularly in catalytic and electrocatalytic applications) mainly due to the presence of noble metals. Our aim is in developing these functionalities while avoiding noble metals in a Critical Raw Materials (CRM)-free approach. Perovskites are complex and very versatile oxides of the type ABO_3 in which A is a big 12- coordinated cation from (alkali earths or lanthanides) and B is a small 6-coordinated cation, usually a transition metal. The functionality of perovskites can be developed and optimized by means of doping, nanocomposition (Fig. 1), exosolution. In this presentation all three strategies will be presented through their application to catalysis (abatement of pollutants, Three Way Catalysts and dry reforming) and electrocatalysis (in Intermediate Temperature Solid Oxide Fuel Cells and Electrolysers). In all cases, the selected strategy allows tuning oxygen mobility and exchange, surface distribution of active sites. [1-5]

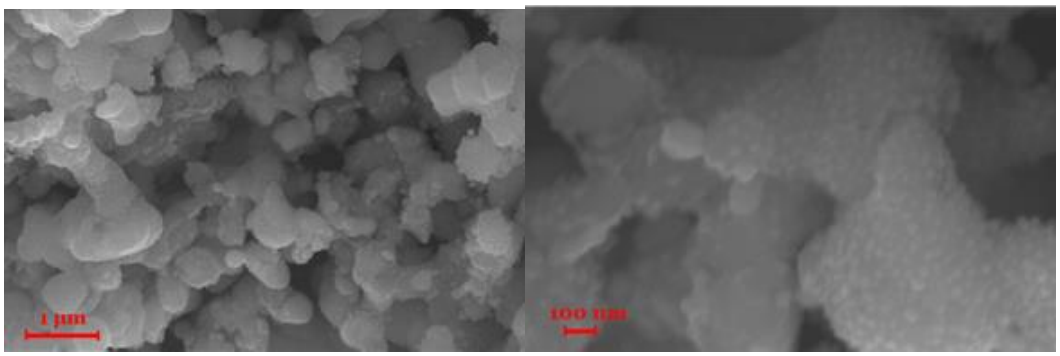

Fig. 1 SEM images of a nanocomposite obtained by depositing Ni on a $BaMnO_3$ based perovskite.

Preparation of electrocatalysts via oxide-oxide galvanic exchange reactions. New evidences on the reaction mechanism

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Metal-metal galvanic exchange reactions are well-known processes, common in fields as diverse as corrosion, metal recovery and preparation of metal nanoparticles. Analogous reactions occur between solid oxides and dissolved cations. Our group has used such reactions to convert porous PbO_2 layers, prepared by oxygen bubble templated anodic deposition, to active electrocatalysts. Using electrochemical methods, SEM-EDS and XPS, we have studied the reactions of PbO_2 with (i) a single cation, (ii) two cations used in succession, (iii) two cations dissolved in the same solution. We have obtained new evidences on: (i) the effect of the thermodynamic driving force on the growth rate of the secondary oxide, (ii) the location of the exchange reaction, (iii) the species transported through the growing oxide layer (iv) the rate-determining step of the overall process.

The commissioned research contract

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Commissioned research plays an increasingly important role among research funding types, due to the production world's demand for highly specialized technical and scientific skills. Consequently, the need to perfect contracts is becoming more and more stringent and necessary. Through such agreements, CNR researchers can share their scientific knowledge and expertise with public and private partners, in compliance with the institutional aims and mission.

However, during the negotiation of commissioned activities, researchers need a legal support leading the contracting parties to the signing of agreements that guarantee the respect of the national legislation as well as the statute and regulations of CNR.

Therefore, it becomes mandatory to establish the basis for a collaborative partnership between the research sector and the administrative legal division, providing basic information on the required essential characteristics of commissioned research contracts and particularly on the regulation in terms of management and exploitation of intellectual property.

Towards Horizon Europe: the new Frame Program for European Research

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New sensitivities grown in almost all the EU Member States (albeit with different intensities) led the EU Institutions to draft the next FP- Framework Programme for Research and Innovation (named Horizon Europe) with characteristics quite different from the previous one. The new FP is paying greater attention to the social acceptability (mainly among the civil society and the companies) of the increased funds that the next Multiannual Financial Framework assigns to Research & Innovation. The main task of Horizon Europe is therefore very much focused on the co-creation of "Jobs and Growth". The possibility to reach these targets is still under debate and many are the criticisms coming from researchers who see Horizon Europe unbalanced in favour of short-term technology innovation and financial instruments against a consistent support to (true) research actions and long-term knowledge production. However, a more shared opinion in Brussels positively evaluates the overall structure of Horizon Europe and the newly considered thematics (i.e. security and defence, Artificial Intelligence, ...) that can open new funding lines for the public research performing organizations.

The laboratory of Tensiometry: where emulsions and foams are shaping up

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The present lecture aims at showing how the investigation of the interfacial properties of systems containing surface active agents represents an important tool for advancing in different applied fields. In fact, the study of the dynamic and equilibrium interfacial tension and of the dilational viscoelasticity are strictly related to the formation and stabilization of foams and emulsions, which enter in several scientific and technological topics. As examples, in our laboratory these techniques are applied as support in ophthalmology for avoiding the emulsification during vitrectomy, in cosmetics and foods for obtaining biocompatible products, in biomedicine for understanding the interactions between pulmonary surfactant and particles, for the production of new materials.

Experimental methods for the determination of macro- and micro-structural properties on materials for industrial applications

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The possibility of technology transfer and the innovation level of a materials research design should take into account experimental techniques able to describe and foresee the material properties during its possible work conditions. For this reason the work presents experimental methods for the mechanical characterization (e.g. fatigue test and creep test) of materials, correlated to suitable micro-structural analysis capable of explaining the occurred phenomena. In particular instrumentations, procedures and research examples are shown, in order to highlight the scientific/technologic advantages and opportunities of the presented facilities.

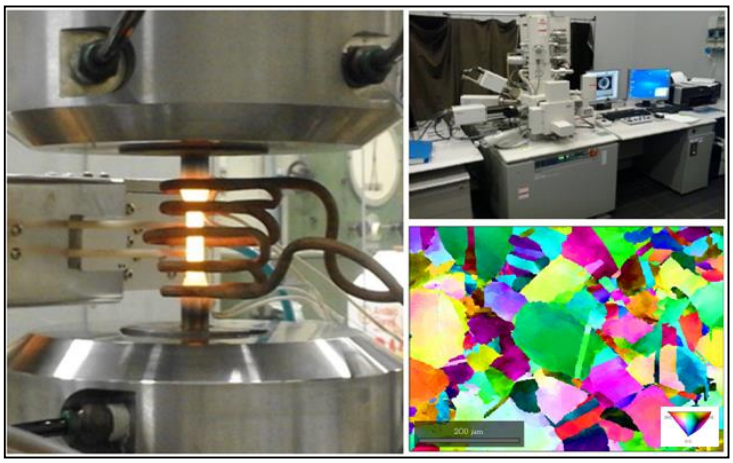

Fig. 1: characterization of metal materials subjected to high temperature and stresses

Porous metal electrodes prepared by electrodeposition with simultaneous hydrogen evolution

Luca Mattarozzi, Sandro Cattarin, Nicola Comisso, Paolo Guerriero, Rosalba Gerbasi, Marco Musiani, Lourdes Vázquez-Gómez and Enrico Verlato

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A practical preparation method of porous metal electrodes with high specific surface area is the so-called dynamic hydrogen bubble templated (DHBT) electrodeposition [1]: the metal (or alloy) layer is obtained applying a large cathodic current, causing a vigorous evolution of hydrogen bubbles that provide a temporary confinement of metal deposition. The resulting morphology shows large surface area and hierarchical porosity. Moreover, the approach is simple, fast and easily applied to deposition of various metals/alloys on substrates of different shape and dimension. We report here on the preparation of various porous materials and their applications: Cu-Ni alloys, used as cathodes for reduction of nitrates in alkali [2]; Ag, tested in the electrochemical detection of H_2O_2[3]; Zn-rich Cu-Zn alloys, used as alternative anode materials for Li ion batteries [4].

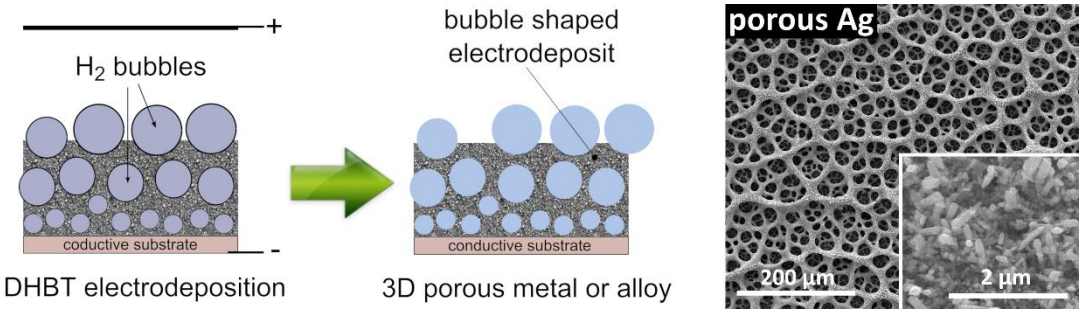

Fig. 1: left: scheme illustrating the operating principles of DHBT method and right: typical morphology of metal or alloy obtained by DHBT (porous Ag).

[1] B. J. Plowman, L. A. Jones and S. K. Bhargava, *Chem. Commun.* 51 (2015) 4331-4346.
[2] L. Mattarozzi, S. Cattarin, N. Comisso, A. Gambirasi, P. Guerriero, M. Musiani, L. Vázquez-Gómez and E. Verlato, *Electrochim. Acta* 140 (2014) 337-344.
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Understanding the behavior of high performance aluminum alloys: the importance of multiscale analyses.

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It is well known that the behavior of metals depends on their microstructure: not only grain size, but also other features are important for the mechanical and other properties of metals. A detailed analysis of microstructure is fundamental to identify them, from mm down to nm size. The cooperation between institutions with different facilities is of utmost importance to get the complete overview of what's going on inside the material: suitable European project as well as other national funding programs are very important to foster such collaboration. In this presentation the integration of results of different microscope analyses (optical microscope, SEM, TEM) together with related analytical techniques are presented to describe the evolution of the mechanical properties of new aluminum alloys developed for high temperature applications, during service.

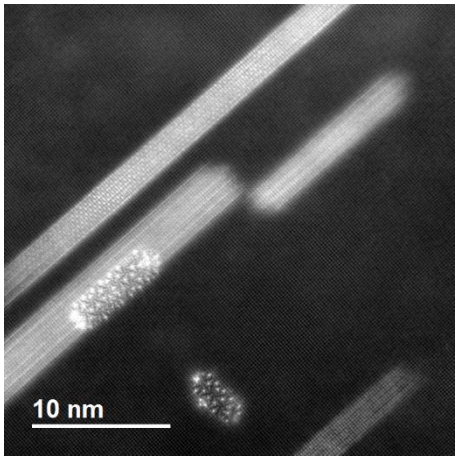

Fig. 1: HR-TEM images of reinforcing particles in crept aluminum sample, observed with beam aligned along <100>□ direction of the matrix (FELMI-ZFE centre in Graz, Austria).

Acknowledgements - The research leading to these results has received funding from the European Union Seventh Framework Programme under Grant Agreement 312483 - ESTEEM2 (Integrated Infrastructure Initiative II - DRAGON-Aloa proposal, and Tagifal proposal), and from National Research Council of Italy (CNR) within the framework of the Short Term Mobility program (2016 and 2018 calls).

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Hydrothermal synthesis: a natural process exploited for the synthesis of compounds with controlled size and morphology

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Hydrothermal processes are of great relevance in nature, being among the ways in which rocks and minerals are formed or transformed: the term hydrothermal is in fact of geological origin. The study of mineral genesis and transformation has been the driving force for the earlier studies of crystallisation mechanisms, followed by the interest in the formation of synthetic gems, like emerald and ruby. However, today the number of synthetic compounds exceeds the variety of phases reproduced from nature. The hydrothermal process is, in fact, unique for the synthesis of new phases, as well as for the control of size and morphology of the produced crystals. We will show examples of systems that can be synthesised in the laboratory with good control over particle morphology, as well as new emerging processes to obtain dense ceramics at low temperature.

Thermo-mechanical analysis: from calorimetric measurements to dynamic thermo-mechanical characterization for a complete investigation of microstructure and functional properties of materials

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In ICMATE Lecco laboratories there is a complete series of instruments for calorimetric and mechanical characterisation: DSC, MDSC, TG/DTA and different kind of equipment to test the material in various mechanical configurations, in static and dynamic condition. Moreover a possibility to prepare ad hoc set up for particular investigations is also available. The combination of these measurements and the correlation among the information obtained from thermal and mechanical studies give a powerful way to understand in deep the properties of material and to design new systems with improved functional performances.

Gasdynamics of Propulsion Systems Lab

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Within the framework of a cooperation agreement between Politecnico di Milano, Dept. Aerospace Science and Technology, and CNR-ICMATE, a high enthalpy pulsed hypersonic tunnel, developed in the CNR-ICMATE labs, is used to simulate flight conditions suitable for "airbreathing" propulsion for flight Mach numbers from 3 to 8. The maximum size usable test section allows tests on components or subscale full engine models, and is located inside a large vacuum chamber capable of hosting auxiliary systems and diagnostics for measurements of forces, pressures, and temperatures. When complete engine models are operated, propulsive parameters such as combustion efficiency, thrust and specific impulse can be obtained. Studies have been carried out on hypersonic air intakes [1], geometries and injection systems of ramjet engines [2, 3, 4] and, more generally, combined cycle propulsion systems (e.g., Rocket Based Combined Cycle engines).

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Nuclear Magnetic Resonance, a versatile and powerful spectroscopy

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NMR spectroscopy since its inception in 1946 has accompanied the progress of science by constantly improving its performance and fields of use. Currently the "family" of Nuclear Magnetic Resonance (NMR) techniques includes the NMR spectroscopy in solution, the Solid State NMR (SSNMR) and NMR imaging (Magnetic Resonance Imaging, MRI). In our institute the first technique has been present since 1975 and five years ago the Solid State NMR has been added to have a deep insight on material science. In this brief presentation we will illustrate the fields of use of this powerful spectroscopy, the investigative techniques used and the facilities present in our Institute.

Studying and developing inorganic and organic materials and their interfaces by computational methods.

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Computational methods are now a key piece in the toolbox available to researchers in chemistry and in materials science. In fact, they give access to a different perspective in the understanding and description of chemical systems and allow to build a rationale behind the behavior of such systems, thus helping the development of new materials with desired properties. In this communication, we will present a few examples of successful application of Density Functional Theory (DFT) to chemical problems, such as the calculation of physico-chemical properties of inorganic oxides, the study of reactivity at the organic/inorganic interface, and the prediction of the thermodynamic stability of metal alloys.

Phase Change Materials Emulsions for heat transfer and storage applications

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Phase change material emulsions (PCMEs) or phase change slurries have risen interest in scientific community in the last years as potential heat transfer and heat storage fluids [1]. These systems consist on a base fluid, which, basically, is a suitable heat transfer fluid, and an emulsified phase change material that should be immiscible with the base fluid. The idea is to exploit the latent heat of melting and crystallization of PCM to increase the thermal energy storage capacity of the base fluid that from the other side confers higher thermal conductivity and lower viscosity with respect to PCM. Moreover, the large interface between base fluid and PCM favors the heat transfer between the two phases. The applications and the temperature ranges investigated so far include solar thermal storage, waste heat recovery and heat transfer.

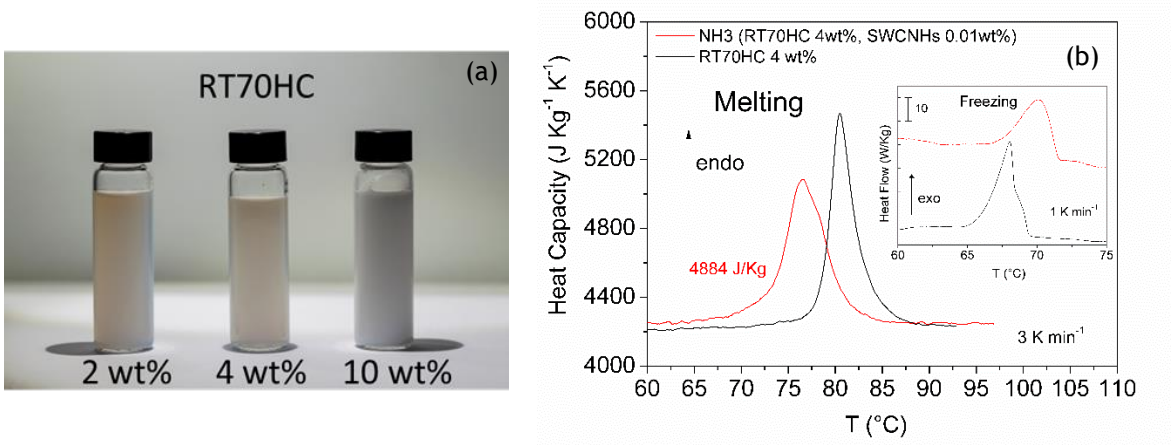

Fig. 1: Typical PCMEs samples (a) and Differential Scanning Calorimetry profiles (b).

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Heavy metals and radionuclides presence and mobility in food and environment: some recent research activities

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Geological features, energy production, waste management and nuclear weapon tests could affect the radioactivity content of many natural and anthropogenic matrixes to which we are exposed. The Environmental Radiochemistry group at CNR-ICMATE is specialized in radionuclide analysis and in studies of radioactivity distribution and mobility among natural ecosystems, industrial settings, waste products and food. In this work we show the results obtained in the last years about radioactivity content in thermal waters and mud [1], in drinking water, in several food [2-4] (meat of wild and bread animals, food supplementation, marmalade/jams) and waste products [5,6] (phosphate fertilizer industries and urban wastewater). In a companion poster, the methods and the instruments used to detect ultralow activity concentration are further described.

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POSTERS

Deposition of AlTiN Thin Films onto Additive Manufactured Parts in Ti6Al4V Alloy

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This work reports the preliminary results of AlTiN hard coating deposition process carried out via reactive Physical Vapor Deposition High-Power Impulse Magnetron Sputtering (PVD HiPIMS), with the aim of improving the surface features of Ti6Al4V substrates, realized via Selective Laser Melting (SLM). Additive manufacturing (AM) is a bottom-up technology that could be the answer to particular needs, supporting the rapid fabrication of components with complex shapes. The choice of Ti-6Al-4V alloy is justified by the spread use of this alloy in several fields, such as the biomedical and aerospace ones [1]. On the other hand, AlTiN based hard films are widely used in many industrial applications (such as cutting tools, aero-engine sector, bio-implants, etc.) for their excellent wear and corrosion resistance properties up to 900°C [2–6]. In particular, two different SLM process conditions were employed for modifying the obtained part surface morphology and, later, the samples were heat treated in high vacuum. The conditions of the deposition process were adjusted in order to optimize the matching between the metallic substrate and the ceramic coating (Fig. 1).

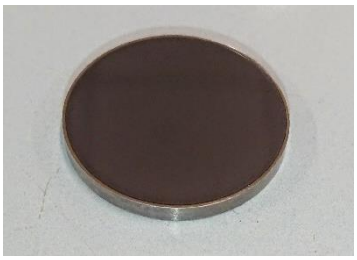

Fig. 1: AlTiN coating onto Ti6Al4V disk realized by SLM.

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Microstructural and mechanical characterization of superalloys processed through advanced manufacturing technologies

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In the industrial field of metal materials production, advanced manufacturing processes represent challenging processing where the laser process induces peculiar microstructures by rapid cooling. This can promote significant and crucial modifications of the mechanical properties of the wrought materials. Therefore, in order to verify the suitability of the semi-finished/final products on the foreseen heat treatments and/or work conditions, the analysis of the micro-structural features and their evolution depending on the process parameters is fundamental, in particular about Fe-Ni and Ni based superalloys. In this context the present work shows methodologies and results regarding of two superalloys, Inconel 625 and 718 , subjected to laser welding and selective laser melting, respectively, which are currently under study within laboratory facilities of the ICMATE institute.

Mechanical characterization of thin films

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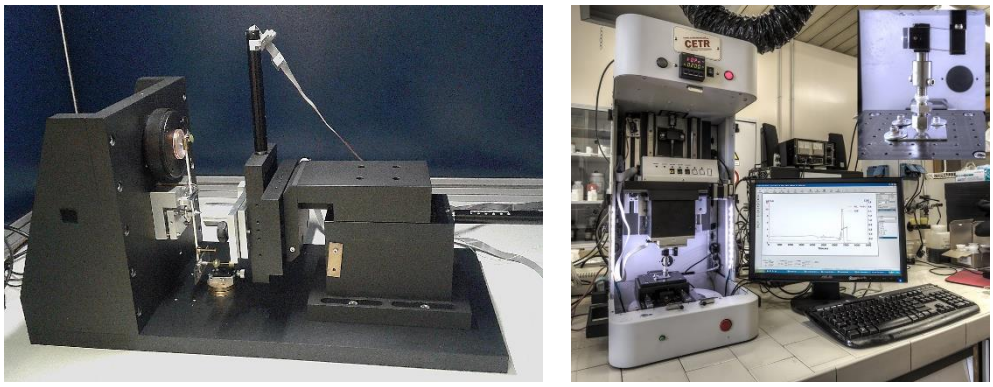
For a satisfactory mechanical stability, some properties of coatings are essential, i.e. elastic modulus, hardness, interfacial adhesion, and fracture toughness. The recent interest in studying mechanical properties at nanoscale is motivated by the increasing demand for miniaturized engineering, development of nanostructured materials, thin film technology, and surface science. Only few existing technologies lead to perform such measurements, and nanoindentation is the leading candidate, thanks to fast, simple and economical operation, without any surface preparation [1-4]. Beyond nanoindentation, quantitative data on film adhesion and toughness can be obtained by tribology, by means of microindentation and scratch tests, together with the simultaneous characterization of corrosion and wear behaviour that is crucial for coatings operating in harsh conditions [5].



(a) (b)

Fig. 1: (a) Nanotest instrument and (b) tribometer at ICMATE laboratory in Padova

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Exploitation of Atomic Layer Deposition (ALD) technique for the synthesis of inorganic nanostructured thin films

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Atomic Layer Deposition (ALD), belonging to Chemical Vapor Deposition (CVD) techniques, is an attractive process for the manufacturing of nanostructured thin films, with thickness down to a fraction of a monolayer. It is a powerful and unique technique that has achieved a lot of interest: it allows the deposition of high quality thin films with atomic level control and high conformal coverage even on complex shaped surfaces [1]. The advantages of ALD method include low impurity content, pinhole-free deposition, and low processing temperature (LT-ALD), so permitting the employment of temperature-sensitive substrates [2]. The basics of the technique and an overview of its potentiality are here presented.

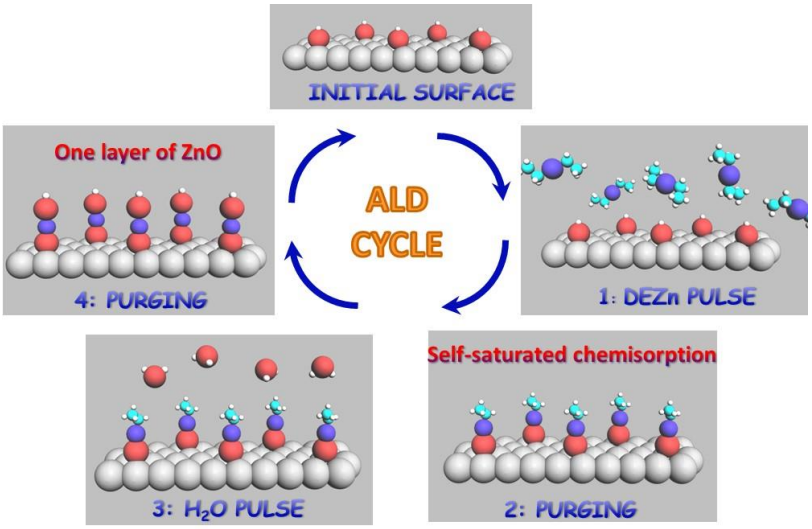

Fig. 1: Schematic representation of a two-reactant ALD growth of ZnO from diethyl zinc (DEZn) and H_2O.

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Selective Laser Melting of Aluminum - Silicon based alloys

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Selective Laser Melting, belonging to the family of additive manufacturing techniques, is based on locally melting and solidifying small volumes of powder. As a consequence, the extremely high heating and cooling rates, which are experienced by the material, induce deep microstructural differences with respect to conventionally produced parts. Moreover, precipitation phenomena are deeply modified in terms of thermodynamic and kinetic behavior. Therefore, the thermal treatments usually applied to cast aluminum alloys shall be modified in order to be adapted to the peculiar properties of the SLM built parts. The present poster recollects the achievements obtained in the last few years in proposing dedicated thermal treatments for aluminum – silicon alloys produced by SLM [1-4].

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Design of competitive light-weight composites: Interfacial phenomena at the Si-Ti/C and Si-Ti/SiC interfaces

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Highly-dense, nearly net-shaped SiC/$TiSi_2$ composites (Fig. 1) effortless produced by reactive infiltration of liquid Si-16.2at%Ti eutectic alloy into bimodal SiC_p-C porous preforms under an atmosphere, are presented. Such composites might be promising candidates as light-weight advanced materials for construction and assembling of lightweight transportation systems such as aircraft, high-speed trains or even for the construction of satellites. Following the MS paradigm (Processing, Microstructure, Properties, Performance) such achievement was successfully obtained by a previous investigation of wetting characteristics, reactivity, interfacial properties and thermodynamics concerning Si-Ti/C-based and Si-Ti/SiC systems. In particular, all the possible factors (methods, operating conditions) affecting within the process the final microstructure will be pointed out.

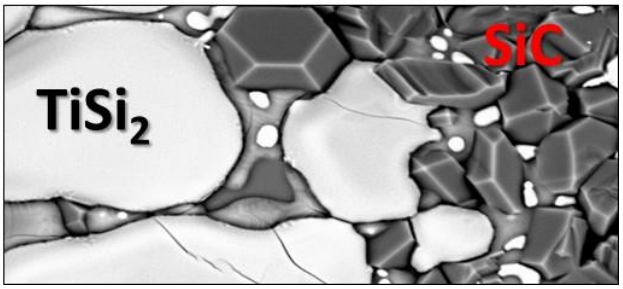

Fig. 1: SEM image of SiC/$TiSi_2$ fabricated by Liquid Reactive Infiltration

Acknowlegements

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Material Science in Space: a study of surface properties of Cu-Zr based glass-forming alloys

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The ESA-MAP* THERMOPROP project aims to measure and analyze the thermophysical properties of liquid metal alloys over a range of high temperatures. The THERMOPROP International team has the opportunity to perform measurements on the International Space Station (ISS), optimally sharing the use of the Electro Magnetic Levitation (EML) facility. In parallel, terrestrial measurements are performed to indicate the magnitude of corrections and giving the scientific basis for the properties modelling. As part of this project, the ICMATE team studied surface tension and surface segregation of liquid Cu-Zr alloys [1] and determined new surface tension data, measured by the sessile drop method [2]. In particular, the new surface tension values of the $Cu_{50}Zr_{50}$ alloy were compared with the available literature data, with model predicted values of the model as well as with the corresponding data recently obtained in microgravity on board of ISS [3].

*European Space Agency-Microgravity Application Programme. THERMOphysical PROPerties of Liquid metals for Industrial Process Design

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Correlation between Creep and Relaxation Behaviour in a Cr Martensitic Steel

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A constitutive equation, with parameters derived from the interpolation of primary and steady state stages of constant load creep curves, has been utilized to estimate the stress relaxation behavior of a martensitic steel alloy utilized in turbine power plants. Creep and stress relaxation tests have been performed at 350°C, temperature close to the negligible creep temperature of the studied alloy for stresses of interest for engineering applications. After a stress relaxation period, each specimen was generally reloaded at the initial stress and a new relaxation test, on the same specimen, was carried out. This “reloaded procedure”, simulating the re-tightening of bolts during maintenance interval of turbine, has been repeated several times. The proposed equation has shown to well predict the experimental creep and stress relaxation behavior of the steel under investigation.

1D-Zigzag Lanthanides Coordination Chains endowed with temperature dependent luminescence

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In last years Lanthanide-based Coordination Polymers (LCPs) have been increasingly employed as self-calibrated luminescent molecular thermometers due to lanthanides unique luminescent properties [1]. However, the rational design of LCPs is an intriguing challenge still far from be rationalized and hampered by the hight coordination number of these ions and their lability. Recently, we developed a convenient and high-yield synthesis of high luminescent mono-dimensional CPs based on lanthanide β-diketonate complexes as nodes and 4,4'-bipyridine (bipy) as unique connector with molecular formula $[Ln(dike)_3(bipy)]\cdot(toluene)$ [2]. We studied the temperature effect on the photoluminescence properties of $[Eu(HFA)_3(bipy)]\cdot C_7H_8$, $[Tb(HFA)_3(bipy)]\cdot C_7H_8$ (HFA= hexafluoroacetilacetonate) and their mixtures having different Eu/Tb molar ratios finding composition dependent thermometric properties influenced by Tb^{3+}-to-Eu^{3+} energy transfer processes.

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The influence of polar order on the photoluminescence of Eu:$BaZr_xTi_{1-x}O_3$ ceramics

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The ability to tune and enhance the properties of luminescent materials (phosphors) is essential for optimizing the performance of devices and understanding the luminescence mechanisms. Eu^{3+} was used as a local structural probe for studying the impact of ferroelectric order and, more generally, of polar order on the photoluminescence of the model $BaZr_xTi_{1-x}O_3$ perovskite (x = 0-1). The polar order evolves from long-range order typical of classic ferroelectrics (x = 0-0.15), via a diffuse transition behaviour (x = 0.15-0.25), to short-range order typical of relaxors ($x \geq 0.25$) until the paraelectric state of $BaZrO_3$ is achieved. The cooperative polar interactions existing in the lattice ($x < 1$) promote the off-centre displacement of Eu^{3+} determining a change of the lanthanide site symmetry and, consequently, an abrupt variation of the photoluminescence emission with temperature.

From a molecule to a thermometer: design and development of temperature sensitive materials

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Temperature measurements are very important in different research fields ranging from engineering to life sciences. In the last few years, particular attention has been posed on the development of luminescence thermometry, a semi/non-invasive technique that exploits luminescence to determine the temperature [1]. Herein, we present a family of molecular thermometers based on europium antenna complexes $[Eu(\beta_x)_3(L_c)_2]$, where the β-diketonato ligands act as Eu^{3+} emission sensitizers. The luminescence and thermometry studies highlight that the thermometric response of the system varies with the co-ligand L_c (triphenylphosphine oxide and ethanol). In particular, vibrational quenching, associated with the presence of OH groups, has a boosting effect on the thermometric response, giving systems with a good thermal sensitivity in the range 240-320 K.

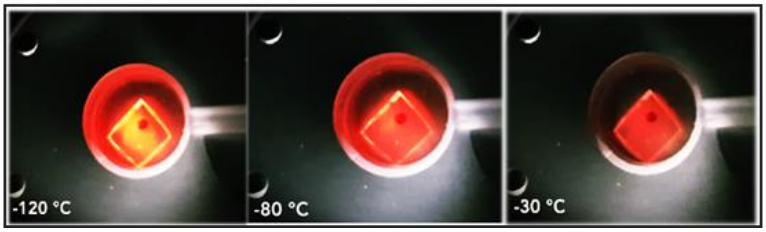

Fig. 1: temperature effect on luminescence emission intensity of $[Eu(\beta_x)_3(L_c)_2]$.

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Amphiphobic coatings with self-cleaning properties for photovoltaic panels

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Solar modules are subject, in addition to the endogenous phenomena of the module, to various factors that reduce their performance such as progressive dirtying of glass by deposition of fine particles, liquid or solid organic components and dew formation.
Highly hydrophobic and oleophobic (amphiphobic) coatings can be used as an effective solution to reduce the negative effect due to surface alteration thanks to the "self-cleaning" effect both with water and oily liquids, allowing to prevent the penetration into the surface cavities of powders, particulate, organic residues as well as the formation of dew.
In this work, easily applicable and high transmitting amphiphobic coating have been prepared, characterized and tested for its employ on solar panels. Preliminary wearing, thermal stress and durability test have been also performed.

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Acknowledgement:
ANFISOL-Design and development of superamphiphobic coatings with self-cleaning properties for photovoltaic panels (ID ROL 20718) funded by the Fondazione Bancaria Compagnia di San Paolo, Torino.

Synthesis and characterization of new fillers for antifouling coatings via incorporation of the zosteric sodium salt in silica nanocapsules

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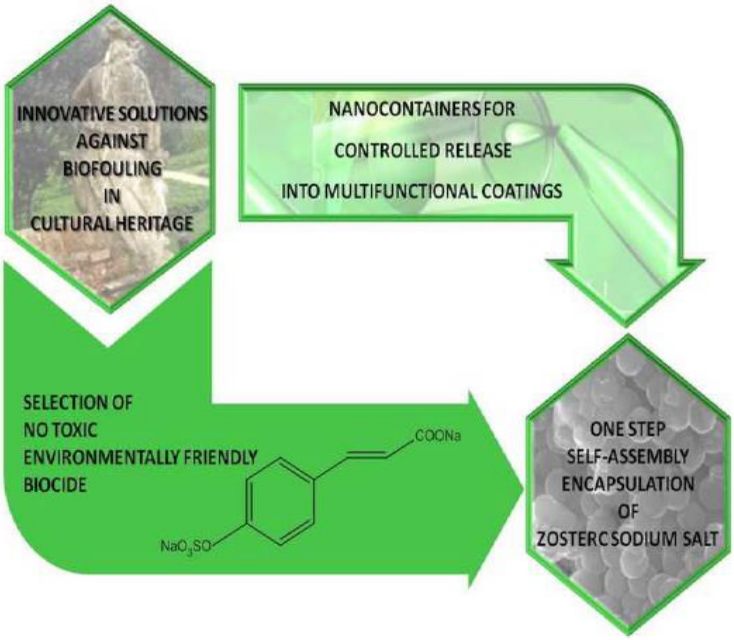
This work (scheme 1) reports, for the first time, the synthesis and characterization of silica nanocontainers loaded with a natural product antifoulant, the zosteric sodium salt which is a non-commercial and environmentally friendly product with natural origin. The synthesis approach is a single step dynamic self-assembly with tetraethoxysilane (TEOS) as silica precursor. The structure of these silica nanocontainers provides loading capacity and allows prolonged release of biocide species. The obtained nanocapsules have been characterized morphologically by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The encapsulation was checked by FTIR ATR spectroscopy and thermogravimetric analyses. The results of the release studies show the great potential of the here presented newly developed nanofillers in all applications where a controlled release of non-toxic and environmentally friendly biocides is required.



Scheme 1

Technology Transfer and Third Mission Activities

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Giorgio Luciano, Cristina D'Arrigo, Michela Tassistro

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Various technology transfer and third-party activities are carried out in collaboration with industries on the basis of useful knowledge and consolidated expertise developed over years on: i) synthesis of monomers, oligomers and polymers, addressing reaction/curing mechanism and kinetics; ii) melt blending and compounding to produce blends, micro- and nanocomposites (Fig. 1a); iii) surface modification of polymers, fillers, fibers and other substrates to improve phase adhesion; iv) molecular, structural, spectroscopic, thermal, mechanical characterization of polymeric materials; v) morphological and morphometric analysis of micro- and nanostructured polymer systems by optical and electron microscopy.

In parallel, different actions and public engagement tools have been developed to 'Communicate the Research in 3D (Dissemination-Divulgation-Diffusion)' in unconventional contexts related to the territory (productive activities, research bodies, schools, institutions) to involve stakeholders (citizens, students, policy makers) setting up activities and interactive laboratories in technical events, dissemination Festivals, etc. (Fig. 1b).

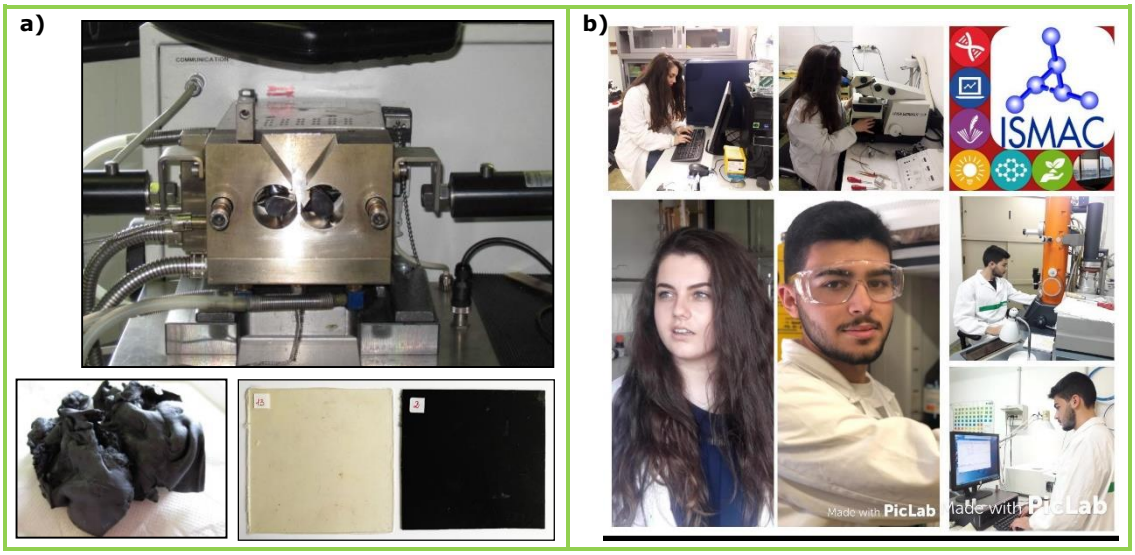

Fig. 1: a) Rubber-based materials obtained by compounding in a Brabender mixer; b) MIUR's Alternanza Scuola Lavoro activities.

[8] Vv. Aa., ISMAC-Genova Reports on: "Characterizations by TEM, SEM, DSC, TGA, GPC, etc. of polymeric materials" and "Formulation and preparation of polymer blends and compounds" for enterprises, industries and other public research institutions (from 2008 to date).
[9] M. Tassistro, "Rendiconto_Attività Terza Missione 2016-ISMAC-Genova".
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Sulfur-Based Polymers from Inverse Vulcanization as High Refractive Index Materials for Planar Photonic Crystals

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In recent years novel polymeric structures, named IV-Ps because obtained by means of a how efficient as simple process termed Inverse Vulcanization (IV), and having high contents of S-S bonds (50–80 wt% Sulfur) have been proposed as very high refractive index materials (n∼1.8) also possessing excellent transparency in the NIR spectral range [1,2]. Such Sulfur-based polymers appear particularly intriguing from the applicative point of view being self-healing, very stable on standing and processable as the common thermoplastics.
PIVOT project intends to exploit the IV process as a simple, efficient and promising method of using Sulfur (a by-product of gas and oil industry) in the design and development of new functional polymeric materials suitable for the fabrication of devices based on planar photonic crystals [3], such as dielectric mirrors and microcavities emitting in the NIR region.

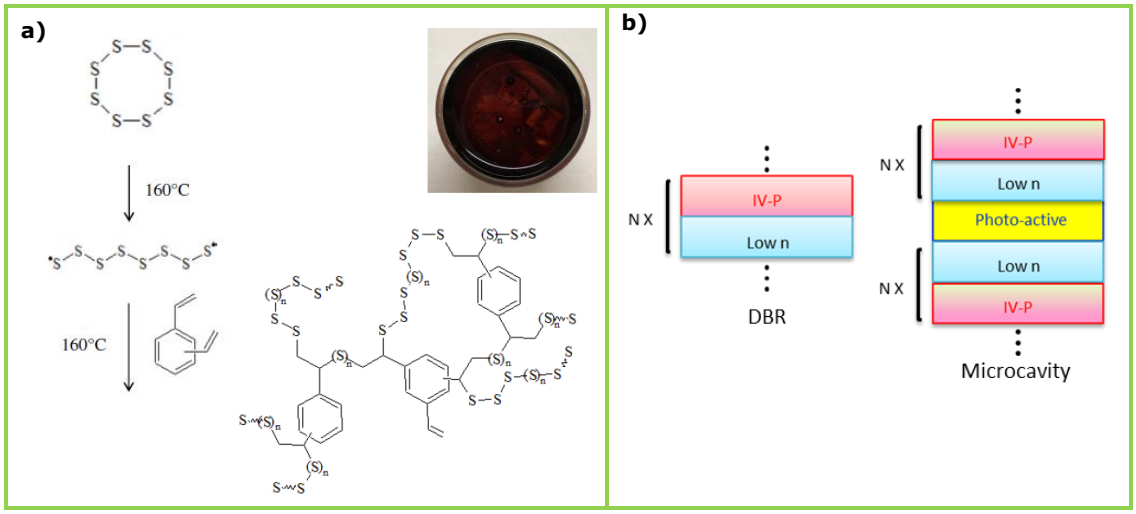

Fig. 1: a) Scheme of Inverse Vulcanization process; b) Distributed Bragg Reflector and planar microcavity structures based on IV-Ps.

Acknowledgment: Project "PIVOT - Sulfur-based Polymers from Inverse Vulcanization as high refractive index materials for planar photonic crystals: dielectric mirrors and microcavities" (IDROL 20583) funded by Fondazione Bancaria Compagnia San Paolo.

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[14] Organic and Hybrid Photonic Crystals, Ed. D. Comoretto, ed. 1, Springer International Publishing (2015) XXI, 497.

Polyaniline-based thermoelectric materials

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The investigation of conductive polymers such as polyaniline (PANI) as active materials for thermoelectric generators in the room temperature range is gaining interest because of several key advantages offered by these materials. Their versatility towards different processing techniques together with low density and low thermal conductivity make conductive polymers suitable for integration in a thermoelectric generator[1-4]. In this work, PANI-based nanocomposites with carbon particles such as single wall carbon nanohorns (SWCNHs) and inorganic thermoelectric chalcogenides were considered as composites thermoelectric materials for room temperature energy harvesting.

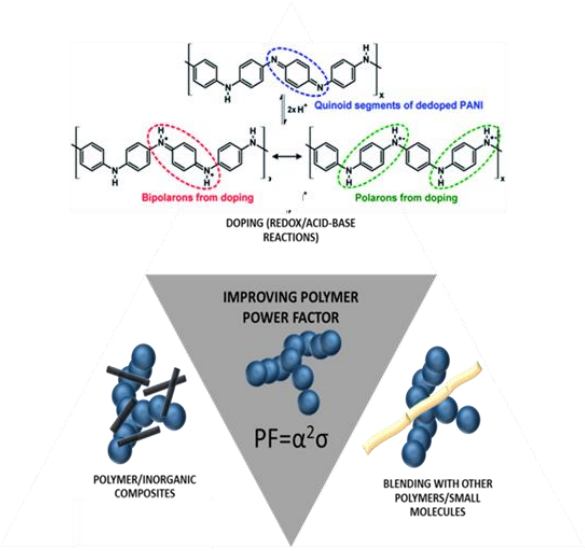

Fig. 1: Strategies for optimization of polymer based thermoelectric materials.

[1] O. Bubnova, Z.U. Khan, A. Malti, S. Braun, M. Fahlman, M Berggren, Nat. Mater. 10 (2011) 429–433.
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[4] X. Guo, M. Baumgarten, K. Müllen, Prog. Polym. Sci. 38 (2013) 1832–1908.

Electrical and thermal characterization of thermoelectric materials and devices

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The transition from laboratory research on thermoelectric (TE) materials to industrial modules development requires the correct measurement of material properties and device performances [1]. A custom built apparatus has been developed to measure the Seebeck coefficient and electrical conductivity of bulk thermoelectric materials as a function of temperature. A second instrument has been designed for an accurate determination of electrical contact resistance between TE material and electrode. Moreover, in order to evaluate electrical and thermal characteristics and efficiency of TE modules, especially for intermediate temperature, we developed a flexible test facility. It allows for testing of TE modules up to 60 x 60mm^2 footprints, from room temperature up to about 600 °C, in vacuum inert atmosphere.

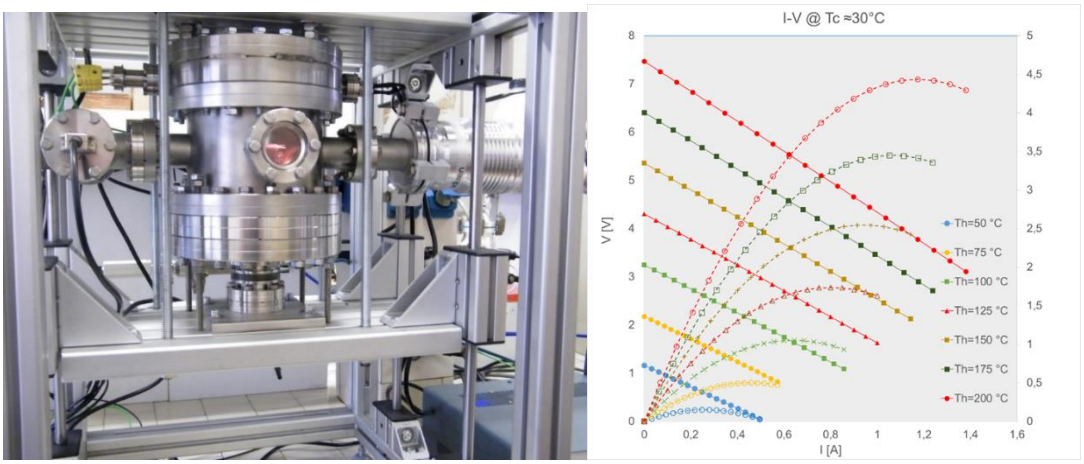

Fig. 1: Picture of the custom built apparatus for thermoelectric module testing and example of current-voltage characterization.

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Low temperature difference energy harvesting: characterization of DC-DC converter for thermoelectric generators with low and variable heat sources

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Thermoelectric modules (TEM) provide electrical power from heat flux. Typically, low power TEM or a TEM working with a small temperature gradient produces very low (tens or hundreds of mV) and unstable voltage. Thus, for environmental harvesting, we need unusual boost converter to obtain usefull power from very low voltage. In this work, we developed a DC-DC boost converter with a commercial IC, and a set-up for the characterization of a complete TEG/Converter system as a function temperature variation and output power. The system under test can give an output power in the range of hundreds of µW with few K.
Moreover, environmental heat source can be variable or temporarily unavailable. Here, we also study the possibility and the behaviour of using external capacitor with higher voltage to store surplus energy, which allows to maintain a constant output power.

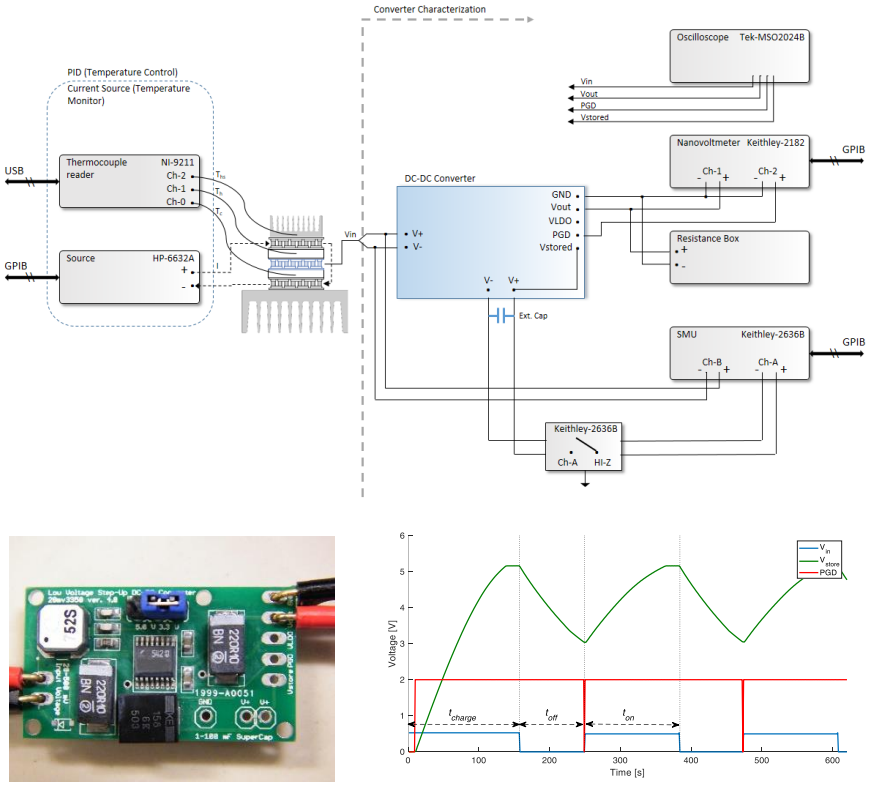

Fig. 1: a) Experimental set-up for the TEG/Converter system characterization as a function of temperature variation, output power and external capacitor. b) Prototype of low voltage DC-DC converter. c) Characteristic curves with variable heat source and energy storage.

Finite element evaluation of critical thermal stresses in silicide – based thermoelectric module

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Silicide-based thermoelectric modules are thought to operate with mid-high temperature gradients. In the operating conditions, thermal stresses in materials with different coefficient of thermal expansion (thermoelectric legs, connectors, ceramic substrates) may reduce the mechanical strength of the modules. In particular, a rigid connection of thermoelectric elements with the ceramic substrates may lead to critical tensile/shear stress and to the potential failure of thermoelectric materials. In this work, some results of finite element simulation of mechanical behavior of a single Mg_2Si and of a 4-couple Mg_2Si - HMS module under different thermal gradients are presented. Available failure criteria for brittle materials have been implemented in the numerical model and investigated to adequately identify the ultimate strength of silicide legs. The results of numerical simulation have been compared with the damage pattern observed during the test of a module prototype.

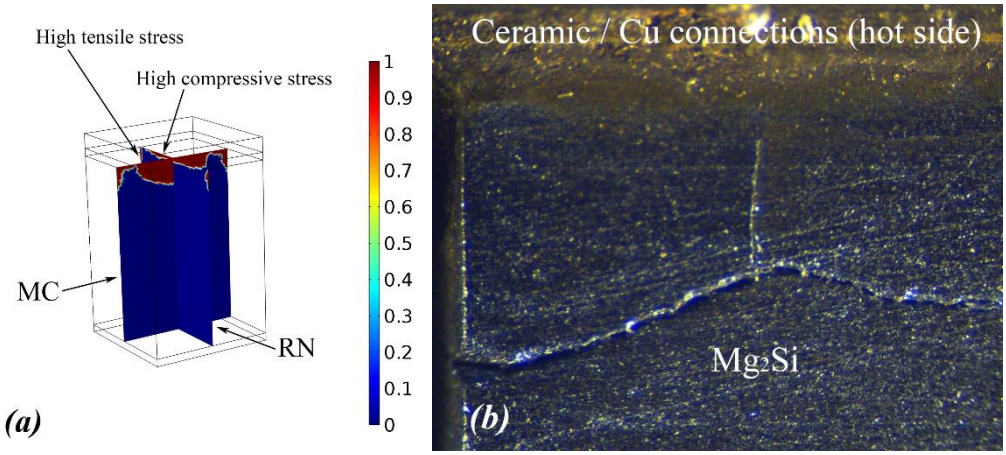

Fig. 1: *(a)* Numerical evaluation of potential failure (red regions) in a single Mg_2Si leg with Mohr-Coulomb (MC) and Rankine (RN) criteria; *(b)* Detail of an observed failure on the hot side of n-type legs of a tested prototype.

High-k engineered PVDF-$BaTiO_3$ composites for energy storage

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High-permittivity (high-k) polymer-ceramic composites with engineered nano-architecture meet the increasingly marked tendency towards a more rational and sustainable use of energy. They provide a smart solution to combine the good dielectric properties of the ceramic filler with the processability, flexibility and high breakdown strength of the polymer matrix [1]. In this work, 0-3 connectivity nanocomposites based on poly(vinylidene fluoride) (PVDF) and containing 30 vol% of ceramic inclusions were prepared by solution casting followed by compression moulding. $BaTiO_3$ nanoparticles, both as synthesised and coated with a thin shell of a binary oxide (SiO_2 or TiO_2), were employed to understand the role of interfaces, shape and morphology of inclusions. A better insight of the correlation between composite microstructure and dielectric properties was gained by combining FEM simulation and experimental data.

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Preparation of catalytic anodes for oxygen evolution by oxide-oxide galvanic exchange reactions

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Spinel oxides like Co_3O_4 and $NiCo_2O_4$ are good catalysts for the oxygen evolution reaction (OER) in basic media. Our group has studied a new approach, based on oxide-oxide galvanic exchange reactions [1,2], which allows the deposition of layers of the spinel oxides onto substrates with large surface area and high electronic conductivity, like porous PbO_2. The PbO_2 layers were obtained by gas bubble templated electrodeposition, either by anodic oxidation of Pb^{2+} to PbO_2, or via cathodic deposition of Pb and successive oxidation [3]. The oxide-oxide galvanic exchange reactions were performed at open circuit, by immersion of porous PbO_2 substrates in acetate solutions containing Co^{2+} or Co^{2+} + Ni^{2+} mixtures. The most active catalysts for the OER were those grown on substrates prepared via cathodic deposition and successive oxidation, which had a more favourable morphology.

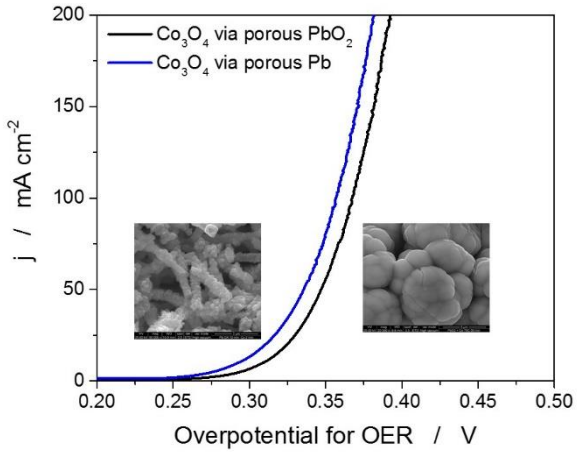

Figure 1: Current-overpotential curves for Co_3O_4-modified porous Pb oxide layers.

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Electrochemistry and Nanomaterials

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The laboratory of Electrochemistry and Nanomaterials was recently founded at the CNR-ICMATE unit of Milan and it provides classical electrochemical techniques, UV-vis and FTIR analyses, thin film photoconductivity determinations. The research activity is devoted to molecular electrochemistry and synthesis of nanoparticles and small molecules. In particular it is focused on:

- Realization of mono-multilayered thin films obtained by the layer-by-layer alternation of inorganic/metallic nanoparticles and organic molecules (Fig. 1a) for opto/electronic and photovoltaic application [1].
- Electrodes modified with oligo-polyconjugated systems (Fig. 1b) or with nanoparticles monolayers functionalized with glycosylated molecules (Fig. 1c) for lectins detection [2].
- Anticancer molecules' electrochemical studies and detection [3].
- Electrochemical characterization of new n-type conjugated polyelectrotrolites for solar-cell applications [4].

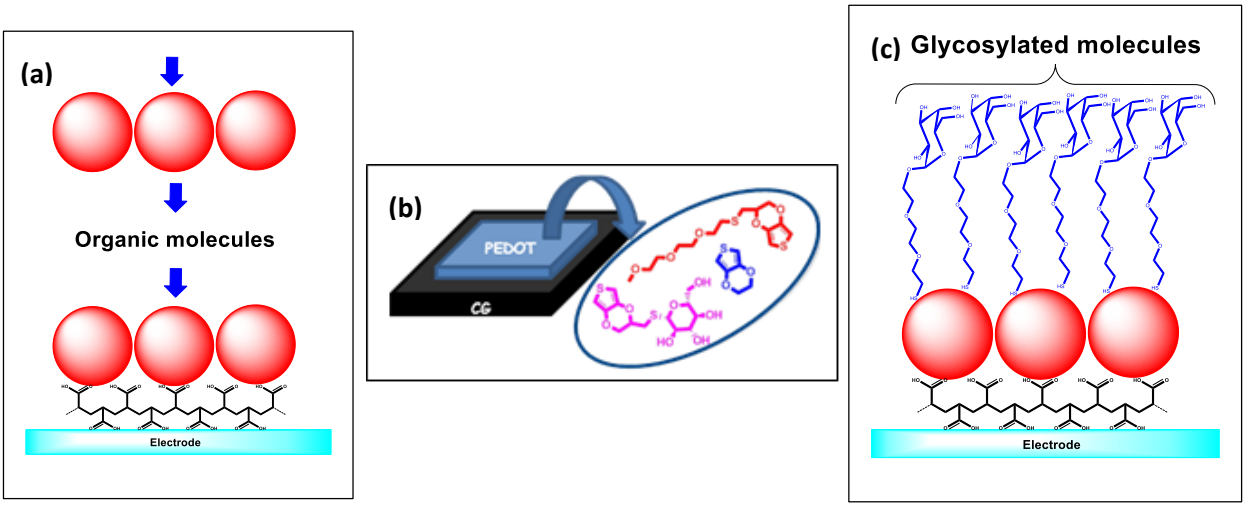

Fig. 1: a) Nanocrystals Multilayered Structure; b) Electrode modified with oligo-polyconjugated systems c) Nanocrystals Monolayer functionalized with sugar-molecules

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Interfacial phenomena in Ni alloys-oxides systems of interest for investment casting of superalloys

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The project "Innovative Surfaces for Superalloys Casting Processes" (INSURFCAST) has the objective of designing appropriate ceramic surfaces and procedures which would enable the use of innovative superalloys for the production of complex-shaped blades by precision investment casting. In any casting process, a liquid alloy is poured into a ceramic refractory container that must be inert to avoid surface and bulk defects in the final product.
In this poster, results from wetting studies aimed at elucidating the interfacial phenomena related to the contact between liquid Ni-based superalloys and the ceramics used for casting are presented. The results are discussed with the aid of thermodynamic data (phase diagrams, energy quantities) in order to interpret and predict the phenomena occurring during industrial high-temperature liquid-assisted processes.

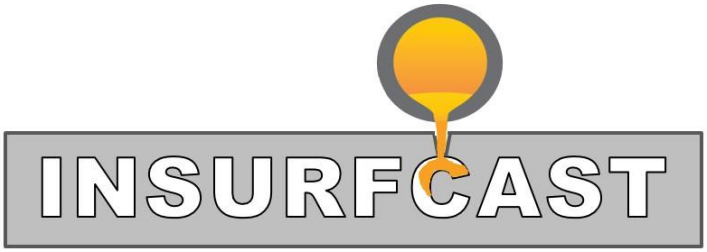

Fig. 1: the INSURFCAST logo

Laser Shape Setting and Characterizations of Nitinol Thin Elements

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Shape setting is one of the most important steps in the production route of Nitinol Shape Memory Alloys (SMAs), as it can fix the functional properties, such as the shape memory effect and the superelasticity (SE). The conventional treatment for making the shape setting is performed at 400–500°C in furnaces. This innovative research proposed, first [1], a laser beam for performing straight shape setting on cold worked NiTi thin wires and low dimension SMA elements [2]. The laser beam, at different power levels and shapes, was moved along the wire length for inducing functional performances. Calorimetric, pseudo-elastic and microstructural features of the laser annealed wires are studied through differential scanning calorimetry, tensile testing and high energy X-ray diffraction, respectively. It is demonstrated that excellent superelasticity can be induced in thin Nitinol elements.

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NiTi components for sensors and actuators

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Near equiatomic NiTi alloys are known for the peculiar characteristic of gain high deformations when subject to thermal cycles under load (shape memory effect) or during loading/unloading cycles at constant temperature (pseudoelasticity). In both cases, the resulting mechanical work may be exploited in practical applications as actuators and sensors. However, the poor workability by means of conventional processing techniques limits the use of NiTi. Therefore, in most applications the NiTi component is designed out from the same semi-finished product (sheet, strip, wire, tube, bar) and its final geometry is simple and it is often in the form of wire, spring or tape [1-3]. In this work, some examples of sensors and actuators made up of NiTi components produced by conventional techniques are presented. Furthermore, selective laser melting is suggested as an alternative and innovative production process of NiTi parts of even complex geometry.

[1] A. Nespoli, D. Rigamonti, E. Villa, F. Passaretti, Sens. Actuators A: Phys. 218 (2014) 142-153.
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Development of non-linear, viscoelastic multimaterials for neurorehabilitation

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The type of force utilised for stabilising human joints during rehabilitation has an impact on the neurological control and execution of movement [1]. The ability to create appropriate therapeutic force fields by exploiting materials with graded visco-elastic characteristics can be key to achieving lasting results [2]. Alongside optimization of the chemical and structural properties, material combinations and engineered morpho-mechanical interactions can be exploited to condition a multimaterial response (Fig. 1). We shall discuss opportunities to incorporate controllable visco-elastic materials such as pseudoelastic alloys into complex-shaped matrices of compliant materials in order to influence and control force evolution, load distribution, and dynamic interaction with the human body. We shall also describe the possible issues connected with the integration of such systems into wearable devices.

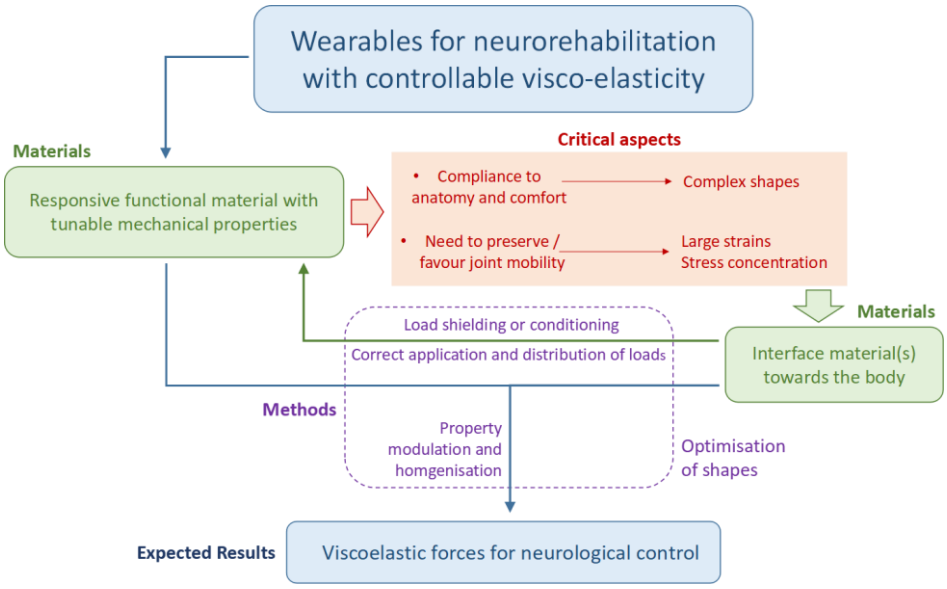

Fig. 1: The diagram shows how the presence of one or more interface materials in the multimaterial can be exploited not just to meet the ergonomic and biomechanical requirements, but also to influence and tune, through the optimisation of shapes, the mechanical response of the functional material, to better control the visco-elastic forces developed.

[1] G. L. Gottlieb, "On the Voluntary Movement of Compliant (Inertial-Viscoelastic) Loads by Parcellated Control Mechanisms," vol. 76, no. 5, pp. 3207–3229 (1996).
[2] L. Garavaglia, E. Pagliano, G. Baranello, and S. Pittaccio, "Why orthotic devices could be of help in the management of Movement Disorders in the young," J. Neuroeng. Rehabil. (2018)

Dynamic characterisation of human-oriented devices based on pseudoelastic alloys through wearable technologies

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Pseudoelastic metal alloys (PMA), thanks to their nonlinear mechanical properties can be advantageous in the fabrication of wearable devices for biomedicine, sports and wellness. Reaching mid-high technology readiness levels in those applications (TRL 5 and above), the possibility to characterise material performance rests upon the availability of effective set-ups for describing the human-material interaction in life-like environments. The present work describes specially-developed wearable systems endowed with inertial (IMU) and surface-electromyographic (sEMG) sensors[1] to test neuromuscular control during PMA-based therapies. Specific sensor fusion algorithms and kinematic models were developed to interpret the raw data. Integration of sensors into PMA multimaterials will be the next step towards controlling the functional behaviour of advanced biomechanic wearables.

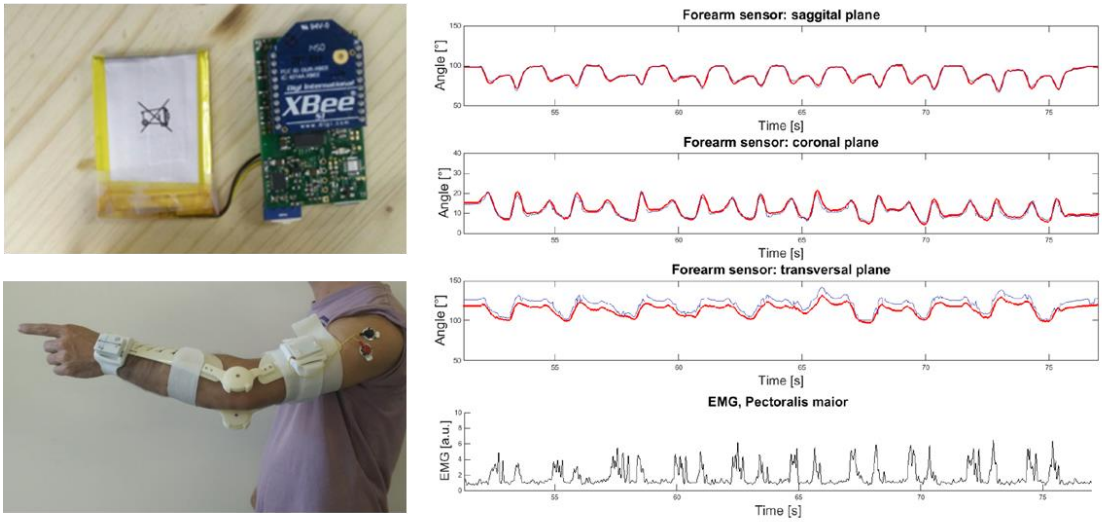

Fig. 1: *Top left*, The sensor acquisition board with 6-axis IMU and 1 sEMG channel. *Bottom left*, Dynamic orthosis with hinges functionalized by pseudoelastic NiTi springs. The sensors are worn on the upper limb segments to test the effects of the device on movement production. *Right*, Comparison of the tracings acquired by the sensors (*black*) with a gold standard (optoelectronic photogrammetry – *red*) during repeated pointing foreward movements.

[1] F. Lazzari, L. Garavaglia, J. Romanò, S. Pittaccio, Prototype of multisignal wearable sensors for the characterisation of Movement Disorders, Acts of Congresso Nazionale GNB, Milano, Jun 2018.

Synthesis and Characterization of Nanoparticles produced in Flames

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Flames are our reactor to produce carbonaceous or oxide nanoparticles for a wide range of applications, including photo-catalysis, gas sensors as well as electric device.
Laboratory flames fueled with hydrocarbons are used to produce nanoparticles with peculiar optical properties, which can be properly modified applying laser treatment.
Flame Spray Pyrolysis is implemented to produce oxide nanoparticles with a continuous process, both powder and deposits. By changing the experimental flame conditions, nanoparticles of different size, composition and phases can be produced.
The application of different optical diagnostic techniques is performed both for synthesis monitoring and for the characterization of the nanoparticles produced. Among them, Laser-Induced Incandescence is a powerful tool to gain information on nanoparticles size.

Heavy metals and radionuclides presence and mobility in food and environment: instruments

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Geological features, energy production, waste management and nuclear weapon tests could affect the radioactivity content of many natural and anthropogenic matrixes to which we are exposed. The *Environmental Radiochemistry* group at CNR-ICMATE is specialized in radionuclide analysis and studies of radioactivity distribution among natural ecosystems, industrial settings, waste products and food. In this poster we show the principal instruments for the quantitative determination of radionuclides and for the determination of elemental composition in many environmental matrices: high resolution gamma spectrometry (laboratory and in-field), high resolution alpha spectrometry, liquid scintillation alpha-beta counter, continuum gas radon monitor, passive radon detectors, Energy Dispersive Polarized X-Ray Fluorescence, Total Reflection X-Ray Fluorescence.

Selective Detection of $\alpha_v\beta_3$ Integrin Using [^{99m}Tc(N)PNP43]-tagged RGDechi Peptides: Synthesis, Structure–Activity and Pharmacokinetic Studies

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New integrin-selective molecules suitable for therapeutic or imaging purposes are currently of interest in development of effective personalized medical platforms. RGDechi is a chimeric echistatin-RGD-peptide, reported as potent and selective antagonist of $\alpha_v\beta_3$ [1, 2]. To explore its potential in SPECT imaging, RGDechi and three truncated derivatives lacking two, three and five C-terminal amino acids were synthetized and cysteine conjugated [RGDechiCys (1), RGDechi[1_17]Cys (2), RGDechi[1_16]Cys (3) and RGDechi[1_14]Cys (4)] to allow the labelling with [^{99m}Tc][Tc(N)PNP43]-synthon (PNP43=diphosphinoamine) [3]. Stability and *in vitro* biological properties of ^{99m}Tc1-4 were assessed. The pharmacokinetics of ^{99m}Tc1 and ^{99m}Tc2 were evaluated on healthy and xenograft mice.

^{99m}Tc1−2 are able to discriminate between endogenously expressed integrins $\alpha_v\beta_3$ and $\alpha_v\beta_5$ and possess favorable pharmacokinetics, which results in positive target-to-nontarget ratios. The presented constructs can be considered the starting point for the development of agents for the selective detection of $\alpha_v\beta_3$ expression by SPECT.

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[2] A. Zannetti, S. Del Vecchio, F. Iommelli, A. Del Gatto, S. De Luca, L. Zaccaro, A. Papaccioli, J. Sommella, M. Panico, A. Speranza, P. Grieco, E. Novellino, M. Saviano, C. Pedone, M. Salvatore, Clin. Cancer Res.15 (2009) 5224−5233.
[3] C. Bolzati, A. Boschi, L. Uccelli, F. Tisato, F. Refosco, A. Cagnolini, A. Duatti, S. Prakash, G. Bandoli, A. Vittadini, J. Am. Chem. Soc. 124 (2002) 11468−11479.

LC-MS and MALDI-TOF supported metabolism studies of the selective $\alpha_v\beta_3$ [^{99m}Tc(N)PNP43]-tagged RGDechi Peptides

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[^{99m}Tc][Tc(N)PNP]-tagged CysRGDechi (**1**) and CysRGDechi17 (**2**) are the first example of Tc-labeled peptides able to discriminate in vivo between endogenously expressed integrins $\alpha_v\beta_3$ and $\alpha_v\beta_5$. In spite of this, the absolute uptake of the tracers in $\alpha_v\beta_3$ positive tumors is low [1]. This occurrence might be due to their partial in vivo instability.

Incubation in murine tissue homogenates of both ^{99m}**Tc1** and ^{99m}**Tc2** showed a metabolic profile, which is in good correlation with those *in vivo* observed.

To define the hydrolysis/cleavage products, the father peptides $^{99m/99g}$**Tc1** and $^{99m/99g}$**Tc2,** synthetized in carrier added conditions, were incubated, at 37 °C, in serum and in fresh mouse kidney homogenate. The mixtures were analyzed by LC-MS and MALDI-TOF MS. For both $^{99m/99g}$**Tc1** and $^{99m/99g}$**Tc2** the cleavage products were identified and compared with those identified for the native peptide.

Spectrometric data provide important information about the approaches that can be adopt to improve the enzymatic stability of the parental peptide, which can result in the overall magnification of the pharmacokinetic profile of corresponding radiolabeled compounds.

[1] C. Bolzati, N. Salvarese, D. Carpanese, R. Seraglia, L. Meléndez-Alafort, A. Rosato, D. Capasso, M. Saviano, A. Del Gatto, D. Comegna, L. Zaccaro, J. Med. Chem. 61 (2018) 9596−9610.

Synergies with Industries, Universities and Research Centers: a continued activity at ICMATE@Lecco

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ICMATE@Lecco is active in many areas of pure and applied research as well as in education, outreach activities and support to the productive sector. In this contribution, we describe the activities carried out in the context of numerous collaborations with Industries, Universities and Research Centers. ICMATE@Lecco offers opportunities for Master and PhD thesis and supports training activities for the High Schools (Alternanza Scuola Lavoro). ICMATE@Lecco promotes the dissemination of its expertise and results through a constant relationship with the Chamber of Commerce, the City and Province governments, the category associations and the local representatives of the regional and national governments, which often originate service contracts and joint research programs with companies. These are beneficial for the society and the private sector as well as for the Institute by opening new contacts, new research topics and new fund-raising opportunities.

INDEX OF AUTHORS