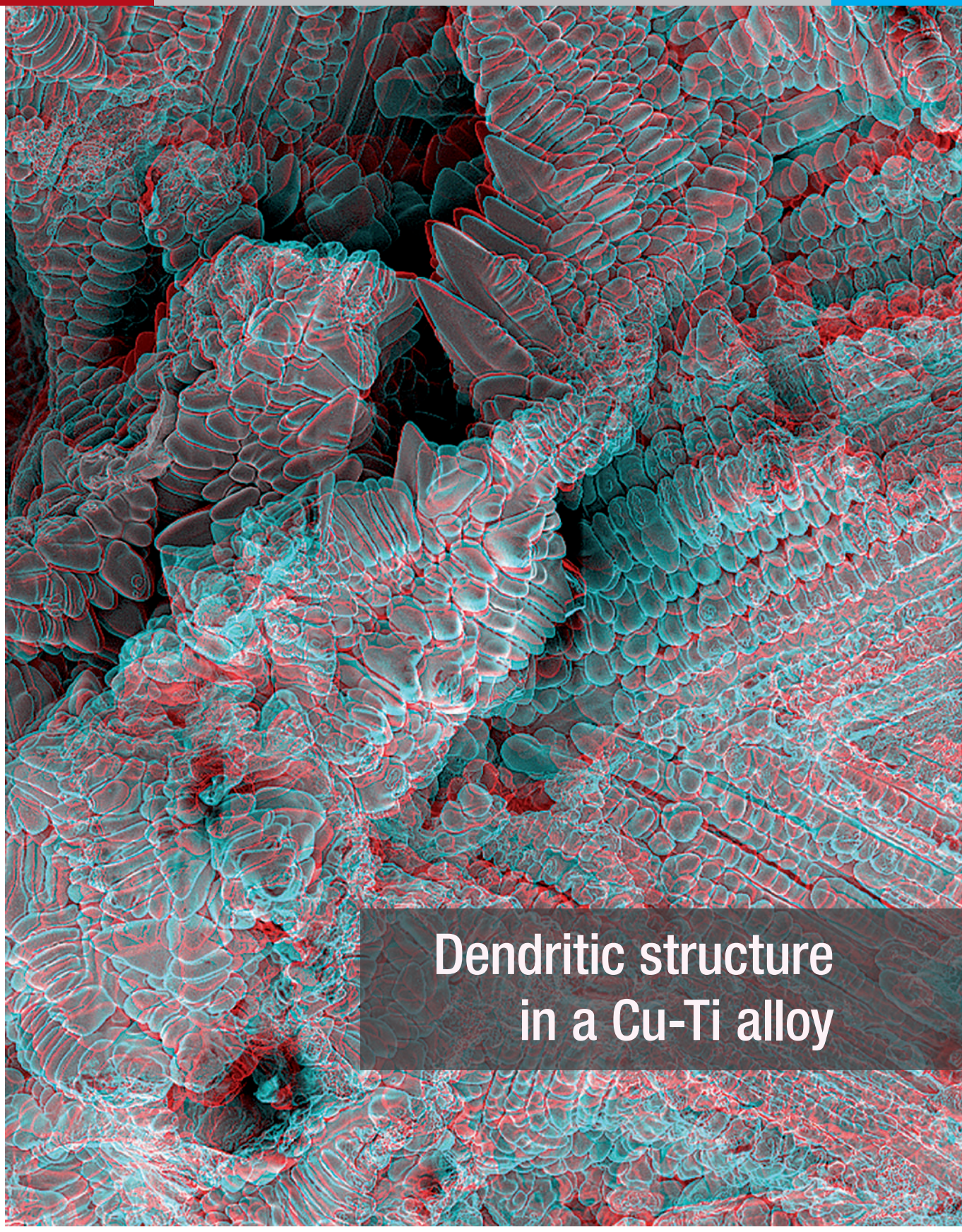
DIINFORMA

2.07
AGOSTO 2021

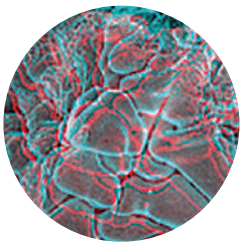
NEWSLETTER DEL DIPARTIMENTO DI INGEGNERIA INDUSTRIALE DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA



Dendritic structure in a Cu-Ti alloy

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

1222·2022 800 ANNI
UNIVERSITÀ DEGLI STUDI DI PADOVA



COPERTINA

Struttura dendritica in una lega Cu-Ti
Dendritic structure in a Cu-Ti alloy

PAGINA

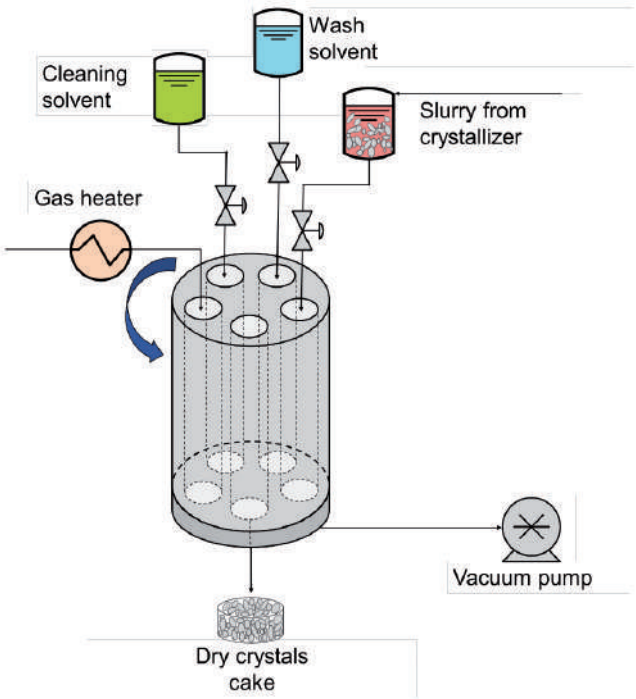
DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

Digital design of a continuous unit for anticancer drugs purification

The median time and cost for the approval of a new drug production process are about 10 years and $1 billion, respectively. These large figures often prevent pharmaceutical companies to present applications to regulatory bodies for producing formulations of drugs that have a limited market, but are not protected by patents anymore. Eventually, this translates in increased costs for national health systems and patients.

Digital tools for supporting pharmaceutical manufacturing have a tremendous potential in reducing the approval time and cost for a new drug, and of decreasing, in turn, the cost paid by patients for medications. In our research, we developed a digital simulator, based on differential mass, energy and momentum balances, for a novel equipment for continuous isolation of active pharmaceutical ingredients crystals from crystallization slurries. This carousel unit purifies active pharmaceutical ingredients from solvents and impurities retained from the reaction mixture, so that the obtained pure drugs can be safely embedded in tablets or capsules to be delivered to patients. The carousel features multiple processing stations, where the crystallization slurry is sequentially filtered, washed and dried into a pure crystals cake. The material being processed is transferred from one processing station into the following one through carousel rotations.

Preliminary studies focused on the digital optimization of aspirin and paracetamol crystals isolation through the carousel. The final objective of the project, developed in collaboration with Purdue University (USA) and with the United States Food & Drug Administration, is using the simulator for the digital optimization of the production process of an anti-cancer drug.



Schematic of the novel carousel unit for continuous isolation of drugs (adapted from [1]).

[1] Destro, F., Hur, I., Wang, V., Abdi, M., Feng, X., Wood, E., S. Coleman, P. Firth, A. Barton, M. Barolo, Nagy, Z. K. (2021). Mathematical modeling and digital design of an intensified filtration-washing-drying unit for pharmaceutical continuous manufacturing. *Chem. Eng. Sci.* **244,** 116803.

Bioingegneria, biotecnologie e tecnologie per la salute
Bioengineering, biotechnology and health technologies

DII research group
CAPE-Lab Computer-Aided Process Engineering Laboratory

Massimiliano Barolo
max.barolo@unipd.it
Phone: +39 049 8275473

Francesco Destro
francesco.destro@unipd.it

Research developed in collaboration with Prof. Zoltan Nagy at Purdue University (USA), and with the United States Food & Drug Administration

CAPE >_lab UNIVERSITY OF PADOVA

https://research.dii.unipd.it/capelab/

Main research topics:

- Process systems engineering
- Production engineering and chemical processes
- Bioengineering, biotechnology and health technologies

Sistemi Elettrici

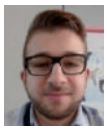
Electrical Systems

EdLab
Electric Drive Laboratory

Silverio Bolognani
silverio.bolognani@unipd.it
Phone: +39 049 827 7509

Nicola Bianchi
nicola.bianchi@unipd.it
Phone: +39 049 827 7593

Luigi Alberti
luigi.alberti@unipd.it
Phone: +39 049 827 7508



Matteo Berto
matteo.berto.2@phd.unipd.it

http://edlab.dii.unipd.it/

The paper "An Effective Ellipse Fitting Technique of the Current Response Locus to Rotating HF Voltage Injection in IPMSM for Sensorless Rotor Position Estimation" has been presented at IECON '18 conference, Washington D.C., USA, October 21-23 2018.

Main research topics:

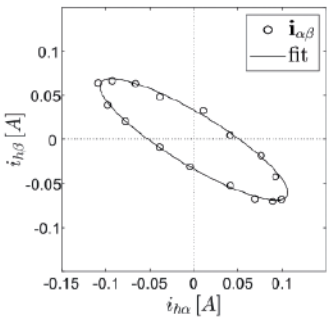
- Control of electrical drives
- Permanent magnet motors
- Rotor position estimation
- Sensorless control

High frequency injection and ellipse fitting for IPMSM sensorless control

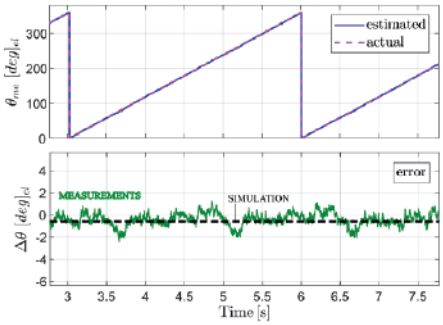
Permanent magnet synchronous motors are extensively used for home appliances and industrial applications thanks to their fast dynamic response, good overload capability and high energy density. A precise knowledge of the rotor position is required to control efficiently this kind of motors. In most of the applications resolvers or absolute encoders are installed on the rotor shaft. The employment of position sensors leads to significant drawbacks such as the increased size and cost of the system and a lower reliability of the drive, caused by additional hardware and cabling. In the last 30 years many techniques have been proposed to control electric drives without the use of position sensors. This type of control, also known as sensorless control, relies on rotor position estimation.

In the case of motors characterized by rotor saliency, for example interior permanent magnet synchronous motors (IPMSM) and synchronous reluctance motors (SynRM), the rotor position can be estimated through high frequency voltage injection and current response processing. This type of sensorless technique is suggested for standstill-low speed operations.

Conventional injection methods require the use of an heterodyning process in order to obtain the position information from the measured currents. As an alternative to the conventional approach, an ellipse fitting technique is proposed. The proposed method does not require a heterodyning demodulation of the current response. Moreover, it is characterized by simple implementation and it is not affected by signal processing delay effects. Present research is addressed to the adoption of the ellipse fitting algorithm for the sensorless control of the ringed-pole motor, a modified surface permanent magnet synchronous enhanced for rotor position estimation.

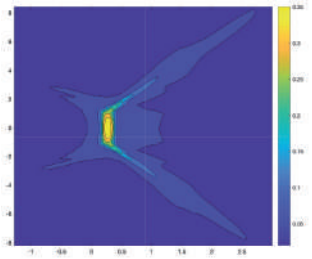


Current samples and fit.
The measured currents describe an ellipse trajectory. In particular, ellipse major semi-axis tilt is related to the rotor position.

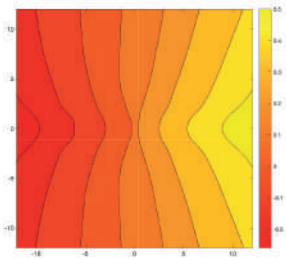


Position estimation and related estimation error during a 10 rpm operation: experimental and simulation results (at no-load). The proposed sensorless scheme has been validated on a IPSM motor.

Example of high-frequency map



Example of flux map



Crystallization of sol-gel derived thin films by excimer laser annealing

ASolution-based approaches such as sol-gel or metal-organic decomposition have been widely investigated for the fabrication of functional inorganic thin films. Conventional procedures involve the deposition onto substrates by spin or dip coating followed by thermal annealing of the film. The temperature reached for the crystallization is sometimes incompatible with inexpensive and temperature-sensitive substrates, such as plastic.

Laser annealing is emerging as an alternative technique for the treatment of solution-based coatings. It offers fast processing and scalability, along with precise control of the irradiated area, surface morphology, and in-depth thermal profile by tuning the laser parameters. Despite the potential, only few works have reported this technique for the crystallization of metal-oxides. Here, we report the crystallization of cerium-oxide sol-gel films by using pulsed excimer-laser annealing. Cerium oxide has a wide range of applications, ranging from sensing and optics to catalysis.

A comprehensive set of experiments was carried out by controlling three different variables: the thickness of the sol-gel film, number of pulses, and laser fluence (Fig. 1). The maximum temperature reached on the surface in the condition investigated was 500°C, and only 70° C on the interface with the substrate (silicon or glass), as verified by thermal simulations. For example, Fig. 2 reports the XRD patterns of a 500 nm thin-film laser annealed at 70 mJ/cm2 with a different number of pulses. A crystalline CeO2 structure was obtained. The morphology of the films was analyzed by FE-SEM imaging. By changing the laser fluence (Fig. 3) or the number of pulses we can control the roughness and nanostructure of the surface.

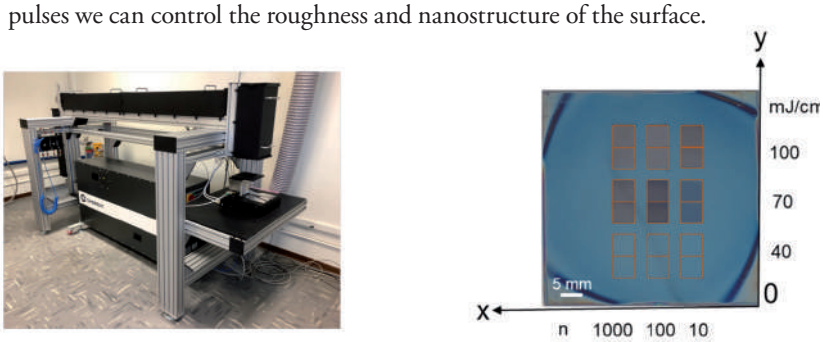


Fig. 1: (Left) Photograph of Coherent - compex PRO 201F excimer laser used for the experiments. (right) Schematic of a set of experiments on a sol-gel film. Each irradited area corresponded to a combination of laser fluence (y-ax) and number of pulses (a-ax).

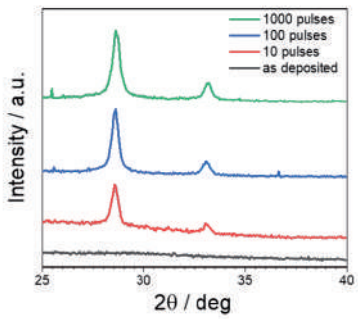


Fig. 2: XRD patterns of Ce02 sol-gel films laser annealed at 70 mj/cm² for different number of pulse.

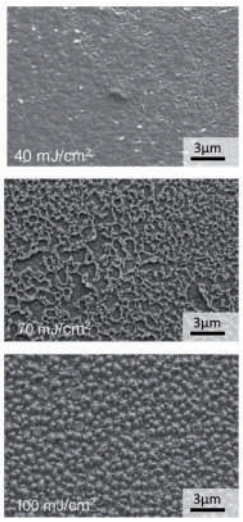


Fig. 3: FE-SEm images of surface morphology of irradiated sample at differen energy for a number of pulse equal to 10.

Materiali

Materials

DII research group
Nanomaterials Engineering Group (NANOENG)

Alessandro Martucci
alex.martucci@unipd.it
Phone: +39 049 8275506

Massimo Guglielmi
massimo.guglielmi@unipd.it
Phone: +39 049 8275509

Elena Colusso
elena.colusso@unipd.it
Phone: +39 049 8275828

Assisted by:
Maria Basso, PhD student

https://research.dii.unipd.it/nanoeng/

The presented research activity is carried out in collaboration with Prof. Enrico Napolitani (DFA, University of Padova)

Main research topics:

- Nanoparticles and nanopowders for functional application
- Thin film for functional application
- Ceramic nanocomposites
- Nanostructured materials for gas sensors
- Biopolymer nanocomposites
- Optical characterization of thin films and nanocomposites

Sistemi elettrici

Electrical systems

DII research group
Three-core transmission cables

Roberto Benato
roberto.benato@unipd.it
Phone: +39 049 8277532

Sebastian Dambone Sessa
sebastian.dambonesessa@unipd.it
Phone: +39 049 8277510

Giovanni Gardan
giovanni.gardan@studenti.unipd.it
Phone: +39 049 8277538

Francesco Sanniti
francesco.sanniti@phd.unipd.it
Phone: +39 049 8277538

https://dii.unipd.it/en/see

Terna
TERNA GROUP

The research activity is carried out in collaboration with Terna Rete Italia.

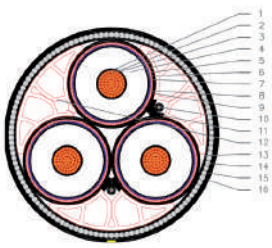
Main research topics:

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

Experimental Harmonic Validation of 3D MCA on the100 km-Long Sicily-Malta 220 kV Three-Core Armoured Cable

The integration of the massive penetration of renewable energy sources in today's electrical networks requires the strengthening of the electrical grid by means of the installation of challenging power transmission lines. Hence, it is necessary to develop reliable simulation tools in order to optimize the project of such systems. In this context, the modelling of three-core armoured cables represents the most difficult situation since they are characterized by active (the phase conductors) and passive (the metallic screens and the armour wires) conductors which are stranded with different lay lengths. In other words, the active and passive conductors change their positions with continuity along the cable length. The 3D Multiconductor Cell Analysis (3D MCA) developed by the Laboratory of Electric Energy Transmission of the University of Padova has proven to be a powerful tool to determine the steady state regimes of three core armoured cables and, in this project, an experimental validation of this approach has been performed in collaboration with the Italian transmission system operator (Terna).

For this purpose, the measurement campaign performed by Terna on the 100 km-long three-core submarine cable between Sicily and Malta has been exploited. The aim of the campaign is to characterize the behaviour of the cable system in frequency-domain by measuring the steady-state impedances at different frequencies (see Fig. 1) . The cable line has been modelled by means of the 3D MCA in the same conditions and the simulation results have been compared with the experimental measurements. The comparison has been performed from 0 to the 40th harmonic (with respect to 50 Hz) and both positive and zero sequence quantities have been assessed. In Fig. 2 the segmentation of phase, screens and armour conductors used in MCA to take into account the current distribution is shown. In Fig. 3 , a comparison among 3D MCA outputs, measurement values and the Cigré direct formulation in frequency domain is shown. The continue curve represents the zero sequence resistance considering the Malta end open, whereas the small circles represent the experimental measurements with their uncertainties. The agreement between measurements and MCA results is very good with a maximum differences of 10 % which is negligible if the measurement uncertainties are considered, especially near the resonance frequencies.



# of Fig. 2	Type	Constituents	[mm]
1	Conductor	Compacted copper strands	30,5
2	Semiconducting filling compound, water-blocking		
3	Conductor screen	Semiconducting XLPE	33,5
4	Insulation	XLPE	81,5
5	Insulation screen	Semiconducting XLPE	84,5
6	Phase ID plastic strand		
7	Longitudinal water-block	Semiconducting water-swellable tape	
8	Lead sheath	Lead alloy 1/2C	92,1
9	Inner sheath	Semiconducting PE	97,3
10	Fibre optic cable		Φ=10
11	Filler element	PE filler W/semicond. layer	
12	Filler element	PE filler	
13	Semiconducting reinforcement tape		~211
14	Armour	One layer of round galvanized steel wires	120×Φ=5,6
15	Outer serving	Two layers of polypropylene yarn and bitumen	
16	Outer serving	PP-yarn	239

Fig. 1. Cross-section drawing of Malta-Sicily submarine three-core cable .

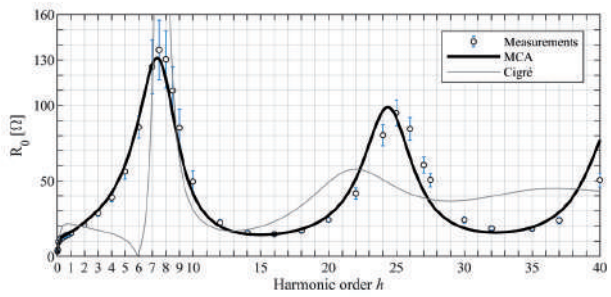


Fig. 2. Comparison between measurements and MCA, Cigré: positive sequence resistance with Malta end open

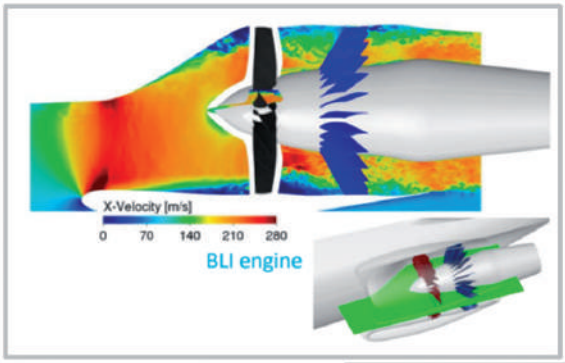
Research findings in future aircraft propulsion

The need for more efficient, low-noise and environmentally friendly propulsors has brought innovative engine configurations to the attention of researchers within both academia and industry. Notable examples include boundary layer ingestion (BLI) and ultra-high by-pass ratio (UHBPR) engines. Although such configurations are characterized by non-negligible technology readiness levels, they still require huge research efforts, both theoretical and experimental, to be validated. The team coordinated by prof. E. Benini is actively involved in the research and development of these technologies with two projects funded by the European Union, namely SUBLIME and IVANHOE.

BLI engines consist of a turbofan partially buried in the rear fuselage (Figure 1 top). Substantial power and fuel burn reductions are expected at the cost of major technical and numerical challenges, as the engine works with nonuniform inflow. The SUBLIME project addresses the experimental assessment of BLI performance over conventional engines. Methodologies based on optimisation and CFD tools are employed to design distortion-tolerant fans, which will be subsequently manufactured and tested in a transonic wind tunnel. The aim is to predict full-scale behaviour of the aircraft architectures suitable for BLI engine installation, targeting minimum inlet distortion and enhanced power saving.

In addition to BLI propulsion, a technology improvement on a shorter-term basis is pursued for podded turbofan engines, by increasing the mass ow through the fan and reducing its acceleration. However, the resulting UHBPR engine (Figure 1 bottom) can be very large and difficult to be installed under the wing. For this reason, even in this case tighter propulsive system integration is needed, causing enhanced interference between the engine and the airframe, that can prevent a real performance improvement.

The IVANHOE project investigates optimal installed nacelle shaping to reduce the negative effects of propulsion integration and fully exploit the aerodynamic benefits of UHBPR turbofans. The research group is directly involved in the design and optimisation of high-speed nacelles using advanced numerical tools. The results of the study will be validated by experimental testing in a partner wind tunnel facility.



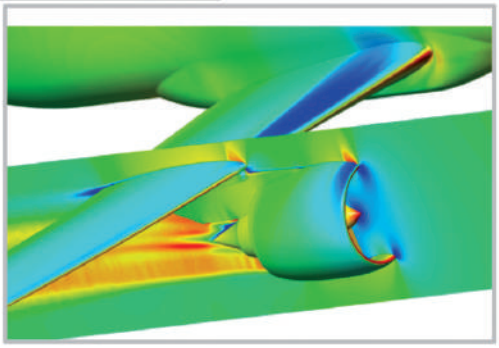


Fig. 1.- Numerical Simulation of a BLI propulsor (top) and of an UHBPR underwing engine (bottom).

Energia

Energy

DII research group
TES – Turbomachinery
& Energy Systems Group

Ernesto Benini
ernesto.benini@unipd.it
Phone: +39 049 8276767

Andrea Magrini
andrea.magrini@phd.unipd.it
Phone: +39 049 8276777

Luca Menegozzo
luca.menegozzo@phd.unipd.it
Phone: +39 049 8276777

IVANHOE and SUBLIME are research programs funded by the European Union under the Horizon 2020 Research Framework

IVANHOE is carried out in cooperation with:
- Chalmers University (Sweden)
- Deutsch-Netherland Wind Tunnel (The Netherlands)
- Hit09 (Italy)
- Technical University of Braunschweig (Germany)
- Deharde (Germany)

SUBLIME is carried out in cooperation with:
- Hit09 (Italy)
- Chalmers University (Sweden)
- Cranfield University (United Kingdom)
- Aircraft Research Association Limited (United Kingdom)

Main research topics:

- Design and Optimization of Propulsion Engines
- Power Generation Systems and Components
- Renewable Energy Systems and Machines
- Internal Combustion Engines

Sistemi Aerospaziali

Aerospace Systems

DII research group
Misure e tecnologie spaziali
Measurements and space technologies

Enrico Lorenzini
enrico.lorenzini@unipd.it
Phone: +39 049 827 6766

Andrea Valmorbida
andrea.valmorbida@unipd.it
Phone: +39 049 827 6779

Lorenzo Olivieri
lorenzo.olivieri@unipd.it
Phone: +39 049 827 6837

Giulia Sarego
giulia.sarego@unipd.it

Alice Brunello
alice.brunello.3@phd.unipd.it

E.T.PACK project partners:
· University Carlos III of Madrid - coordinator (Spain)
· University of Padova (Italy)
· Technical University Dresden (Germany)
· Fraunhofer Institute - IKTS (Germany)
· Sener Aeroespacial (Spain)
· Advanced Thermal Devices (Spain)

https://etpack.eu/

Main research topics:
- Space technologies for deorbiting systems of space debris
- Software and Hardware for laboratory testing of space subsystems
- Measurement, instrumentations and technologies for aerospace applications
- Attitude control of spacecraft

E.T.PACK – Electrodynamic Tether Technology for Passive Consumable-less Deorbit Kit.

The number of space debris orbiting our Earth produced by artificial satellites has been continuously growing since the beginning of the space era. In the last years this serious problem prompted many space agencies all over the world to adopt debris mitigation strategies. In this context, deorbiting technologies and strategies alternative to the traditional chemical propulsion have begun to be investigated and Electrodynamic Tethers (EDTs) appear to be a promising and effective option.

Our research group has been working with five other European partners on the H2020 Future Emerging Technologies FET OPEN Project E.T.PACK - Electrodynamic Tether Technology for Passive Consumable-less Deorbit Kit, that aims at the development and construction of a Deorbit Kit prototype based on electrodynamic tether technology with Technology Readiness Level 4 (Figure 1). EDTs collect ionospheric electrons either from their (anodic) end or, as in E.T.PACK, over a large portion of a metallic tape deployed from a spacecraft and reemit the electrons at the other end (cathode). The resulting electric current flowing through the conductive tether/tape generates a drag Lorentz force through the interaction with the Earth's magnetic field that progressively decreases the orbit altitude of the main satellite causing its re-entry into the Earth's atmosphere in a few months from low Earth orbits (LEO). Depending on the type of cathode utilized, EDTs do not use propellant or use a small quantity of a neutral expellant and consequently are strong examples of a really green space technology. The contributions of UniPD to the project are many: development of a complex software for simulating the system dynamics and estimating the EDT deorbiting time; synthesis of control algorithms to deploy the metallic tape from the spacecraft; design, assembly and integration of the deployer mechanism and its cold gas propulsion system; design and construction of an in-line damper to increase the dynamic stability during deorbiting; validation of the early phase of deployment through laboratory tests at UniPD using the frictionless table (i.e., the SPARTANS facility) (Figure 2); functional testing of the deployer module; system engineering support and technical coordination between industrial and academic partners.

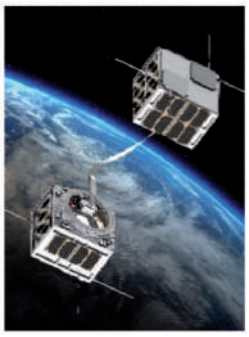


Fig. 1.
E.T. PACK 12U demo flight wite the Electron Emitter Module (EEM) and the Deployment Mechanism Module (DMM) connected by a tape tether.

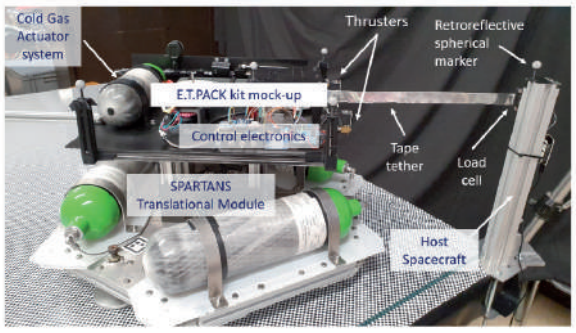


Fig. 2. The E.T.PACK kit mock-up placed above the Translational Module of the SPARTANS facility during a laboratory testing campaign to validate the early phase of the tape deployment.

Polymer-derived Biosilicate®-like glass-ceramics: opportunities for additive manufacturing and functionalization

Silicone resins, filled with phosphates and other oxide fillers, yield upon firing in air at 1100 °C, a product resembling Biosilicate® glass-ceramics (glass of formulation 23.75 wt% Na_2O-23.75% CaO-48.5% SiO_2-4.0% P_2O_5 crystallized into Na-Ca silicate), one of the most promising systems for tissue engineering applications. The process requires no preliminary synthesis of a parent glass, and the polymer route enables the application of direct foaming or direct ink writing (DIW) of silicone-based mixtures, for the manufacturing of highly porous scaffolds at low temperature. The thermal treatment is later applied for the conversion into glass-ceramic scaffolds. Changes in the starting silicone and firing atmosphere (from air to nitrogen) easily lead to functional composite biomaterials featuring a carbon phase embedded in a Biosilicate®-like matrix (Fig.1). Such extra phase promotes the absorption of infrared radiation, in turn useful for disinfection of bone-tissue implants and photothermal therapy (Fig.2). The adopted additive manufacturing technology (DIW, Fig.3) may be easily replaced (e.g. by DLP, digital light processing, Fig.4) by slight corrections of the formulations (with silicones used after blending with photocurable acrylic resins).

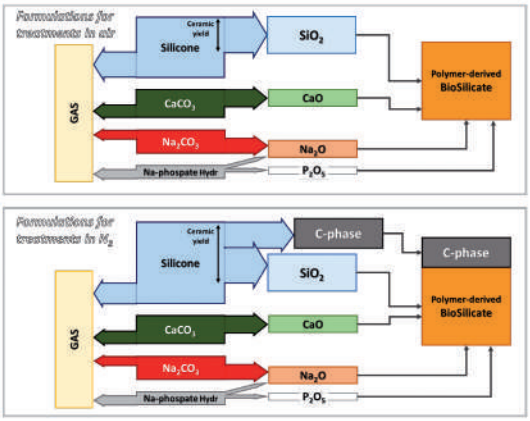


Fig. 1.
Concept of polymer-derived Biosilicate systems, without or with extra C-based phase.

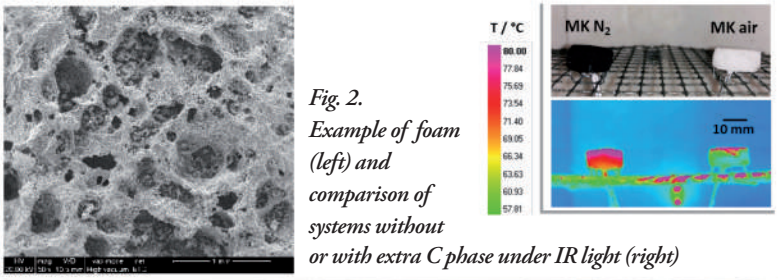


Fig. 2.
Example of foam (left) and comparison of systems without or with extra C phase under IR light (right)

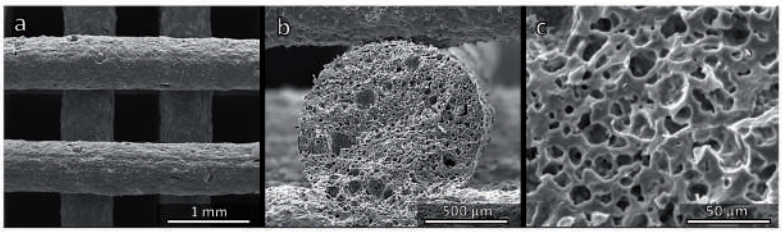


Fig. 3.
Example of reticulated scaffold from DIW:
a) top view;
b,c) cross-section

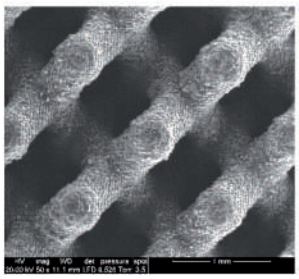


Fig. 4.
Example of reticulated scaffold from DLP

Materiali

Materials

DII research group

CerAMGlass

Enrico Bernardo
enrico.bernardo@unipd.it
phone: +39 049 8275510

Hamada Elsayed
elsisy_chem@yahoo.com
phone: +39 049 8275510

Investigation performed with the support of **Ms Fulden Dogrul** (visiting PhD student) and **Dr Paulina Ożóg** (visiting post-doc) of the FunGlass centre (Alexander Dubcek University of Trencin, Slovakia)

https://research.dii.unipd.it/ceramglass

This paper is a part of the dissemination activitie of the project FunGlass (Centre for Functional and Surface Functionalized Glass).
This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No. 739566.
https://www.funglass.eu/

The support from Dr Stefano Bertolin and Prof Davide Del Col (DII, STET group), for IR heating tests, is greaty appreciated

Main research topics:

- Main research topics:
- Nanostructured ceramic composites from preceramic polymers and fillers
- Advanced porous ceramic components
- Bioceramics from novel formulations and processes
- Monolithic and cellular glasses and ceramics
- Novel building materials from inorganic waste
- Additive manufacturing of porous and dense ceramic components

Sistemi Elettrici

Electrical Systems

DII research group
Power Systems
In cooperation with Technical University of Denmark, DTU Elektro, Center for Electric Power and Energy

Lisa Calearo
lica@elektro.dtu.dk
Phone: +45 50115525

Marco Agostini
marco.agostini.2@unipd.it
Phone: +39 049 8277531

The research activity is carried out in collaboration with:
PhD student Jan Engelhardt, DTU
Dr. Massimiliano Coppo, University of Padova
Prof. Roberto Turri, University of Padova
Prof. Mattia Marinelli, DTU

https://www.cee.elektro.dtu.dk/
https://dii.unipd.it/en/see

The research activity is carried out as part of the projects: InsulaE H2020 project supported from the European Union under the Horizon2020 Programme, grant agreement nr: 824433; TopChargE project supported from the Energy Technology Development and Demonstration Program (EUDP), grant agreement nr: 64019-0540; NEBULE project, supported from the Interdepartmental Centre for Energy Economics and Technology "Giorgio Levi Cases", Padova, Italy; the Veneto Region European Social Fund project.

Main research topics:

- Management and control of distribution networks with high penetration of Distributed Energy Resources
- Ancillary services market evolution due to energy transition and its impact on power system's efficiency
- Energy storage management for grid services in the power system
- EHV/HV dc and ac innovative transmission lines, e.g. insulated cables and gas insulated lines;
- Synergy between railway and highway infrastructures and insulated cables;
- Multiconductor cell analysis (MCA) of asymmetric systems by means of self-implemented matrix procedures;

Management of a new storage technology to optimize EV ultra-fast charging using local PV production

To fulfil new energy policies at European level, the increasing renewables and electric vehicles (EVs) need to be integrated in the power system. In the INSULAE H2020 project, a new storage technology is investigated for integrating ultra-fast charging of EVs with local photovoltaic (PV) production and grid flexibility provision. The system includes the new storage technology, two EV ultra-fast chargers (up to 350 kW shared load), a 60 kWp PV plant and a 66 kW grid inverter, see Fig. 1a. The battery consists of three reconfigurable strings that connect to DC components without the need of DC/DC converters. This allows to operate the strings independently, while targeting collective goals, e.g. one string charges from the PV plant, while another is charging an EV.

This research focuses on the optimal management of the reconfigurable battery, to reduce the grid impact of ultra-fast EV charging and to promote self-consumption of the local PV production. The system is modelled as a Mixed Integer Linear Programming Problem, whose main objective is to minimize the operational costs, accounting for the power exchanged with the grid and the chargers revenue. The constraints characterize the reconfigurable strings behavior and the physical bounds of the different components. The model results are then investigated in technical and economic terms and compared with a traditional solution for the installation of EV ultra-fast chargers. The traditional solution consists of connecting the ultra-fast chargers directly to the grid as shown in Fig. 1b. The optimization results show that the new system proves to have positive impacts on the grid connection, e.g. by cancelling large peak imports during summer days, as shown in Fig. 1c, hence limiting the grid connection fees and allowing for new revenue opportunities in terms of ancillary service provision.
Future research will focus on provision of flexibility services with the storage system. Furthermore, thanks to the installation of the new system in Denmark in summer 2021 (Fig. 2), on-site measurements will provide further insights on the technology performance.

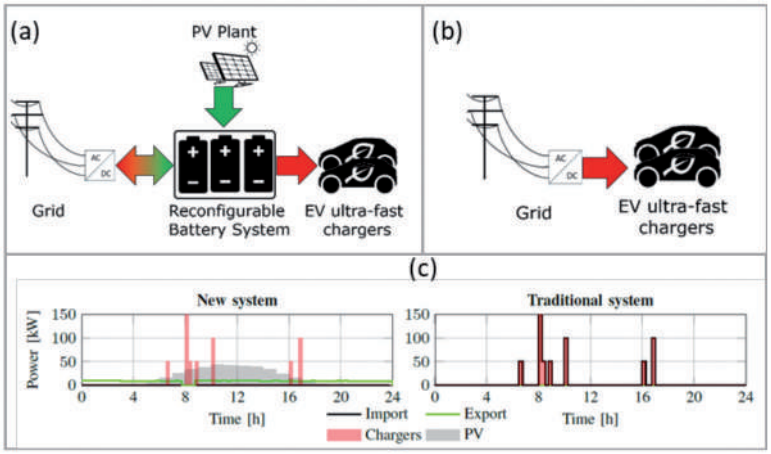


Fig. 1: Layout of (a) the new system with the reconfigurable battery, (b) the traditional system for EV ultra-fast chargers installation. (c) power exchanges at grid level in the two systems.

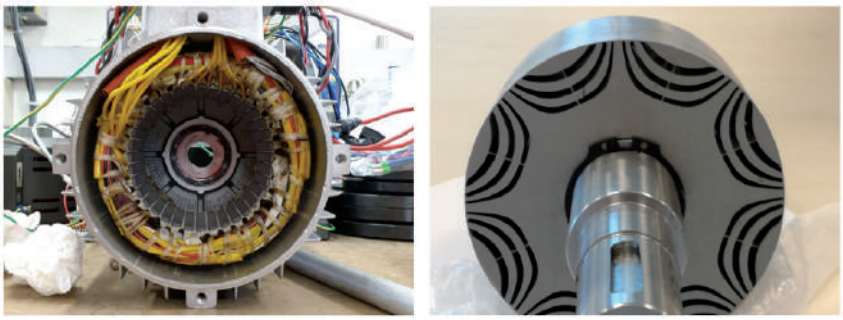
Fig. 2: Picture of the storage system installation with an EV connected, from
https://via.ritzau.dk/pressemeddelelse/verdenspraemiere-pa-danskudviklet-gron-lade-teknologi-pa-bornholm?publisherId=13560550&releaseId=13624191

Control of electric motors designed for off-road mobile machineries

Electric mobility is becoming increasingly successful and widespread. It allows to achieve results and performances hardly obtainable with classical technologies based on internal combustion engine. Only considering the entire energy chain, only electricity offers efficiency advantages and - as long as it comes from renewable sources – a significant reduction of CO_2-emissions. A noteworthy research effort has been devoted toward the electrification of automobiles, both by industry and academia. Only recently there has been a growing focus on the electrification of off-road machineries, and this is posing new challenges. High power, high reliability and high efficiency are required by these machines, but the harsh operating conditions make it more difficult to meet these goals. Nonetheless, new functions can be implemented thanks to the greater flexibility offered by electrification, see the precision agriculture.

My research interests focus on the control of electric motors to increase their efficiency and reliability and my research activity is developed within the frame of the project «Green SEED: Design of more-electric tractors for a more sustainable agriculture». To achieve the aforementioned goals, synchronous reluctance (SynR) motor and permanent magnet assisted synchronous reluctance (PMASynR) motor seems to be viable candidates thanks to their improved environmental footprint, good efficiency and self-sensing rotor position capability due to their inherent rotor anisotropy. In order to exploit this latter feature which allow to remove the rotor position sensor, which is usually prone to failure, sensorless control algorithms must be properly designed and tuned. Moreover, higher system reliability can be achieved using multi three-phase motors. The greater degrees of freedom offered by these motors allow them to operate even under fault conditions, provided the control detects them and manages them properly.

The eDumper truck, produced by Kuhn Schweiz AG.



Stator and rotor of a dual-three phase synchronous reluctance motor

Sistemi Elettrici

Electrical Systems

DII research group

EdLab
Electric Drive Laboratory

Ludovico Ortombina
ludovico.ortombina@unipd.it
phone: +39 049 827 7535

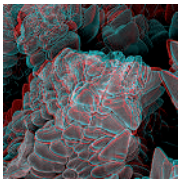
http://edlab.dii.unipd.it/

This research is developed within the frame of the project «Green SEED: Design of more-electric tractors for a more sustainable agriculture» founded by the Italian Ministry of Research and University with the grant 2017SW5MRC, 2017 call.
PI of the project: prof. Luigi Alberti

Main research topics:

- Control of electrical drives
- Permanent magnet motors
- Rotor position estimation
- Sensorless control

Cover story



L'immagine raffigura l'analisi condotta al SEM sulla superficie di frattura di un campione di Rame-Titanio prodotto mediante fusione in cera persa.
La superficie è caratterizzata da una microstruttura dendritica, tipica dei getti di fusione. L'elaborazione dell'immagine come anaglifo permette di valutare al meglio la forma delle dendriti, caratterizzate da un braccio principale centrale e dai bracci secondari. Per la visione dell'immagine è necessario l'uso di occhiali 3D (rosso/ciano).

Denise Hanoz

Si è laureata in Ingegneria Meccanica presso l'Università degli Studi di Modena e Reggio-Emilia nel 2016 e ha conseguito la laurea magistrale presso l'Università degli Studi di Padova in Ingegneria dei Materiali nel 2018. Ha svolto il suo progetto di tesi magistrale in collaborazione con Safilo S.p.A per l'analisi di leghe alternative per la sostituzione del Rame Berillio.
Attualmente sta per concludere il suo percorso di dottorato in Ingegneria Industriale, che si è concentrato nel portare avanti e concludere con successo il progetto iniziato durante la tesi magistrale fino all'introduzione di nuove leghe all'interno del processo di prototipazione di Safilo S.p.A.

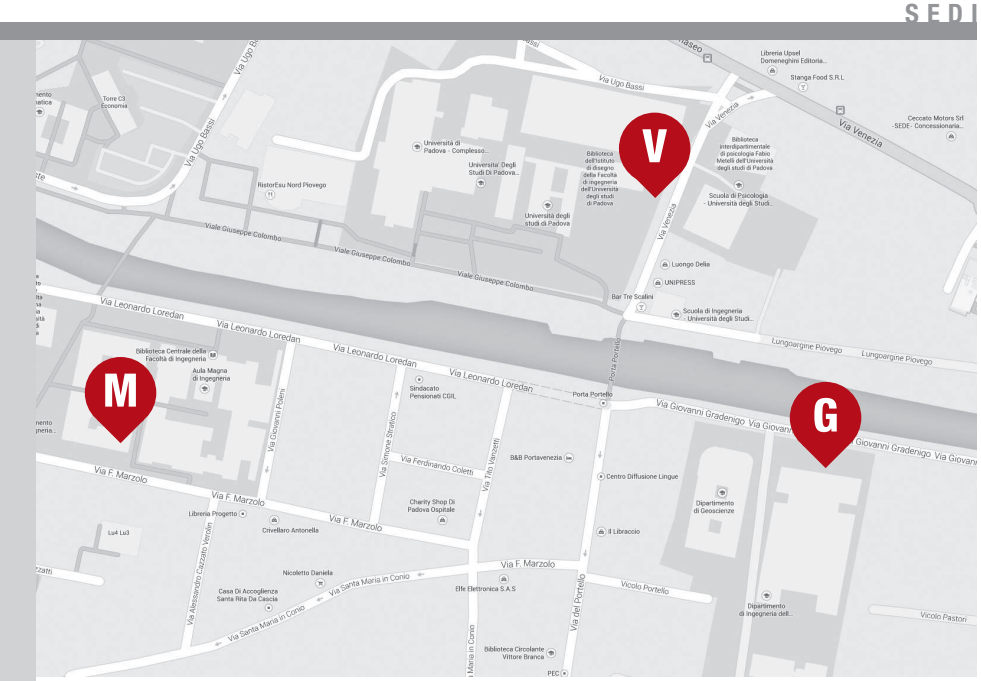
www.dii.unipd.it

Direttore: Stefania Bruschi

Vicedirettore: Piergiorgio Alotto

Segreteria amministrativa:
Paolo Rando

SEDI



DII
Dipartimento di Ingegneria Industriale, Università degli Studi di Padova

Sede legale e amministrativa
Via Gradenigo, 6/a - 35131 Padova
tel. +39 049 8277500
fax +39 049 8277599
segreteria@dii.unipd.it
www.dii.unipd.it

Via Marzolo, 9 - 35131 Padova

Via Venezia, 1 - 35131 Padova