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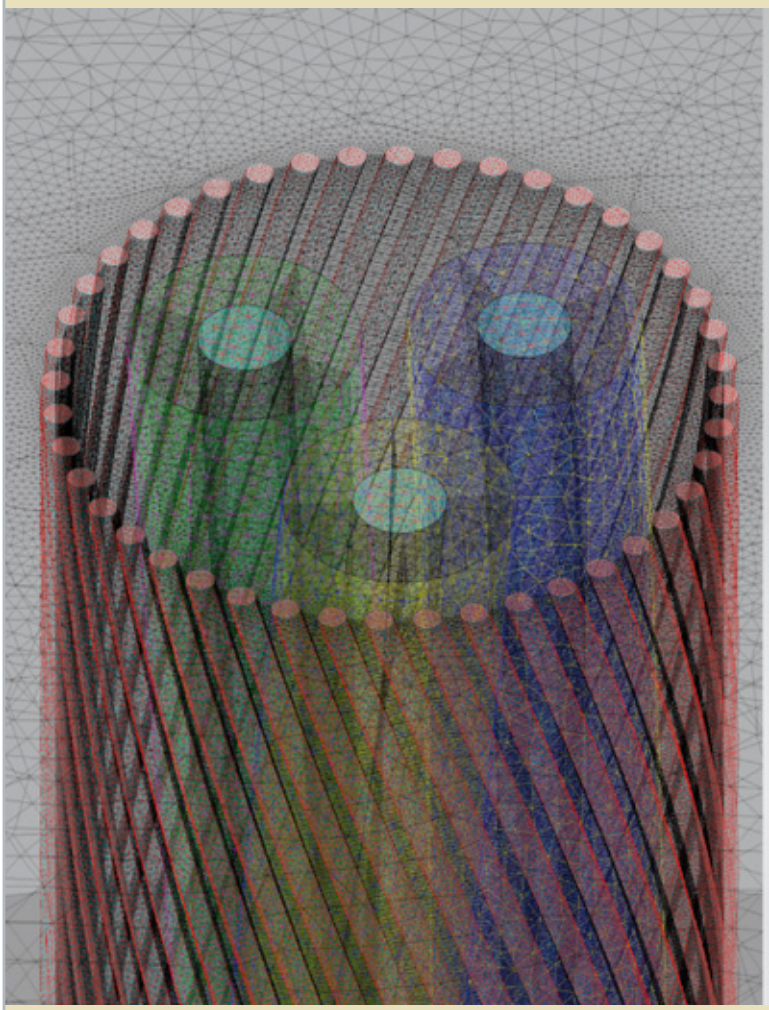
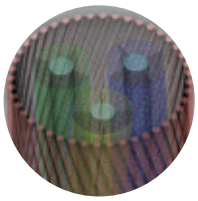
NEWSLETTER DEL DIPARTIMENTO DI INGEGNERIA INDUSTRIALE DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA

UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE





COPERTINA

Modellizzazione agli elementi finiti di un cavo sottomarino.

PAGINA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

SPECIAL EVENT

Il Dipartimento di Ingegneria Industriale saluta Francesco Bettella, ingegnere e atleta

Il Dipartimento di Ingegneria Industriale e la Scuola di Ingegneria dell'Università di Padova si congratulano con l'Ing. Francesco Bettella, vincitore di due medaglie alle recenti Paralimpiadi di Rio de Janeiro:

100 dorso S1 - 9 settembre 2016
50 dorso S1 - 15 settembre 2016

Il DII e la Scuola di Ingegneria lodano il notevole impegno nel coniugare brillanti risultati accademici con altrettanto brillanti risultati nell'attività sportiva ad altissimo livello.

Per tutti i lettori di DIInforma, studenti e docenti, un esempio da seguire!

Sopra, l'Ing. Francesco Bettella dopo la premiazione alle Paralimpiadi di Rio.

A fianco, l'Ing. Francesco Bettella accompagnato dal Prof. Nicola Petrone, dal Direttore del DII, Prof. Massimo Guglielmi (a sinistra), dal Prof. Giovanni Meneghetti e dal Presidente del Consiglio della Scuola di Ingegneria, Prof. Massimiliano Barolo (a destra), in occasione del saluto presso la Sala Consiglio Merigliano (DII sede G), avvenuto il 29 settembre 2016.

Bioingegneria, biotecnologia e tecnologie per la salute
Bioengineering

DII research group

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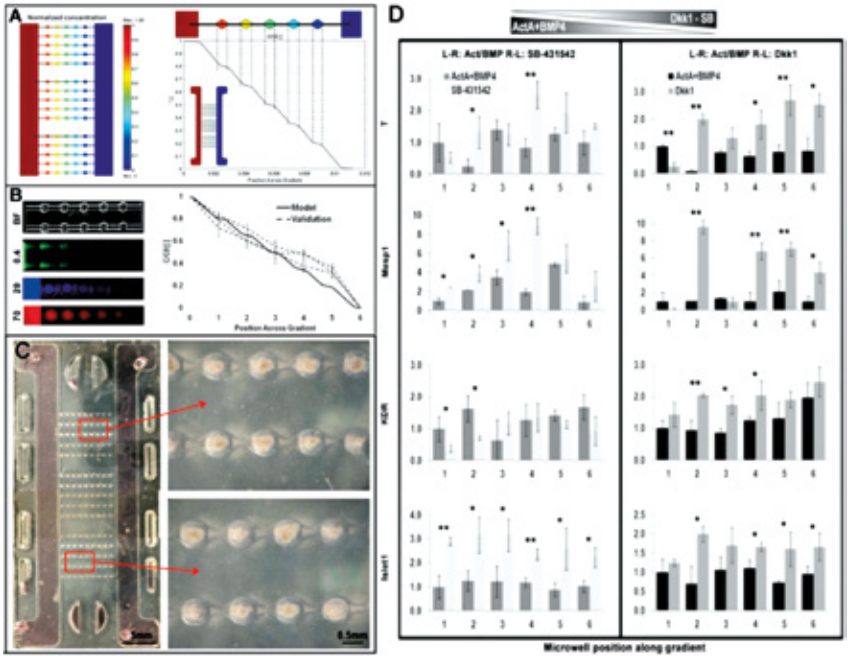
This work was performed at Columbia University (New York, USA) in the laboratory for Stem Cell and Tissue Engineering directed by Prof. Gordana Vunjak-Novakovic
It was also supported by the New York Stem Cell Foundation
(NYSCF, New York, USA)

Main research topics:
- Microscale technologies for stem cells studies
- Microfluidic platforms
- Cancer Stem Cells
- Microphotobioreactors for microalgae studies
- Bioreactors for Tissue Engineering

Microscale technologies as a tool for understanding stem cell behavior

Bioengineered environments that combine tissue-specific transport and signaling are becoming critical in studies of development, regeneration and disease under settings predictive of human condition. Microbioreactors and microfluidic platforms are key in enabling highly controllable and sophisticated experiments at biologically relevant scales and with real-time insights into cellular responses. Laminar flow in micro-channels and short transport distances facilitate the tight control and fine-tuning of the variables of interest. Microbioreactors work at steady state, resembling homeostasis in vivo, and perturbations in the local composition of the microenvironment can be introduced to measure fast dynamic changes in cellular responses.
These technologies combine flexibility of design, precision, and reduced costs to highthroughput and multiparametricity. They can be adapted to a wide range of studies, with the potential to uncover still-elusive cellular behaviors, leading to important advances for global healthcare problems.
In a recent study, we were able to evaluate mesodermal induction in human embryonic stem cells by measuring and correlating the expression of key genes after exposure to concentration gradients of mesodermal-inducing/inhibiting morphogens. The modulation of pathway activations by the local microenvironment resulted in non-linear cell responses to linear concentration gradients: a physiologically relevant behavior, reflecting the complex regulation of mesodermal/mesendodermal differentiation programs by sequences of factors evolving in space and time.



Cimetta E, Vunjak-Novakovic G. "Microscale technologies for regulating human stem cell differentiation". Exp Biol Med. 2014; 239(9): 1255-1263.
E Cimetta#, D Sirabella, K Yeager, K Davidson, J Simon, RT Moon, G Vunjak-Novakovic. "Microfluidic bioreactor for dynamic regulation of early mesodermal commitment in human pluripotent stem cell". Lab on a Chip, 2013; 13(3): 355-64.

Advanced methods for conversion of concentrated solar radiation

A prototype of parabolic trough concentrator is installed at the Lab of Solar Energy Conversion, on the roof of the DII building in Via Venezia 1, Padova. This concentrator (Fig. 1) has an aperture area of almost seven square metres and is asymmetrical. The reflecting optical surface is made of four back silvered glass facets arranged in two rows. The concentrator is equipped with a two-axes solar tracking system and is used to study new types of solar receivers operating under concentrated solar flux. For this purpose, a solar flux mapping system has been set-up. Fig. 2 shows the solar flux distribution measured on the receiver plane in a clear sky day. Two projects are presently going on in this apparatus.

1 The first project addresses the use of nanofluids to absorb solar radiation in solar collectors. Some nanofluids present peculiar optical properties that allow their use as absorbing and heat transfer media in direct absorption solar collectors (DASC). The solar radiation is directly and volumetrically absorbed by the fluid instead of limiting the absorption to a surface and thus high efficiency receivers can be developed. Fig. 3 shows the test section designed and fabricated by our Lab to flow a nanofluid under concentrated solar flux. So far, using a thickness of 18 mm of an aqueous suspension of single wall carbon nanohorns (SWCNHs) with 0,02 g/L concentration, it was possible to absorb 85% of the solar flux. To the best of our knowledge, this is the first experiment of this kind ever done.

Fig.1 Asymmetrical parabolic trough

2 The second project regards the generation of steam of an organic fluid to be used in an expander of a Rankine cycle. The basic concept is the use of the solar flux as energy input in a power generation cycle. The working fluid is a low global-warming-potential fluid classified as R1233zd(E).
The receiver is an internally designed prototype, made in aluminum and manufactured using the bar-and-plate technology. This geometry allows optimal distribution of the two phase mixture and thus efficient generation of vapor directly from the sun.

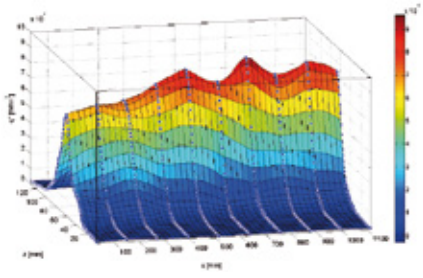


Fig.2 Measurement of 3D concentrated solar flux distribution for a clear sky day in Padova

Fig.3 Test section with flowing nanofluid under concentrated solar flux

Energia
Energy

DII research group
STET – Sustainable Thermal Energy Technologies

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Simone Dugaria (PhD student)

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The research activity regarding the use of aqueous suspension of single wall carbon nanohorns is performed in collaboration with CNR (Istituto per le Tecnologie della Costruzione and Istituto di Chimica della Materia condensata e di Tecnologie per l'Energia in Padova; Istituto Nazionale di Ottica in Florence) and is co-funded by Interdepartmental Centre Giorgio Levi Cases.

The research activity addressing the evaporation of an organic fluid from solar flux for a Rankine cycle is carried out in collaboration with ENEA, in the framework of PAR 2016.

Ingegneria dei sistemi elettrici
Electric systems

DII research group
Gruppo per ricerche sulla fusione


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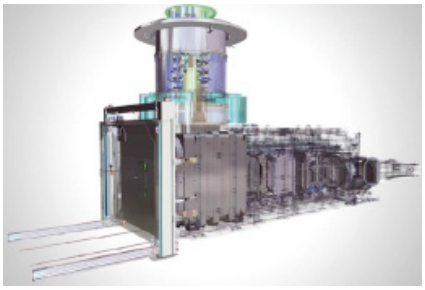
The research is carried out within the framework of the European Fusion Programme, in collaboration with Consorzio RFX (partners: ENEA, CNR, INFN, Università degli Studi di Padova, Acciaierie Venete SpA).

Main research topics:

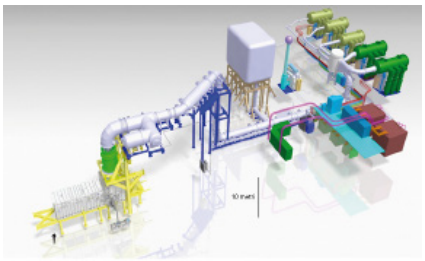
- Fusion science and technology
- Power technology and supplies for fusion
- Neutral beam injection system for plasma heating
- Realization and operation of large fusion devices

Multiconductor 1 MV DC transmission line for large current accelerators

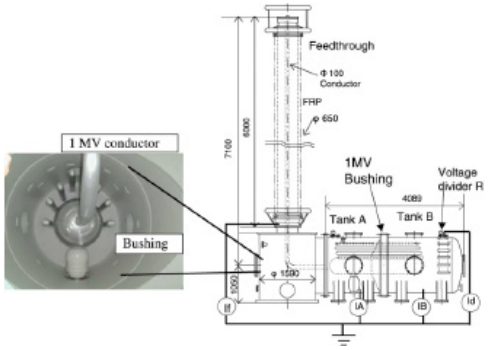
Multiconductors have been "miniaturized" in order to be the smallest conductors (five times smaller than the conductors currently used in high voltage transmission pipelines) able to feed the neutral beam injectors in ITER up to 1MV. The high voltage power supplies for the neutral beam injector involve highly innovative techniques, under development by researchers of Consorzio RFX (in which the University of Padova is involved through the Centro Ricerche Fusione) in collaboration with Japanese colleagues from the Japan Atomic Energy Agency (JAEA); the main components are being manufactured by Hitachi, Japan.
The power supplies of the Neutral Beam Test Facility will include 5 large insulation trasformers, a multiconductor transmission line and the bushing which will connect the line to the beam source and accelerator. Electric power with five different potentials from ground up to 1 MV DC will be conveyed through the line. These voltages will be used to accelerate a beam of hydrogen and deuterium negative ions that, after neutralization, will be injected into ITER tokamak plasma in the form of 1 MeV neutral particles. The injected power will be up to 17 MW for one hour.



The injector in the picture will be used in ITER to "fire" high energy neutral particles, directly into the plasma, where, by means of collisions, they will transfer their energy to the plasma particles.



The injector will heat the ITER plasma to allow the reactor reaching conditions suitable for fusion reactions to occur



CAD scheme of the power supplies of MITICA, the neutral beam accelerator prototype

Multidisciplinary Analysis of the Turin Shroud: digital imaging, measurements and dating

The Turin Shroud (TS) is a handmade 3:1 twill linen cloth, 4.4 m long and 1.1 m wide, on which the front and back images of a corpse are indelibly impressed. According to the Catholic Christian tradition, the TS is the burial cloth in which Jesus Christ was wrapped before being placed in a tomb in Palestine about 2000 years ago, therefore it is the most important Relic of Catholic Christianity. The Science has not demonstrated the contrary.

In 1988, the TS was radiocarbon-dated to 1260-1390 A.D., but the result is not statistically reliable and is also questionable because possible systematic environmental effects could have altered the result. The practical coincidence of the TS face with that of Christ on Byzantine coins, starting from the VII century A.D., demonstrates that it was seen in that age.

New dating methods place the TS in the first century A.D.; among them, a mechanical multi-parametric method was developed in the DII. It bases on the stress analysis. A cycling load machine was designed and built to measure breaking strength, Young modulus and loss factor of single flax fibers 2-20 mm long and having diameters of 8-30 micrometers. These mechanical properties have been compared using two dozen reference samples having ages from 3000 B.C. to 2000 A.D. thus obtaining proper calibration curves relating the mechanical property to the fiber age.

Many hypotheses have been formulated to explain the double body image, impossible to be reproduced. The most reliable one is currently connected to an electrical phenomenon (Corona Discharge). With the help of experts in electric field, leaded by prof. Giancarlo Pesavento, many experimental tests have been conducted in laboratory to try to partially reproduce the TS image. The best result, reported in Figure 3, was obtained by applying a tension of 300 kV to a ½ scale manikin covered by a linen sheet.

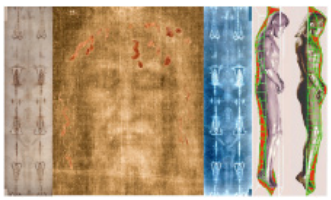


Fig. 1: Turin Shroud and its wrapping.

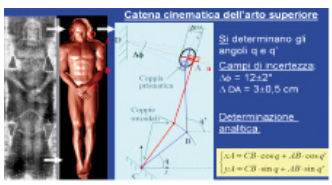


Fig. 2: Cinematic analysis of shoulder.

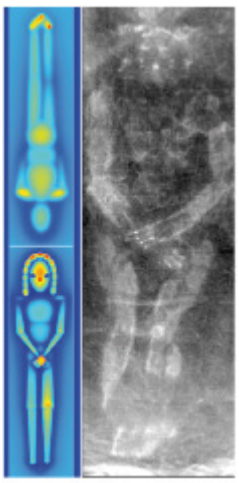


Fig. 3: Numerical and experimental results - Corona Discharge.

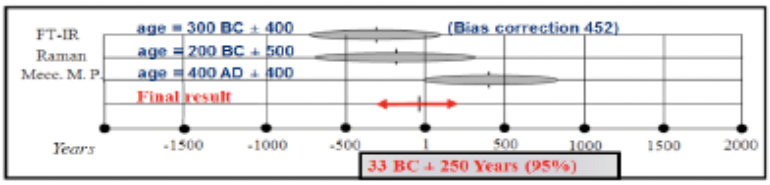


Fig. 4: Results of new dating methods (FT-IR, Raman and Multi-parametric mechanical) of the Shroud.

Ingegneria dei sistemi meccanici
Mechanical systems

DII research group
Mechanical and Thermal Measurements

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The research project was supported by the University of Padova (No. CPDA099244/09,): Multidisciplinary Analysis of the Turin Shroud, study of the body image, of pollution and of micro-particles.

Collaborations:

- Shroud of Turin Education and Research Association, Inc. (STERA, Inc., USA),
- Turin Shroud Center of Colorado (TSC, USA)

Main research topics:

- Scientific studies on the Turin Shroud
- Mechanical analysis of textile fibres
- Image analysis and processing
- Measurement uncertainty analysis
- Testing

Materiali avanzati
Advanced Materials

DII research group
Advanced Ceramics and Glasses

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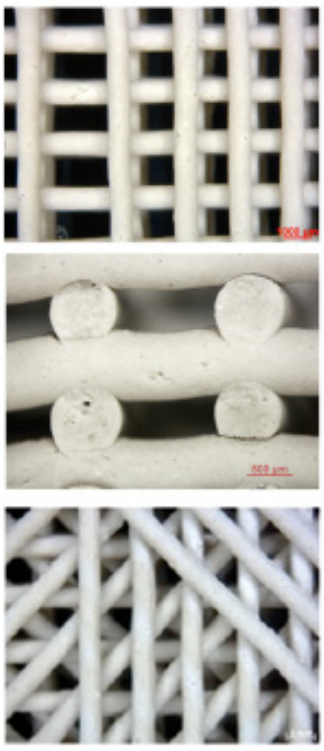
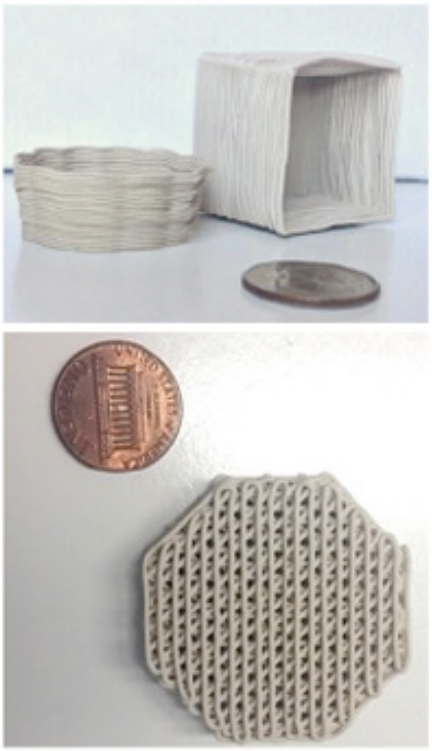
Luca Zeffiro, undergraduate student

Direct Ink Writing of Geopolymers

Geopolymers are based on an inorganic 3D network of alumino-silicate units usually synthesized through the reaction of alumino-silicate powders (e.g. metakalolin) in presence of a silicate alkaline solution. The rheological characteristics of the reactive mixtures and the fact that these systems can consolidate at low or even room temperature, together with their intrinsic micro- and meso-porosity and good mechanical properties, are the reason why they are considered for a wide range of applications, such as construction materials, thermal insulation, filters, adsorbers and so on.
Our group has been exploring innovative fabrication processes for geopolymer components, focusing on foaming or additive manufacturing technologies.
We used, for the first time, mixtures based on an alkaline-geopolymer for 3D printing of components of complex shape which can be used at room or even at high temperature, as they can easily withstand heating up to at least 1200°C.
In particular, we investigated and controlled the rheological properties of geopolymer material, in order to develop inks suitable for generating structures with large overhangs and spanning features, to be employed, for instance, for filtration applications. Different water contents and different types and amounts of additives were used to control and enhance the Bingham pseudo-plastic behavior of the inks.
Such optimization resulted in the ability to fabricate components with large overhangs and spanning features, including highly porous 3D lattices.

Scaffolds with a total porosity of ~45 vol% possessed a compression strength higher than 10 MPa, which decreased to ~2 MPa when the porosity increased to ~65 vol%.

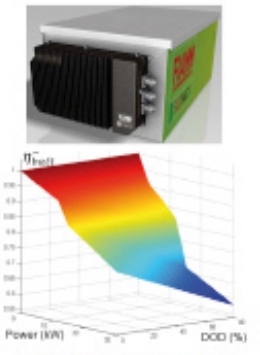




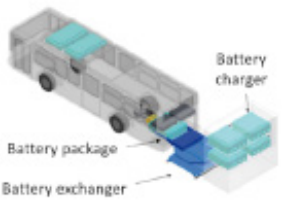
Main research topics
- Polymer-Derived-Ceramic components from preceramic polymers
- Ceramic components from geopolymers
- Advanced ceramic and glass foams by direct foaming
- Additive manufacturing of ceramics (Direct Ink writing (DIW), Powder-bed (3DP), Stereolithography (SLS)

Sustainability Evaluation of an Electric Bus Fleet for the Urban Public Transport System of Padova

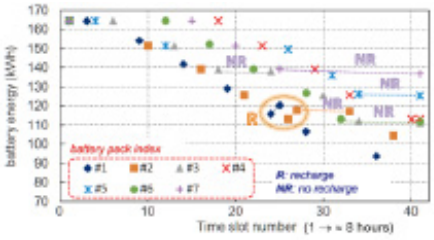
The development of a sustainable and reliable urban public transport service calls for a better integration between novel clean technologies and efficient management of the vehicle fleet. The research focused on the benefits deriving from the introduction of an electric battery-supplied bus (EBB) fleet in the urban transportation context of the city of Padova, provided with exchangeable batteries coupled to recharging stations (battery swap stations). Its main features are the reduced recharging time limited to battery package replacement, the load reduction on the electrical infrastructure with respect to rapid charging systems, the extended battery lifetime due to the optimized state of charge management and charging conditions and the consistency with different battery technologies. After an extensive analysis of the actual urban bus fleet (2014), equivalent bus configurations are defined for both diesel and compressed natural gas vehicles, by means of an analytical elaboration of reference driving cycles. Such elaboration also includes the performance deterioration over the vehicle life by applying a derating function to the propulsion system and catalyzer efficiencies. Then, the EBBs characteristics and operation are determined by an algorithm aiming at the minimization of the battery investment and operating costs on a ten years service. The algorithm includes the efficiency models elaborated from experimental charge/discharge operations of a Sodium Nickel Chloride (ZEBRA) battery, deemed to be the more suited technology in terms of specific energy, purchasing cost, fault tolerance and operating life.
The equivalent buses with different length are compared in terms of energy consumptions and pollutant emissions on the same reference routes.
Such comparison is carried out by numerical simulations, taking into account both the engine practical behavior and the battery charge/discharge operation.
By way of example, the simulations evidence the following savings by replacing 8 m diesel buses with corresponding EBBs : -58% primary energy consumption, -72.6% NOx,-77.7% from HC and NMVOC comparison and -92.8% PM.
In addition to such benefits, a significant noise reduction is expected.
The estimated overall average annual cost is 0.48 €/km, competitive with the actual well-established technologies .



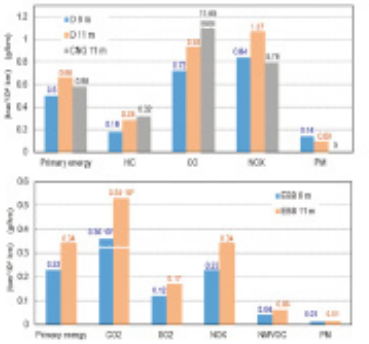
38 Ah ZEBRA battery module and discharge efficiency map (courtesy of FIAMM)



Battery swap principle



Variation of the battery energy with the time slot number (APS DP route, 5 bus fleet, 7 battery packs)



Specific energy consumption and gas emissions for 8 m and 11 long buses; (a): ICE buses (D: diesel type); (b): EBBs.

Mobilità sostenibile
Sustainable mobility

DII research group
Electrical Machines
Laboratory

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Collaboration:
APS Holding SpA
FIAMM Group SpA

Main research topics:

- Electrical Generation from Renewable Sources
- Electrical Energy Storage
- Electrical Systems for the Sustainable Mobility
- Small Electrical Motors and Drives for Home Appliances

Processi, prodotti e servizi
Processes, products and sercice

DII research group
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Turning "big data" into business - The pharma industry case study

Pharmaceutical industries are known as "data rich - information poor" environments. Modern pharmaceutical manufacturing systems are hooked to computers that collect and store the measurements coming from sensors distributed all over the plant. The number of sensors is relatively large, and the measurements are made available at relatively high frequency (typically, one measurement every few seconds). Therefore, the number of data entries that are made available during a production campaign easily reaches the order of hundreds of millions. These data contain a wealth of information that can be extremely useful to optimize the performance of the manufacturing system. However, due to the data overload, extracting the information is not an easy task, so that this information remains largely unexploited.

The CAPE-Lab group has considerable expertise in the analysis of historical sets of manufacturing data to support the periodic review of manufacturing systems. As an example, a methodology based on the use of pattern recognition techniques coupled to multivariate statistical analysis has been recently been developed to support process optimization in a multinational "big pharma" company. Several operations have been made completely automatic, such as: detection of how many lots have been processed in a given manufacturing campaign (Figure 1.a); characterization of the process evolution in each lot (Figure 1.b); comparison of the evolution of the manufacturing across different lots (Figure 1.c). The methodology has been tested with excellent results on a twelve-month historical dataset coming from a commercial-scale granulation/drying system manufacturing a set of drugs. A prototype code has been developed that is being used by the company to identify of possible areas of improvement in secondary manufacturing operations.

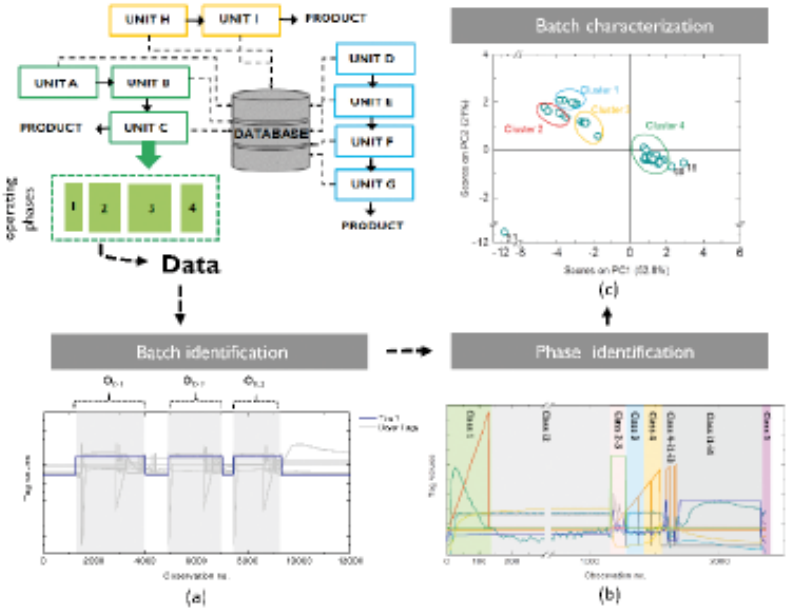


Figure 1. Main steps of the methodology proposed to analyse historical manufacturing data (Meneghetti, N., P. Facco, F. Bezzo, C. Himawan, S. Zomer, M. Barolo, 2016. Knowledge management in secondary pharmaceutical manufacturing by mining of data historians – A proof-of-concept study. *Int. J Pharm.*, **505**, 394–408)

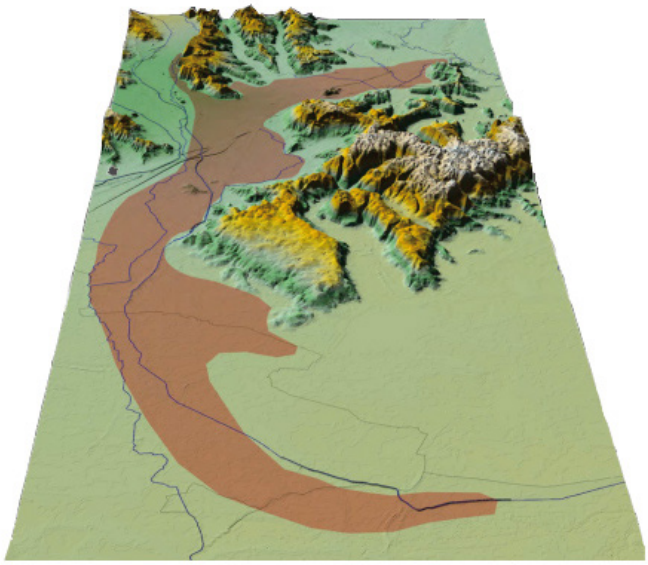
Investigation conducted in collaboration with Dr. Simeone Zomer and Dr Chrismono Himawan - GlaxoSmithKline R&D

Main research topics:

- Product design and quality control
- Data anlysis and process control
- Mode development and identification
- Design of energy systems

Use of strong anion exchange resin for the removal of PFAS from contaminated drinking water

The term "PerFluoroAlkylated Substances" or PFAS, indicates a broad group of anthropogenic compounds comprising a perfluoroalkyl backbone and a terminal functional group.
Because of their unique properties such as hydro and oleophobicity, chemical, thermal and biological stability and extremely low surface tension, PFAS have found widespread use in the last decades. Due to their outstanding stability, PFAS have been globally found in the environment and biota. Persistency and bioaccumulation of PFAS are strongly related to the length of the fluorinated moiety.
In 2013 abnormally high levels of PFAS were detected in waters sampled in an area covering approximately 150 square kilometers in the Veneto region, Italy (Figure 1). Adsorption of PFAS on granular activated carbon (GAC) was adopted as an emergency measure in many drinking water treatment facilities to meet the performance limits set by the Italian Ministry of Health for drinking water (30 ng·L-1 for PFOS, 500 ng·L-1 for PFOA, 500 ng·L-1 for PFBA, 500 ng·L-1 for PFBS and 500 ng·L-1 for the sum of all other PFAS). Efficiency of GAC filters dramatically drops as the length of the fluorinated chain become shorter. Further GAC is not easily regenerable.
In order to overcome limitations of GAC, strong anion exchange resins (Purolite® A600E, A520E and A532E) were tested in three pilot plants. The role of the hydrophobic sorbate-sorbed interactions on selectivity and exchange capacity of resins proved to be of primary importance in comparison with other parameters such as resin matrix. It is plausible that the removal is due to a mechanism involving both ion exchange of single molecules and retention of molecular aggregates (micelles and hemi-micelles). Further, exchange resins were regenerated in-situ using various solvent and solvent-free saline solutions.
In conclusion strong anion exchange resins are a viable alternative to GAC for removal of PFAS in drinking water decontamination (Table 1).



Resin	µg·g^{-1} of PFBA	µg·g^{-1} of PFOA	µg·g^{-1} of PFBS	µg·g^{-1} of PFOS
A600E	0.6	28.5	2.8	2.2
A520E	1.5	37.2	4.3	3.7
A532E	3.3	45.1	5.9	4.7
Activated carbon "C"	4.3	39.6	8.1	4.1
Activated carbon "S"	2.3	31.6	7.1	3.9
Acitvated carbon "J"	3.8	17.3	6.8	2.4

Table 1 - Exchange capacity of anion resins Purolite® A600E, A520E, A532E and granular activated carbon "C", "S" and "J" for PFOA, PFBA, PFOS and PFBS derived from exchange and sorption curves of continuous experiments.

Ambiente
Environment

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Milano, Italy

Main research topics:

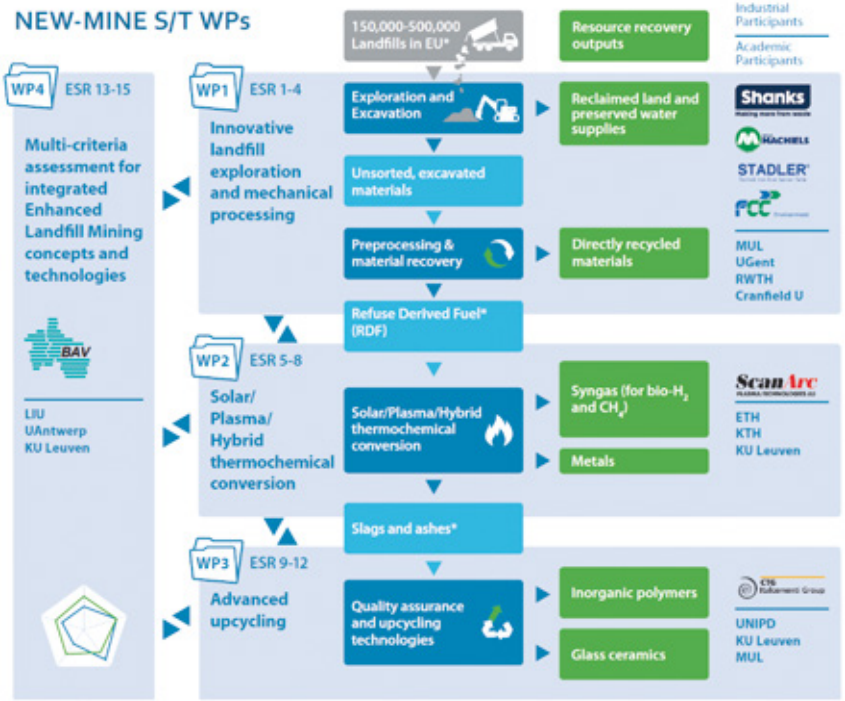
- Design, synthesis and reactivity of fluorinated compounds for advanced applications
- Design and operation of drinking, process and wastewater treatment plants

Archievements

NEW-MINE: primo progetto europeo su ‘Enhanced Landfill Mining’

Il Consorzio europeo European Enhanced Landfill Mining Consortium (EURELCO) di cui il DII fa parte dal 2014, ha ricevuto il primo finanziamento europeo finalizzato ad attività sulla tematica dell’”Enhanced Landfill Mining” (ELFM - recupero di risorse da discariche), attraverso il progetto NEW-MINE. Il progetto -ITN-2016 (progetti EU Horizon 2020 Marie Skłodowska-ha ottenuto un punteggio record di 97,6% nell’ambito della call MSCACurie MSCA-ETN). Il progetto, che avrà inizio il 1 ° settembre 2016, è coordinato dalla KU Leuven, che ha unito le forze con altri 9 Beneficiari, afferenti a 6 Stati membri dell'UE. Il finanziamento di questo primo progetto ELFM (3,8 milioni di euro) rappresenta un importante passo avanti per il raggiungimento di un’economia circolare in Europa, in quanto porterà a nuove soluzioni per separare e ricavare risorse, in termini di energia e materiali, dall’escavazione di 500.000 discariche in Europa. La tecnologia NEW-MINE porterà alla trasformazione dei rifiuti presenti in discarica in prodotti ad alto valore aggiunto. Il DII partecipa al progetto attraverso il gruppo Advanced Ceramics and Glasses (Ceramici Avanzati e Vetri).

Il Prof. Enrico Bernardo sarà il supervisore di uno dei 15 early stage researchers reclutati nell’ambito del progetto, per attività riguardanti l’ottenimento di materiali vetroceramici porosi per applicazioni strutturali e funzionali, a partire da residui inorganici derivanti, a loro volta, da processi di separazione delle frazioni organica e metallica del materiale da discarica, effettuati presso altri partners. Il Prof. Bernardo sarà anche leader del work package (WP3) dedicato alle “up-cycling technologies” (tecnologie di valorizzazione) di rifiuti inorganici, che comprenderà, oltre alle attività presso il DII, attività presso KU Leuven e Italcementi, anche in collaborazione con il DICEA (Prof. Carlo Pellegrino).

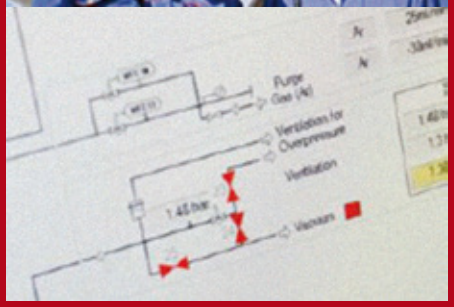


Corso di laurea magistrale in Ingegneria Chimica e dei Processi Industriali

L'Ingegnere chimico e dei processi industriali (comunemente chiamato anche "Ingegnere di processo") è una figura professionale riconosciuta e apprezzata a livello internazionale. Grazie alla specifica formazione in ambito chimico-fisico e biologico, è in grado di progettare e gestire in modo sostenibile i processi e gli impianti di produzione di beni di largo consumo, e di promuovere l'innovazione tecnologica industriale.

Il Corso di Studi attualizza al mondo contemporaneo le competenze tradizionali dell'Ingegneria chimica. Questa disciplina ha da sempre guidato l'industrializzazione delle scoperte della chimica (per esempio materie plastiche, fibre sintetiche, fertilizzanti, combustibili), evolvendosi quindi come una disciplina autonoma e indipendente dalla Chimica e dalla Chimica industriale, e pervadendo una varietà di sistemi industriali un tempo non riconosciuti completamente affini alla chimica (dall'industria farmaceutica a quella alimentare, dalla produzione di detergenti e cosmetici all'energia, dai processi biotecnologici e biomedici ai processi di trattamento degli inquinanti, dalla gestione della sicurezza industriale all'industria elettronica). In tal modo, l'Ingegneria chimica contribuisce in modo determinante alla creazione di quei processi produttivi che concorrono a diffondere un moderno livello di sviluppo sostenibile, sotto forma di disponibilità (su vasta scala e a costo limitato) di sostanze chimiche, materiali, alimenti, indumenti, medicinali, detergenti, combustibili, strumenti informatici, strumenti per la gestione ambientale e la sicurezza, …

La disciplina dell'Ingegneria chimica si distingue per un approccio fortemente metodologico e interdisciplinare. In particolare, l'approccio interdisciplinare costituisce una caratterizzazione importante del profilo professionale dei laureati in questo Corso di Laurea Magistrale, rendendoli capaci di interagire proficuamente con tecnici e scienziati di diversa estrazione professionale (come ingegneri dei materiali, meccanici, elettrici, aerospaziali, energetici, elettronici, biomedici; e con chimici, biologi, biotecnologi, fisici, matematici, statistici), grazie alla capacità di impiegare conoscenze e tecniche proprie di molti settori diversi, sia delle Scienze (chimica, fisica, biologia), che dell'Ingegneria (meccanica dei solidi e dei fluidi, termodinamica, macchine, analisi dei segnali, strumentazione e controllo, …). Questa interdisciplinarietà è stata da sempre il vantaggio competitivo degli ingegneri chimici, che hanno dimostrato di eccellere nelle più svariate mansioni (tecniche, di ricerca e gestionali), e che per questa loro versatilità sono particolarmente apprezzati in ambito industriale, sia in Italia che all'estero. Questa versatilità è inoltre una ragione di allargamento degli orizzonti occupazionali.



http://icm.dii.unipd.it/ingegneria-chimica-e-dei-processi-industriali/

http://icm.dii.unipd.it/ingegneria-dei-materiali/

Corso di laurea magistrale in Ingegneria dei Materiali

L'Ingegneria dei Materiali è un settore interdisciplinare e rivoluzionario. Infatti l'Ingegneria dei Materiali ha trasformato ogni aspetto della vita moderna. I nuovi materiali sono stati tra i più grandi successi di tutti i tempi e risultano fondamentali per la crescita, per la sicurezza e per la qualità della vita umana fin dall'inizio della storia. È sempre grazie a nuovi materiali che si è aperta lo sviluppo di nuove tecnologie. I progressi nei materiali sono cruciali per la continua vitalità di numerose industrie.

Attualmente gli Ingegneri dei Materiali continuano ad essere in prima linea in moltissime aree della scienza e della tecnologia. Essi esplorano le fondamenta scientifiche dei materiali, il loro design e le loro trasformazioni per le applicazioni nel mondo reale in modo da influenzare la nostra vita ogni volta che acquistiamo od utilizziamo un nuovo dispositivo, una nuova macchina o struttura. Gli Ingegneri dei Materiali applicano i principi basilari della chimica e della fisica per conoscere la struttura e le proprietà dei materiali. Essi sviluppano processi per la modificazione dei materiali per soddisfare le esigenze della moderna tecnologia.

Un materiale può essere scelto per la sua resistenza meccanica, per le sue proprietà elettriche, per la sua resistenza al calore o alla corrosione, o per una serie di altre ragioni che tutte però si riferiscono alle loro proprietà. Tutte le proprietà utili di un materiale sono intimamente legate alla sua struttura a qualsiasi livello, compreso quali tipi di atomi sono presenti, come gli atomi sono legati e come i gruppi di atomi sono disposti in tutto il materiale. Gli Ingegneri dei Materiali apprendono come questa struttura e le proprietà risultanti da essa, possano essere controllate mediante la lavorazione del materiale. L'Ingegneria dei Materiali spazia dal molto piccolo, come le nanotecnologie, all'estremamente grande, come la produzione di migliaia di tonnellate di ferro alla settimana in un altoforno.

Conoscere le relazioni tra le proprietà, la struttura, la lavorazione e le prestazioni di un materiale, rende l'Ingegnere dei Materiali il signore dell'universo dell'Ingegneria.

Electrical-thermal-structural coupled-field finite element modeling and experimental testing of high-temperature plasma ion sources for the production of radioactive ion beams

Presentato da G. Vivian - *Dipartimento di Ingegneria Industriale, Università di Padova*

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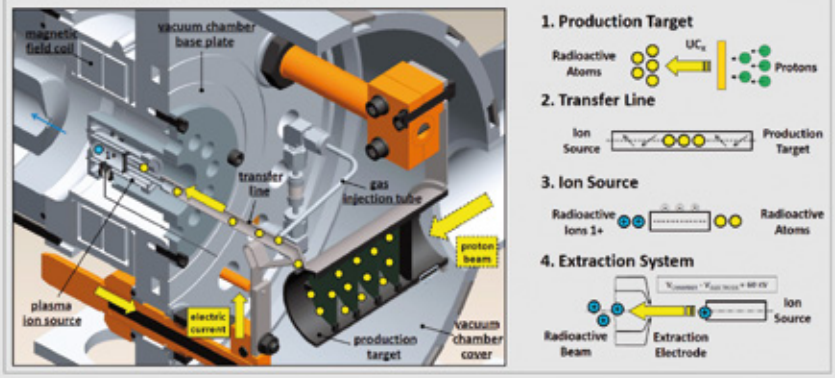
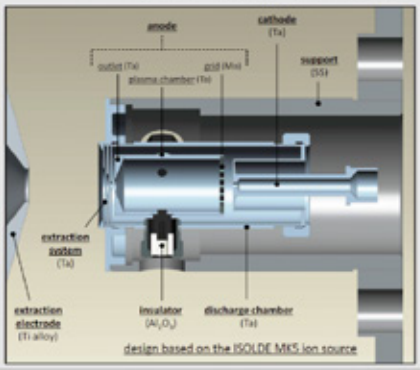
ABSTRACT AND TARGET OF THE STUDY: In the field of isotope separation on line (ISOL) facilities, the plasma ion source[1] (that is a forced electron beam induced arc discharge ion source) is used to ionize a wide range of elements. The aim of this work was to develop a virtual model of the ion source, with the purpose of improving the quality of the design phase. The main components of the ion source are a cathode and an anode, that require a *high temperature field* to allow the ionization with acceptable efficiency: the electron beam that causes the ionization is produced by thermionic effect from the metallic cathode[2]. In this work the *electrical-thermal behaviour* of plasma ion sources is studied in detail by means of coupled field finite element models[3]. Moreover, the thermal behaviour can affect significantly the functioning of the ion source because it modifies the cathode-anode interface distance. Therefore a detailed thermal-structural study is also presented: the temperature data obtained from electrical-thermal model were used as a new thermal load in the *structural model*. After that, numerical results were compared with electric potential difference, temperature, and displacement measurements to validate the electrical-thermal as well as the thermal-structural models. Finally, by considering the plasma ion source the thermionic effect parameter, called ionizing electron current, was measured, and then compared with the analytical values estimated combining calculated temperatures with the well-known Richardson formula and Child-Langmuir relation. The approach presented in this work defines a reference procedure for the electrical-thermal-structural design of plasma ion sources, characterized by improved ionization efficiency.

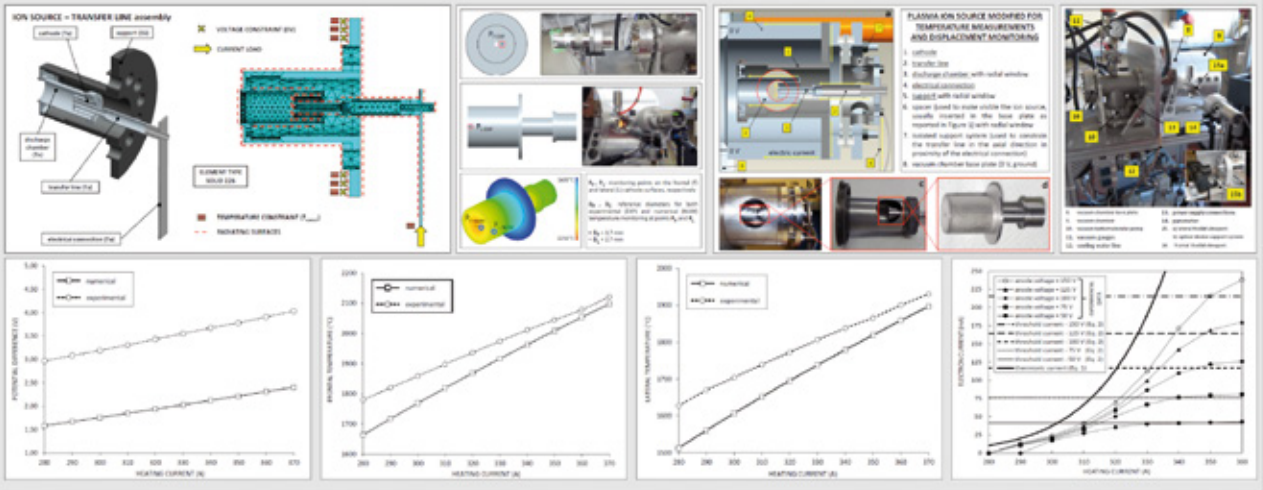
The SPES target-ion source system



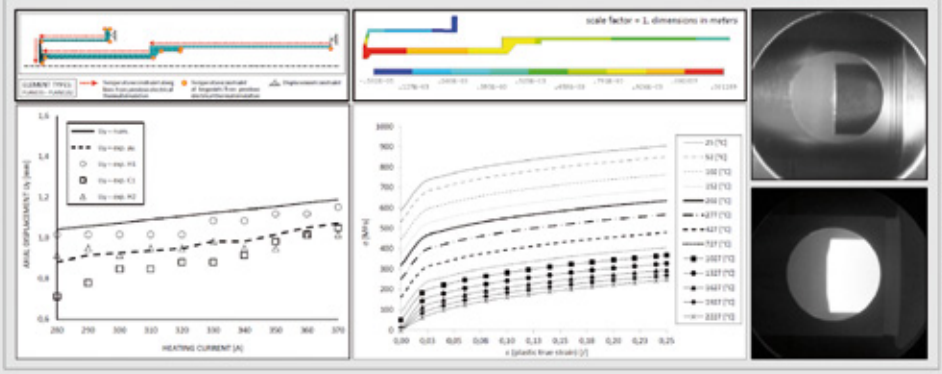
The SPES plasma ion source



The SPES plasma ion source electrical-thermal model



The SPES plasma ion source thermal-structural model



Theoretical Frame

1. Thermionic effect (Richardson formula[2]):

$$J_{em} = A \cdot b \cdot T^2 \cdot exp\left(\frac{-e\phi}{kT}\right) \left[A/cm^2\right]$$

2. Threshold effect (Child-Langmuir relation):

$$J_{tr} = \chi \cdot V^{\frac{3}{2}}/a^2 \left[A/cm^2\right]$$

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[1] M. Manzolaro et al., Rev. Sci. Instrum. 85, 028918 (2014).

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[3] G. Meneghetti, M. Manzolaro, A. Andrighetto, Fin. Elem. Anal. Des. 47, 559 (2011).

Poster presented at:
INTERNATIONAL CAE CONFERENCE
2015 October 19-20, 2015, Pacengo del Garda

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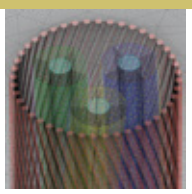
UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

Cover story



Modellizzazione agli elementi finiti di un cavo sottomarino.

La figura mostra la rappresentazione, mediante metodo agli elementi finiti (FEM) di un cavo tripolare sottomarino armato a 132 kV. Il cavo, isolato in polietilene reticolato, è costituito da conduttori in rame, schermi in piombo e un' armatura a fili di acciaio zincato. Sia i conduttori di fase sia i fili dell'armatura sono cordati, con differenti passi. La modellizzazione FEM, realizzata per di uno spezzone di cavo lungo 3 m, tiene conto di tutti gli elementi succitati senza l'introduzione di ipotesi semplificative.

Ing. Sebastian Dambone Sessa

Nato a Mestre, il 06/07/1981. Dottorando in Ingegneria Industriale, XXIX° ciclo sotto la supervisione del Prof. Benato. Laureatosi in Ingegneria Elettrica nel 2010 ha lavorato fino al 2011 presso l'azienda Ampere di Milano nell'ambito delle misure elettriche su alternatori e cavi. Inizia nel 2012 la sua attività di ricerca presso l'università di Padova nel gruppo di Sistemi Elettrici per l'Energia come assegnista. I suoi campi di ricerca sono la modellizzazione matriciale avanzata di sistemi elettrici di potenza e lo sviluppo di modelli sperimentali per tecnologie di accumulo elettrochimico stazionario dell'energia elettrica.

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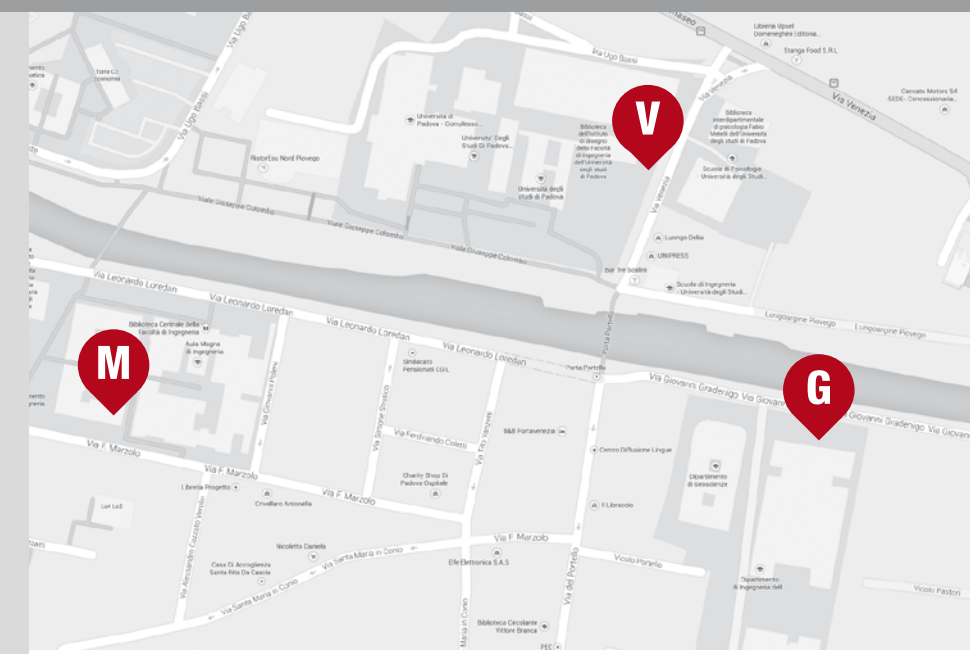

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