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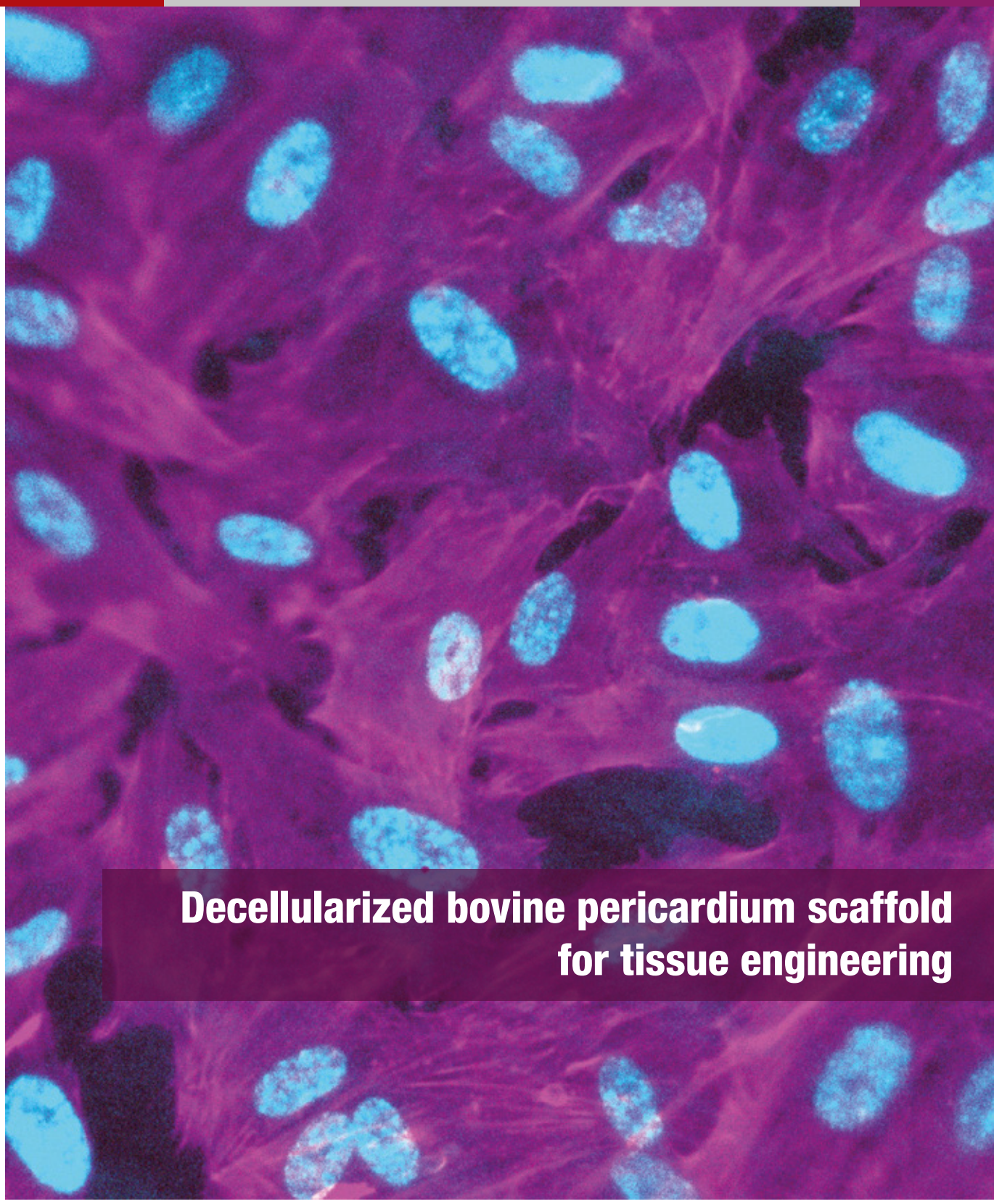
NEWSLETTER DEL DIPARTIMENTO DI INGEGNERIA INDUSTRIALE DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA



Decellularized bovine pericardium scaffold for tissue engineering

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

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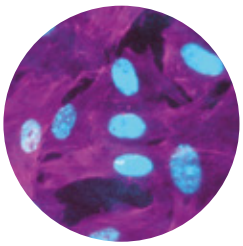

COPERTINA

Scaffold di pericardio bovino decellularizzato per ingegneria tissutale
Decellularized bovine pericardium scaffold for tissue engineering

PAGINA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

A complete suite for autonomous monitoring of light pollution from stratospheric balloons and drones

A complete autonomous sensor suite has been designed to measure the luminous intensity and spectral power density of ground polluting sources in parallel with brightness of the night sky using stratospheric balloons and drones.

The suite is completely autonomous: the imaging subsystem, which includes three cameras with dedicated filters and two commercial Sky Quality Meter (SQM-L) units, is controlled by Raspberry based Central Data Management Unit performing sensor conditioning, data acquisition, compression and storage; power is provided by a rechargeable power bank allowing continuous operation up to 5 hours.

The structure has been designed and optimized to withstand dynamic loads during launch and parachuted descent and realized using 3D printed ABS internal components achieving a total final mass of 2.5 kilogram. The sensor suite has been already successfully tested using a tethered balloon system and will fly to stratospheric altitudes (up to 36 kilometer) in Spring 2021 allowing the first continuous direct measurement of sky brightness from ground.

Figure 1. Stratospheric balloons Flight Unit

Figure 2. Test campaign with tethered balloon

Sistemi aerospaziali

Aerospace systems

DII research group
Space flight dynamics
Illumination & Photometry

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Mirco Bartolomei
Giacomo Colombatti

(Center of Studies and Activities for Space "CISAS" G.Colombo)

And the precious support of :

Federico Toson

Main research topics:

- Stratospheric balloons
- Light pollution
- Artificial lighting & urban monitoring
- Remote sensing
- Photometry & spectral analysis

Part of the project has been developed under coordination and funding by Department of Industrial Engineering as part of the Twinning research program of the University of Padova.

Energia

Energy

Turbomachinery and
Energy System Group (TES)

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The research activity is carried out in collaboration with prof. Alarico Macor, Dipartimento di Tecnica e Gestione dei Sistemi Industriali (DTG), Università degli Studi Padova

Main research topics:

- Biogas Engine Emissions Characterization
- Design and Optimization of Large-Scale Thermal Energy Storage System
- Fossil Fuels based Power Generation Unit Flexibilization
- Power Generation Units Dynamic Analysis
- Waste Heat Recovery Units Design and Optimization
- Hybrid Power Generation System Optimization
- Life Cycle Assessment
- Application of sono-cavitation for the concentration of CO2 in a liquid flow

A Human Health Toxicity Assessment of Biogas Engines Regulated and Unregulated Emissions

With over 17600 plants and an installed electricity capacity exceeding 9900 MW, Italy is one of the leading countries in the biogas sector. Agricultural, landfill, sewage and manure substrates are converted into biogas using anaerobic digestion and then, into electricity and heat by means of properly arranged internal combustion engines (ICEs).

Despite engine's high efficiency, fuel renewability and strict emissions regulations, biogas facilities are the source of concern for people living close to them due to ICEs' release into the atmosphere. Therefore, to cover the literature lack and provide the answers required by citizens, biogas engine regulated and unregulated emissions need to be measured and then used to evaluate their damage to human health. The need of including also unregulated emissions like polycyclic aromatic hydrocarbons (PAHs), aldehydes and dioxins and furans is twofold: (i) to cover the lack in biogas engine emissions measurements and (ii) to complete the picture on biogas harmfulness to human health by identifying the substances with the highest impact. To this purpose, an experimental campaign is conducted on six in-operation biogas ICEs characterized by an electric power of 999 kWel. Moreover, to complete the picture and draw useful comparisons, also a 999 kWel engine fed by the natural gas is included in the analysis.

Collected data are used to perform an impact analysis on human health combining the Health Impact Assessment and the Risk Assessment. Measurements show that PAHs, aldehydes and dioxins and furans are almost always below the detection limit, in both biogas and natural gas exhausts. The carcinogenic risk analysis of PAHs for the two fuels established their substantial equivalence. The analysis of equivalent toxicity of dioxins and furans reveals that biogas is, on average, 10 times more toxic than natural gas. Among regulated emissions, NO_X in the biogas ICEs exhausts are 3 times higher than those of natural gas. They are the main contributors to human health damage, with approximately 90% of the total. SO_X ranks second and accounts for about 6% of the total damage. Therefore, (i) the contribution to human health damage of unregulated emissions is limited compared to the damage from regulated emissions, (ii) the damage per unit of electricity of biogas engines exhausts is about 3 times higher than that of natural gas and it is directly linked to NO_X concentration, (iii) to obtain a good estimation of the human health damage from both biogas and natural gas engines emissions is enough to consider NO_X and SO_X, iv) SO_X need to be included among regulated emissions also in the case of biogas ICEs.

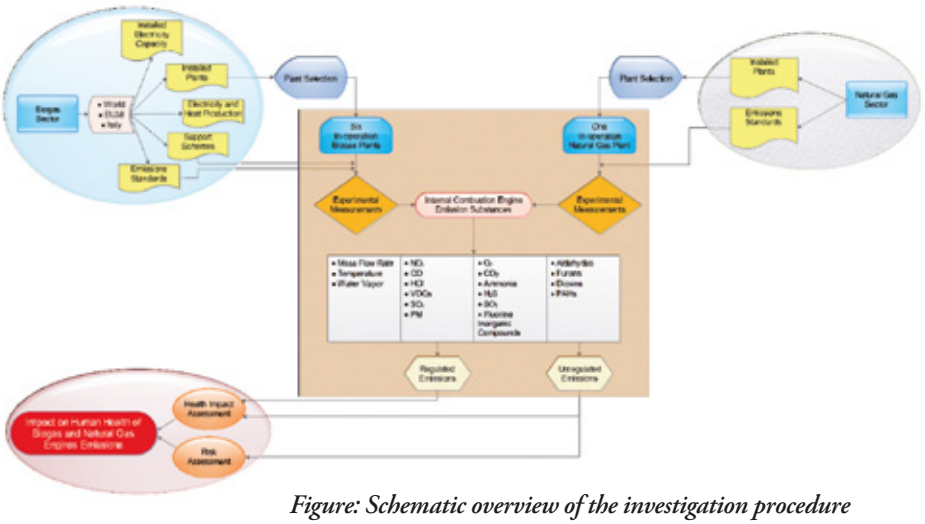

Figure: Schematic overview of the investigation procedure

Mechanical and microstructural behaviour of AA7075 aluminium alloy for subzero temperature sheet stamping process

Age-hardenable aluminum 7XXX alloy sheets represent a very attractive material for the aerospace field; however, their limited formability at room temperature restricts their adoption in the industrial context.

In the present study, deformation of AA7075 sheets at temperatures lower than the room one is presented as a possible strategy to overcome this limitation.

To this aim, a comprehensive experimental campaign was carried out on AA7075 sheets in peak aged condition at varying temperature and triaxiality stress states. Specifically, the temperature was changed from -100°C to 300° whereas different stress triaxialities states were achieved by adopting different specimen configurations, namely smooth, notched and shear. Fig. 1 shows a picture of the mechanical testing equipment. The thermal field was applied by means of an environmental chamber , where sub-zero temperatures are assured by using liquid nitrogen.

A necking locus curve was presented and modelled, as show by Fig. 2. As shown by the results, in sub-zero conditions, regardless of the stress states undergone by the workpiece, higher values of strain are needed to trigger the necking phenomenon, and, therefore, higher values of strain can be achieved under uniform elongation conditions. Microstructural and mechanical investigations carried out on the deformed samples revealed that deforming at temperatures higher than the room one drastically increased the number of coarse intermetallic particles. On the contrary, sub-zero deforming temperatures favored the intermetallic particle fragmentation and the formation of high density of precipitates and dislocations.

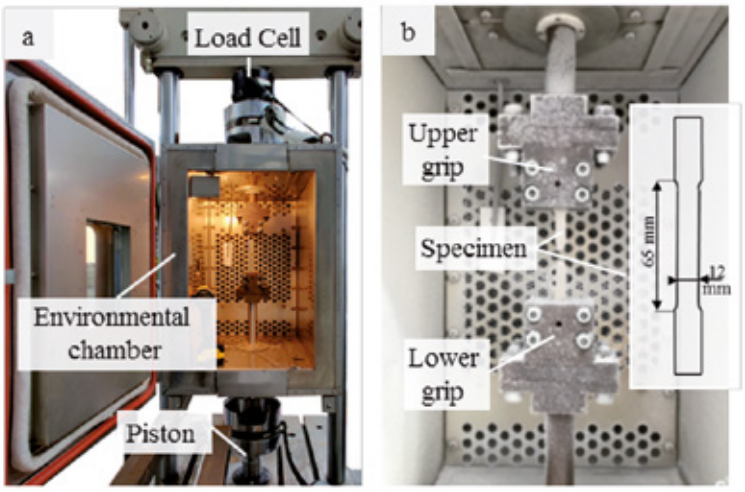

Fig.1: Experimental equipment for sub-zero temperature tests.

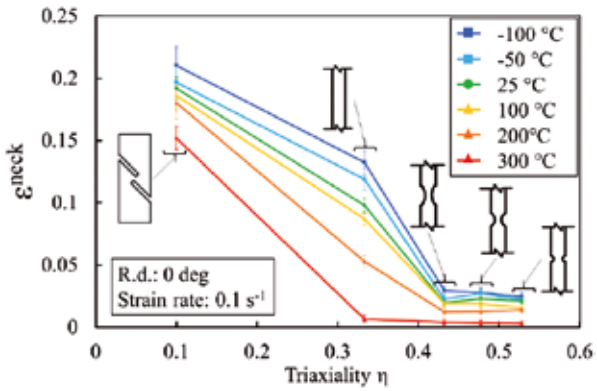

Fig.2: Necking locus at varying temperautre.

Sistemi meccanici

Mechanical systems

DII research group
Precision Manufacturing Engineering


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Main research topics:

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

Sistemi elettrici

Electrical systems

DII research group

Plasmas and Fusion

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Prof. Giuseppe Chitarin, DTG, University of Padova
Dr. Roberto Cavazzana, Consorzio RFX, Padova
Dr. Eng. Simone Peruzzo, Consorzio RFX, Padova
Dr. Eng. Riccardo Torchio, DII, University of Padova

Main research topics:

- Plasma physics and engineering
- Design of Neutral Beam Injector (NBI)
- Plasma active and passive diagnostics
- Analysis, synthesis and optimization of magnetic configurations
- Fusion reactor studies
- High voltage devices gas and vacuum insulated

Magnetic sensors: key diagnostic in fusion experiments and versatile device for many sensing applications

Magnetic field measurements are essential in magnetic confinement fusion experiments. The accurate knowledge of the magnetic field configuration is fundamental for the real time control of the plasma, for assuring the safe operation of the machine and to provide important physics insight.
The resulting system has very demanding requirements: high resolution in both time and space, hundreds of kHz of bandwidth, wide dynamic range, increasingly long time acquisition and relative accuracy up to 100 ppm. In addition the measurement probes must be installed in a very harsh environment: ultra-high pure vacuum, high or extreme temperature gradient and possibly neutron and gamma radiation. In short, very challenging needs to be accomplished at the same time by a single system. The choice of materials and of design solutions, along with considerations on the final installation and calibration must be addressed in an integrated way, which make both numerical analyses and realization of mock-ups mandatory.
The development of the new magnetic diagnostic system for RFXmod2, here in Padova, and of the new Italian tokamak DTT are currently ongoing.
The fluxgate technology has been chosen as sensing elements for the active field cancellation inside the Neutral Beam Injector (NBI) of the international ITER reactor experiment, which requires a precise measurement of DC and slowly varying magnetic field. Therefore, a robust fluxgate sensor able at measuring fields up to 10 mT under neutron radiation has been recently developed.
The same technology, suitably adapted, has also been chosen for the development of a high precision chip-integrated commercial sensor, for its affordability and stability.

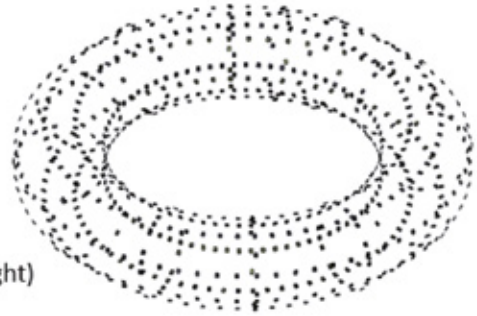

Figure1: new three-axes pick-up sensor (left) and system layout (right) of the RFXmod2 experiment

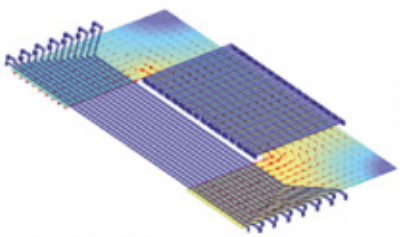

Figure2: FEM analysis of a miniaturized fluxgate sensor

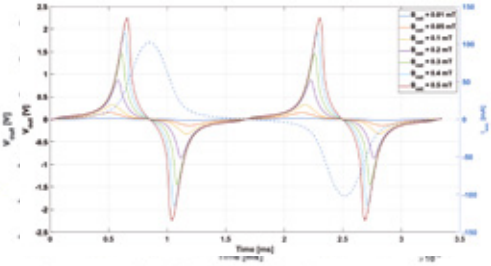

Figure3: simulated excitation current and raw output signal

Lifetime assessment of welded joints according to the peak stress method: industrial case studies

In the context of the fatigue design of welded joints, the Peak Stress Method (PSM) is an FE-oriented engineering application of the local approach based on the Notch Stress Intensity Factors (NSIFs). The PSM allows to rapidly estimate the NSIFs taking advantage of the singular, linear elastic, peak stresses calculated from coarse FE models. The damage parameter is the equivalent peak stress, which has been defined on the basis of the averaged strain energy density (SED) fatigue criterion and it should be compared with the proper design curve to estimate the fatigue life of the analysed welded joint. According to the PSM, two design curves are available: one for prevailing opening stresses and one for prevailing shear stresses, having inverse slopes k=3 and k=5, respectively, in agreement with Eurocode 3.

In a recent research activity, plate-to-tube steel joints of industrial interest have been fatigue tested under in-phase bending-torsion loading (Fig. 1a). Full-penetration joints (Fig. 1b) adopted in the structure of a roundabout-type carousel and fillet-welded joints (Fig. 1c) for quarter-turn scotch-yoke valve actuators have been tested. The Peak Stress Method (PSM) has been applied to the tested welded details: the equivalent peak stress has allowed to identify the crack initiation location in agreement with experimental observations and to estimate the fatigue life of the considered welded joints. Despite the applied nominal bending-torsion loading, from the local point of view it has been observed that the tested welded joints were subjected to prevailing shear stresses at the crack initiation location. The experimental fatigue results have been converted in terms of equivalent peak stress and compared with the design curve valid for prevailing shear stresses (blue curve in Fig. 2). A good agreement has been obtained between theoretical predictions and experimental results.

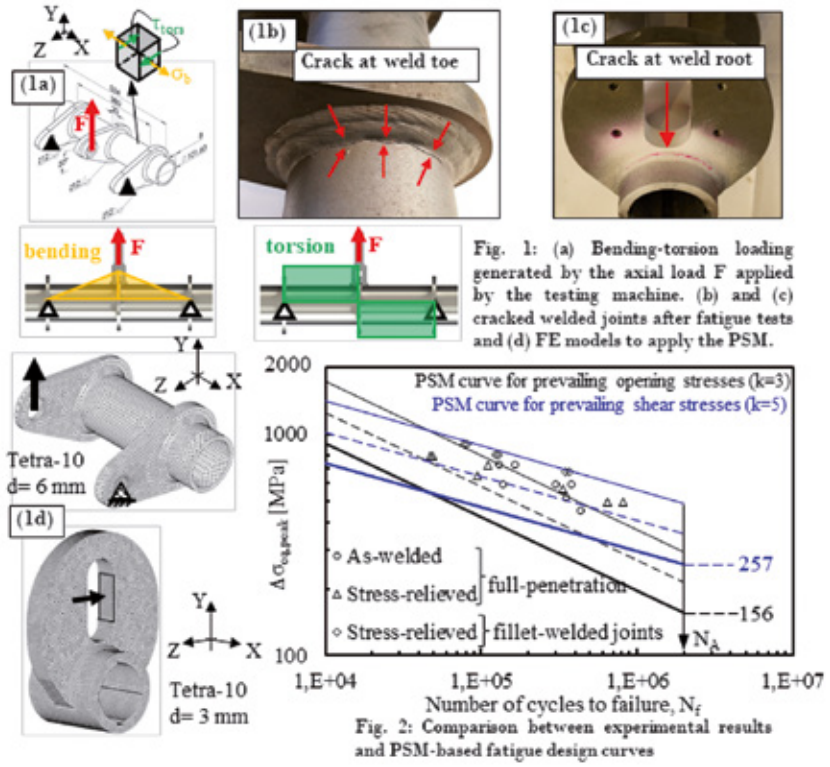

Fig. 1: (a) Bending-torsion loading generated by the axial load F applied by the testing machine. (b) and (c) cracked welded joints after fatigue tests and (d) FE models to apply the PSM.

Fig. 2: Comparison between experimental results and PSM-based fatigue design curves

G. Meneghetti, A. Campagnolo, V. Babini, M. Riboli, A. Spagnoli, Multiaxial fatigue assessment of welded steel details according to the peak stress method: Industrial case studies, Int. J. Fatigue. 125 (2019) 362–380.

Sistemi meccanici

Mechanical systems

DII research group

Machine Design

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This research activity has been carried out in collaboration with:

Prof. Andrea Spagnoli - (University of Parma)
Dr. Vittorio Babini - (Zamperla spa)
Dr. Matteo Riboli - (Flowserve srl)

Main research topics:

- Development of numerical and experimental methods for the evaluation of the structural integrity of mechanical components and structures
- Static mechanical characterization and fatigue of metallic materials
- Development of local approaches for structural analysis and fatigue design of components and structures weakened by defects and notches

Materiali

Materials

DII research group

CHEMAMSE

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In the field of secondary batteries, the CheMaMSE group is currently involved: (i) in the European Project "VIDICAT" (proposal ID SEP-210514183); and (ii) in the Italian National Project "TRUST" (proposal ID 2017MCEEY4).

Main research topics:

- Electrolyte and electrode materials for fuel cells of the type PEMFCs (Polymer Electrolyte Membrane Fuel Cells), AEMFCs (Anion Exchange Membrane Fuel Cells), HT-PEMFCs (High-Temperature Proton Exchange Membrane Fuel Cells), DAFCs (Direct Alcohol Fuel Cells), and for PEM electrolyzers (since 1999)
- Electrolytes and innovative electrode materials for the reversible storage of electrical energy in secondary lithium and magnesium batteries
- Study of the electric response of ion-conducting, electric and dielectric materials by broadband electrical spectroscopy (BES)
- Redox Flow battery materials including ion-conducting membranes, innovative redox couples and electrode configurations

Development and study of advanced materials for secondary battery applications

The humankind is facing a global transition towards a decarbonized power sector, dominated by renewable energy sources such as solar and wind. In parallel, the market of electric vehicles is expanding in the automotive field. These two events have in common the necessity of relying on novel and better performing energy storage systems. Despite an optimal performance, secondary (i.e., rechargeable) lithium ion batteries (LIBs) still suffer from several drawbacks: (i) limitation of the energy density; (ii) low safety; and (iii) dependence on critical, strategic and expensive raw materials (e.g., Li and Co).

Among the different Research Topics covered by the Chemistry of Materials for the Metamorphosis and the Storage of Energy (CheMaMSE) group (e.g., Fuel Cells, Electrolyzers, Redox Flow Batteries), large efforts are dedicated to the development and study of advanced materials for secondary battery applications. In details, materials which belong to the so called "beyond Li-ion" class of compounds have been and are currently studied in our lab, such as: (i) high-voltage cathodes for high-energy Li and Mg batteries (see Figure 1 and 2); and (ii) polymer-, ionic liquid-, and ceramic-based electrolytes for Li, Mg, Ca and Na batteries (see Figure 3). Particular attention is given to this latter point, where we are focusing on the design of advanced and high performing electrolytes for novel chemistries, based on abundant, low-cost and environmentally friendly metals such as magnesium, calcium and sodium. Indeed, CheMaMSE is currently involved: (i) in the European Project "Versatile Ionomers for DIvalent CAlcium baTteries – VIDICAT", which is focused on advanced electrolytes for application in Ca-ion batteries; and (ii) in the Italian National Project "TowaRds sUstainable, high-performing, all-solid-state Sodium-ion baTteries - TRUST", dedicated to the development of innovative solid-state electrolytes and cathode materials for Na-ion batteries.

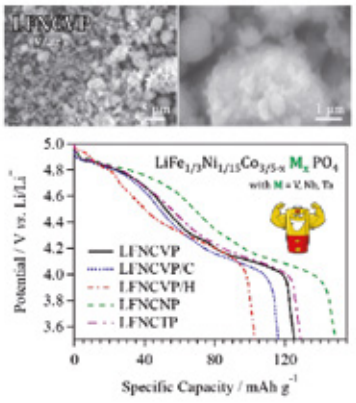

Figure 1 - Morphology and battery performance of advanced high-voltage cathods for LIBs

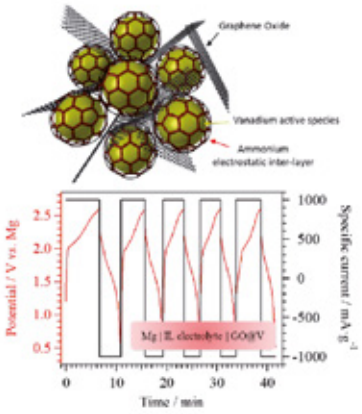

Figure 2 - Architecture and performance of anadvanced cathode material for magnesium secondary batteries

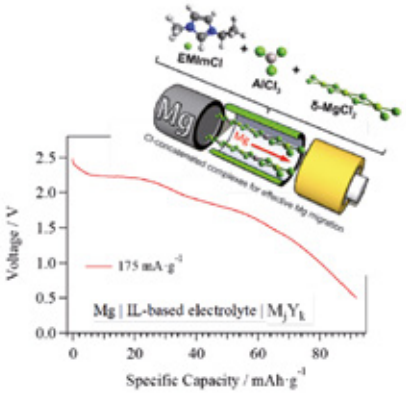

Figure 3 - Concept and performance of a magnesium secondary battery employing an ionic liquid-based electrolyte and the highly active δ-MgCl2 salt

Progetto di economia circolare ‘Recycle Your Boots’

Il DII in collaborazione con Tecnica Group partecipa al progetto “Recycle your boots”: un progetto di economia circolare che punta a trasformare i vecchi scarponi da sci in materie di seconda generazione da usare per produrre nuovi scarponi o altri componenti sportivi.

Il progetto, promosso dall'azienda italiana Tecnica group, si avvale della collaborazione di due gruppi di ricerca del Dipartimento: il gruppo Ingegneria dei Polimeri (PEG) e il Centro Studi Qualità Ambiente (CESQA). L'obiettivo è quello di progettare un innovativo sistema di riciclo dei vecchi scarponi da sci, che sia allo stesso tempo tecnicamente ed economicamente sostenibile.

Il gruppo di Ingegneria dei Polimeri, diretto dal Prof. Michele Modesti, collaborerà con le altre aziende coinvolte nel progetto per ottimizzare i processi di separazione e riciclo dei vari materiali, per nobilitarli mediante tecniche di compounding ed estrusione reattiva e per riciclarli in nuovi manufatti secondo i criteri del design for recycling/disassembling. Il gruppo CESQA, coordinato dall'Ing. Alessandro Manzardo, invece si occuperà della definizione di un modello di analisi dei potenziali impatti ambientali del nuovo sistema di riciclo al fine di ridurli e minimizzarli.

“Recycle your boots” sarà operativo dall'autunno 2021 nei negozi presenti in Italia, Francia, Svizzera, Austria e Germania. Per il successo dell'iniziativa sarà fondamentale la collaborazione dei negozianti, ma anche quella dei consumatori: ogni sciatore che vorrà comprare un nuovo paio di scarponi da sci Tecnica, potrà infatti restituire in negozio i suoi vecchi scarponi, di qualunque marca.

Achievement

DII research group
Polymer Engineering group (PEG)
CESQA
Centro Studi Qualità Ambiente

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Polymer Engineering Group

CESQA
CENTRO STUDI QUALITÀ AMBIENTE

RECYCLE YOUR BOOTS

Achievement

"Valorizziamo i canali cittadini" Progetto di pubblica utilità per la cura delle vie d'acqua

DII research group

Laboratorio di Analisi dei Sistemi Ambientali (LASA)

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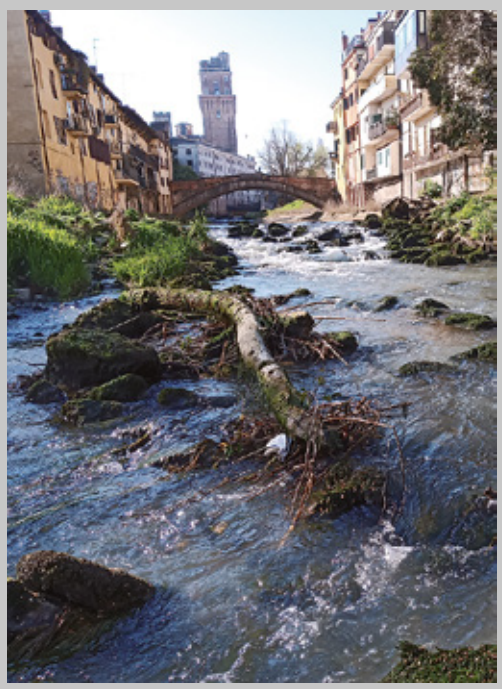
Il Dipartimento di Ingegneria Industriale dell'Università di Padova si è fatto promotore di un innovativo progetto di ricerca sulle tecniche per la gestione del verde urbano dal titolo "Valorizziamo i canali cittadini". Il progetto di pubblica utilità per la manutenzione ordinaria e continuativa del verde pubblico lungo i canali cittadini implementa un approccio integrato che considera contemporaneamente aspetti ambientali, culturali e socio-economici. Il progetto, che ha preso il via nel luglio 2018, visto il successo in termini di risultati raggiunti sia esecutivi che sociali, è stato in seguito rinnovato sulla base di un protocollo d'intesa firmato dai partner.
L'iniziativa è il frutto della collaborazione tra il gruppo di ricerca Laboratorio di Analisi dei Sistemi Ambientali (LASA) del Dipartimento di Ingegneria Industriale, Comune di Padova, Cooperativa Piovego, associazione Amissi del Piovego, e si avvale del sostegno del Fondo straordinario di solidarietà per il lavoro della Fondazione Cariparo.

Gli interventi, realizzati manualmente con strumenti a basso impatto ambientale come decespugliatori, roncole e cesoie, coinvolgono alcuni tratti di canali urbani non raggiungibili da terra e prevedono:

- l'asportazione dei rifiuti dalle rive e dall'alveo;
- gli sfalci e la gestione selettiva della vegetazione spondale con l'eliminazione della vegetazione infestante e alloctona dannosa in favore di quella autoctona e tipica degli ambienti acquatici;
- l'asportazione dei legnami caduti naturalmente o lasciati da lavorazioni precedenti sia in argine che in alveo e la rimozione della vegetazione da manufatti idraulici e dalle mura medioevali adiacenti i canali.



https://www.padovanet.it/informazione/progetto-valorizziamo-i-canali-cittadini

Buona parte di tali attività è svolta utilizzando apposite imbarcazioni a fondo piatto. Visti i limiti del contesto ambientale, questo tipo di intervento manutentivo, ormai caduto in disuso, resta tuttavia l'unico in grado di contrastare l'iperproliferazione delle piante acquatiche durante il periodo di maggior spinta vegetativa, in estate. Lavorare a mano, inoltre, permette di agire con maggior rispetto per la biodiversità dei canali.

L'approccio integrato del progetto ha come obiettivo, oltre al miglioramento della qualità ambientale dei canali e delle aree ripariali, la creazione di posti di lavoro per residenti in situazione di disagio socio-economico. "Valorizziamo i canali cittadini" infatti si è avvalso della manodopera di disoccupati italiani e di immigrati recenti presenti sul territorio del Comune di Padova, dando loro la possibilità di compiere concreti passi in avanti verso una vera integrazione, basata sul lavoro, attraverso l'accesso a un'occupazione che garantisca un reddito dignitoso, una formazione costante e l'acquisizione di una professionalità.

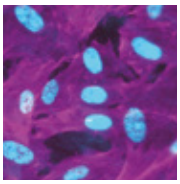
La cura delle vie d'acqua, infine, consente una maggiore fruibilità delle aree da parte di residenti e turisti, la creazione di collaborazioni attive tra amministrazioni locali, enti di gestione del territorio e portatori di interesse e la salvaguardia del patrimonio storico-culturale legato alle vie d'acqua cittadine e alle mura medioevali.

"Valorizziamo i canali cittadini"
Progetto di pubblica
utilità per la cura
delle vie d'acqua

UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

Cover story

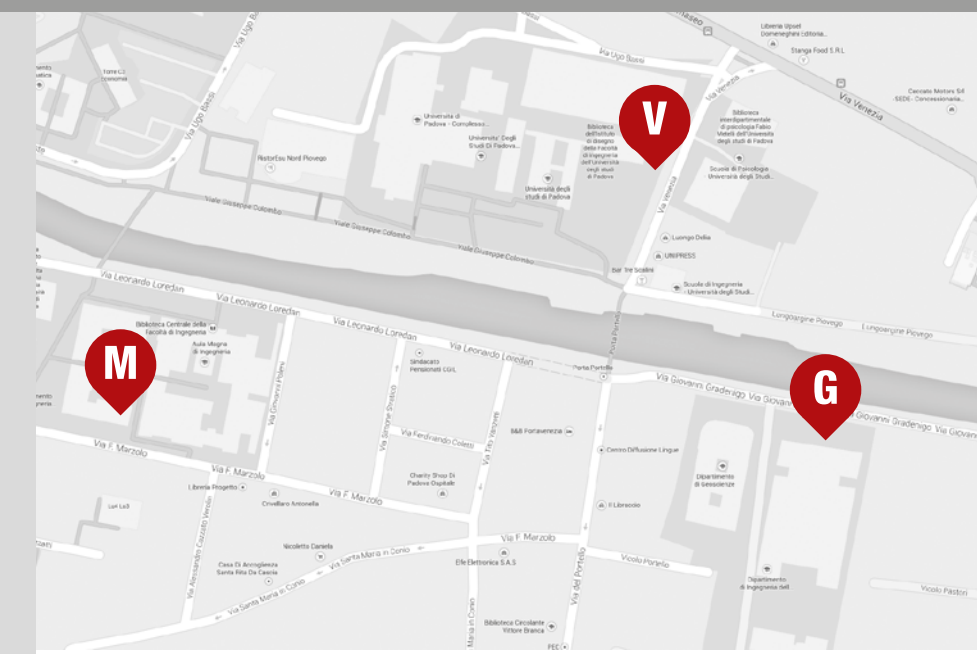


Immunofluorescenza di uno scaffold realizzato con pericardio bovino decellularizzato e ripopolato da una linea cellulare di fibroblasti. Il tessuto è stato analizzato dopo 7 giorni dalla semina delle cellule. I fibroblasti in coltura sono stati colorati con falloidina, che permette il riconoscimento del citoscheletro della cellula (viola). I nuclei delle cellule (blu) sono evidenziati grazie all'utilizzo di un colorante (DAPI) che si lega al DNA.

Martina Todesco

Si è laureata in Ingegneria Biomedica e in Bioingegneria presso l'Università degli Studi di Padova, rispettivamente nel 2015 e nel 2018. Ha svolto il suo progetto di tesi magistrale come borsista presso IRRIV (Istituto Internazionale di Ricerca Renale di Vicenza), occupandosi dell'interazione sangue-materiale e della caratterizzazione dell'efficienza depurativa di un emodializzatore per la terapia sostitutiva renale continua. Attualmente è assegnista di ricerca presso il Dipartimento di Ingegneria Industriale e lavora nell'ambito del progetto LifeLab finanziato da CORIS (Consorzio per la Ricerca Sanitaria).

SEDI



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