PERSONAL INFORMATIONS

Alfredo Rondinella

Università degli Studi di Udine, DPIA - Dipartimento Politecnico di Ingegneria e Architettura, Via del Cotonificio 108, 33100 Udine, Italia

EDUCATION AND TRAINING

MARCH 2019 — PhD "Materials Chemistry" — Level 8 QEQ

京都工芸繊維大学 - Kyoto Institute of Technology, Matsugasaki Hashikamicho, Sakyo Ward, Kyoto, 606-8585, Japan

The main skills acquired during the PhD were:
- Hip implantology;
- Ceramic and polymeric biomaterials for biomedical applications;
- Surface functionalization and biocompatibility of materials;
- Degradation phenomena at the interface between prosthetic components (wear behavior, fretting, third body wear);
- Raman spectroscopy;
- FTIR spectroscopy;
- X-ray diffraction (XRD);
- Scanning electron microscopy (SEM);
- Optical and laser microscopy;
- Technical scientific English for article writing (see Publications List).

Research title: "INNOVATIVE APPROACHES TO BIOMATERIALS' TECHNOLOGY THROUGH SYSTEMATIC SPECTROSCOPIC ANALYSES"
- Analysis of degradation phenomena of Zirconia Reinforced Alumina (ZTA) femoral heads and Ultra High Molecular Weight Polyethylene (UHMWPE) acetabular cups by failure analysis and accelerated aging processes;
- Development of an automated algorithm for analysis and 3D modeling of degradation phenomena in HAZ;
- Analysis of surface chemistry and wear behavior of oxide and non-oxide bioceramics

JULY 2015 — Master's Degree in "Materials and Process Engineering" — Level 7 QEQ

Università degli studi di Trieste, Trieste (Italia)

The main skills acquired during the Master's degree course were:
- Definition and use of physical/mathematical models suitable for analyzing the characteristics and performance of materials and products, equipment, plants and production processes;
- Design of materials and production processes;
- In-depth study of Biomaterials and Prosthetics;
- Spectroscopic Methods of Analysis;

Dissertation title (conducted at Kyoto Institute of Technology, Kyoto): "CRISTALLOGRAPHIC AND CHEMICAL CHARACTERISTICS INDIVIDUED IN THE RAMAN SPECTER OF HYDROSSIAPATITE IN HEALTHY MOUSE BONES AND OSTEOPOROTIC SPECTROSCOPIC ANALYSES" (Funded in part through study award from Osiris-Brovedani Foundation ONLUS, contribution of €1000)
- Study of murine bones by Raman spectroscopy;
- Identification of spectroscopic parameters that can assess and detect demineralization phenomena early;
- Development of an algorithm to differentiate healthy and osteoporotic bones;

JUNE 2012 — Bachelor's degree in "Materials Science and Engineering" — Level 6 QEQ

Università degli Studi di Napoli "Federico II", Napoli (Italia)

The main skills acquired during the graduate course were:
- Application of basic principles of chemistry and physics to understand structure and properties of various classes of materials;
- Selection and combination of different materials according to their intended application;
- Understanding and management of production technologies of artifacts made from the

different types of materials;

Dissertation title: "COMPOSITE MATERIALS FOR DIRECT RESTORATION IN ORTHODONTIC APPLICATIONS."
- Analysis of polymer-based composite materials for orthodontic applications;
- Study of radical polymerization initiation techniques of Bowen resins (PMMA);
- State of the art of processes and materials used for direct restorative procedures;

JULY 2008 **Experimental Scientific High School Diploma (Progetto Brocca)** Level 4 QEQ

Liceo Statale "E. P. Fonseca", Napoli (Italia)

PROFESSIONAL EXPERIENCE IN ACADEMIA

10/01/2022 - TODAY

Fixed-term researcher (letter A)
PON project entitled "Innovative "green" materials for the management and storage of hydrogen and other fuels with reduced environmental impact"
Disciplinary scientific sector ING-IND/22 (Materials Science and Technology)

Università degli Studi di Udine, Udine (Italia)

Study of degradation mechanisms produced by the contact between hydrogen and materials constituting storage containers in collaboration with FABER SPA.

Research activities include:
- Literature survey of the various types of hydrogen storage containers;
- Characterization in plan and section of the materials of which a type IV storage container is composed (polymer liner and composite wrapping) using ATR-FTIR and SEM/EDXS techniques;
- Study of the mechanical behavior of the liner and composite material by tensile testing;
- Failure analysis of specimens that failed during preliminary tests;
- Thermal analyses of the polymer material;
- Viscosimetric analyses of the composite material matrix;
- Development of alternative "green" materials with lower environmental impact that improve the mechanical efficiency of the constituent materials of storage containers.

Scientific responsible at the University of Udine: Prof. Lorenzo Fedrizzi

01/07/2020 – 09/01/2022 (DURATION: 1 year and 6 months)

Researcher in PON MIUR Research and Innovation project
Project title: ARS01_00293 "THALASSA - TecHnology And materials for safe Low consumption And low life cycle cost veSSels And crafts" - CUP: B26C18000830005,
Scientific Disciplinary Area ING-IND/22 (Materials Science and Technology).

Università degli Studi di Udine, Udine (Italia)

Welding study of high-performance bimetallic systems and development of systems for corrosion monitoring of painted ship structures.

Research activities include:
- Literature survey;
- In-plane and cross-sectional characterization of organic coating using ATR-FTIR and SEM/EDXS techniques;
- Selection and development of a method for monitoring the degradation of the coated system;
- Impedance measurements on the coated system to identify a normalized threshold parameter suitable for identifying the good functional state of the system;
- Study of the influence of Zinc sacrificial anodes on the monitoring system;
- Study of the corrosion behavior and durability of metal joints obtained by FSW and blast welding;

Scientific responsible at the University of Udine: Prof. Lorenzo Fedrizzi

01/07/2019 – 30/06/2020 (DURATION: 1year)

Researcheri n HEaD project "Higher Education and Development" Scientific disciplinary area ING-IND/22 (Materials Science and Technology)

Università degli Studi di Udine, Udine (Italia)

Study of anti-stick coatings with high durability and improved healthiness and hygiene for applications

in the "food-service" sector in collaboration with Electrolux Professional.

Research activities include:
▪ Literature survey;
▪ Choice and study of solutions available on the market;
▪ Choice and set-up of aging methodologies for PTFE-based composite coatings;
▪ Conditioning and aging tests;
▪ Morphological and chemical characterization of pre- and post-aging specimens;
▪ Definition of degradation mechanisms.

Scientific responsible at the University of Udine: Prof. Francesco Andreatta

Scientific responsible at Electrolux Professional: Michele Simonato (until 29/02/20), Emidio Tiberi (from 01/03/20)

01/10/2015 – 31/03/2019 (DURATION: 3 years E 6 months)

Winner of the competition issued by rectoral decree 8/05/2019, no. 344 of the University of Udine

Winner of the "Monbukagakusho" scholarship issued by the Government of Japan at Kyoto Institute of Technology (Total amount 6216000 JPY).

京都工芸繊維大学 - Kyoto Institute of Technology, Matsugasaki Hashikamicho, Sakyo Ward, Kyoto, 606-8585, Giappone

Study of the biocompatibility of metallic, polymeric and ceramic materials used in biomedical applications:

The main research activities involved:

Studying the surface chemistry of silicon nitride and developing surface treatments to modulate the amount of non-stoichiometric nitrogen on its surface;
▪ Testing the biocompatibility of each treatment by culturing cell populations (mainly osteosarcoma and mesenchymal cells) and bacteria;
▪ Pre- and post-treatment surface material characterization by various analytical techniques (ATR-FTIR spectroscopy, Raman spectroscopy, X-ray Photoelectron Spectroscopy, SEM and EDXS, Cathodoluminescence, FIB)

Development of polymer-ceramic composites for improving the biocompatibility of PEEK spinal prostheses;
▪ Production of samples with different silicon nitride content;
▪ Verification of the biocompatibility of the composite material by culturing cell populations (mainly osteosarcoma and mesenchymal cells) and bacteria;
▪ Characterization of the material by various analytical techniques (ATR-FTIR spectroscopy, Raman spectroscopy, X-ray Photoelectron Spectroscopy, SEM and EDXS, Cathodoluminescence, FIB)

Functionalization by laser-patterning of the surface of bioceramics and study of the increase in bone mineralization;
▪ Production of specimens with a composite, ceramic-matrix surface with Bioglass-based fillers;
▪ Testing the biocompatibility of the composite material by culturing cell populations (mainly osteosarcoma and mesenchymal cells) and bacteria;
▪ Characterization of the material through various analytical techniques (ATR-FTIR spectroscopy, Raman spectroscopy, X-ray Photoelectron Spectroscopy, SEM and EDXS, Cathodoluminescence, FIB)

Study of the osseointegrative properties of polyphenols from green tea;
▪ Production of Ti6Al4V samples with a surface functionalized with polyphenols extracted from green tea leaves;
▪ Testing the osseointegrative properties of the surface using two KUSA-A1 cell cultures (with and without osseointegration supplements);
▪ Characterization of the material by different analytical techniques (ATR-FTIR spectroscopy, Raman spectroscopy, X-ray Photoelectron Spectroscopy, SEM and EDXS)

04/2016 – 09/2018 (DURATION: 2 years 5 monthsI)

Part-Time Job as an English Teacher

京都工芸繊維大学 - Kyoto Institute of Technology, Matsugasaki Hashikamicho, Sakyo Ward, Kyoto, 606-8585, Giappone

Teaching technical and scientific English for students.
The main topics taught during the classes included:
▪ How to conduct a bibliographic analysis on dedicated search engines;

- How to set up a scientific report or article;
- Grammar and technical terminology;
- Presentation tests in preparation for conferences and seminars;

TEACHING ACTIVITIES

Courses at the University of Udine (Disciplinary Scientific Area ING-IND/22)

a.y. 2022-2023	**Polymeric Materials Science and Technology** **Master's Degree in Mechanical Engineering**	6 credits 48 hours
a.y. 2021-2022	**Polymeric Materials Science and Technology** **Master's Degree in Mechanical Engineering**	6 credits 48 hours
a.y. 2020-2021	**Polymeric Materials Science and Technology** **Master's Degree in Mechanical Engineering**	6 credits 48 hours

Seminars at the University of Udine (Disciplinary Scientific Area ING-IND/22)

a.y. 2022-2023	**"Polymers for Construction."** **Seminar within the Materials Technology Laboratory course** **Vocational degree program in Building and Land Use Technology**	2 hours
a.y. 2021-2022	**"Biocompatibility improvements through surface modifications."** **Seminar within the Materials for Biomedical Applications course** **Master's Degree in Molecular Biotechnology**	2 hours
a.y. 2020-2021	**“Biocompatibility improvements through surface modifications”** **Seminario all’interno del corso di Materiali per applicazioni biomediche** **Laurea magistrale in Biotecnologie Molecolari**	2 hours
a.y. 2020-2021	**"Composite materials for biomedical applications."** **Seminar within the Composite Materials Science and Technology course** **Master's Degree in Mechanical Engineering**	2 hours
a.y. 2019-2020	**"Composite materials for biomedical applications."** **Seminar within the Composite Materials Science and Technology course** **Master's Degree in Mechanical Engineering**	2 hours

Participation in examination committees for examinations. (Disciplinary Scientific Area ING-IND/22)

Science and Technology of Polymeric Materials	Mechanical Engineering [757]
Materials Science	Mechanical Engineering [757]
Structure and mechanical properties of materials	Mechanical Engineering [757]
Composite materials science and technology	Mechanical Engineering [757]
Corrosion	Mechanical Engineering [757]

Tutoring students in the preparation of dissertations at the University of Udine

(Disciplinary Scientific Area ING-IND/22)

Mechanical Engineering [751] - Bachelor's Degree Program

1.	**B. Fregolent** Stoccaggio dell'idrogeno in serbatoi in pressione per uno sviluppo sostenibile Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2020-2021
2.	**M. Coletto** Trattamenti e rivestimenti superficiali per la funzionalizzazione dei componenti metallici protesici Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2020-2021
3.	**L. Toson** Le applicazioni biomedicali dei geopolimeri Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2020-2021
4.	**V. Niemiz** Studio dell'effetto di additivi sul comportamento a stiction di pastiglie freno. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2020-2021
5.	**N. Antoniazzi** Effetto della tipologia di mescola sulla resistenza a Stiction di pastiglie freno per l'impiego nel settore automotive. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2020-2021
6.	**N. Andreoni** Studio dell'effetto del legante sul comportamento a stiction di pastiglie freno per impiego nel settore automobilistico. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2019-2020
7.	**L. Contessi** Ottimizzazione della procedura di prova per valutare la resistenza a stiction di sistemi frenanti. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2019-2020
8.	**L. Morgante Piano** Caratterizzazione di rivestimenti a base geopolimeri per la protezione dalla corrosione di leghe ferrose e non ferrose. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Mechanical Engineering a.y. 2019-2020

Management Engineering [750] - Bachelor of Science Degree Program

1.	**M. Meneghin** Life Cycle Assessment di una bombola per lo stoccaggio di idrogeno per un carrello elevatore con cella a combustibile Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Bachelor Degree in Managment Engineering a.y. 2020-2021

Mechanical Engineering [757] - Master's Degree Program

1.	**E. Tubaro** Rivestimento geopolimerico per leghe di magnesio: studio del degrado in soluzioni fisiologiche Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2021-2022

2.	**S. Cardi** Stoccaggio di idrogeno in serbatoi di Tipo IV: materiali e criticità Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master Degree in Mechanical Engineering a.y. 2021-2022
3.	**M. Costantini** Produzione e caratterizzazione di Rivestimenti a base geopolimerica su Magnesio Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2021-2022
4.	**L. Pascolo** Studio del degrado di mescole per pastiglie freno per impiego automobilistico Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
5.	**Ivan Maniacco** Studio dell'effetto dei solfati sulla corrosione della ghisa impiegata in sistemi frenanti nel settore automotive Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
6.	**L. Dell'Antone** **Produzione e caratterizzazione di rivestimenti a base geopolimerica su lega Ti6Al4V** Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
7.	**M. Arkaxhiu** Caratterizzazione della protezione dalla corrosione di rivestimenti organici. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
8.	**A. Pavan** Produzione e caratterizzazione di rivestimenti geopolimerici su acciaio ed alluminio. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
6.	**G. Pagotto** Effetto del trattamento termico sul comportamento a corrosione della lega di titanio Ti6Al4V prodotta per Additive Manufacturing. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2020-2021
7.	**T. Adriano** Caratterizzazione del comportamento a corrosione di Ti6Al4V prodotto attraverso processo Electron Beam Melting e Selective Laser Melting. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2019-2020

Environmental and energy engineering [753] - Master's degree program

1.	**T. Beltrame** TRATTAMENTI SUPERFICIALI E RIVESTIMENTI PER STAMPI IN ALLUMINIO. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's degree in environmental and energy engineering a.y. 2019-2020
2.	**D. Olivieri** Fenomeni di degrado di tessuti in apparecchiature industriali di lavaggio. Università di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's degree in environmental and energy engineeringa.y. 2019-2020

Tutoring students in the preparation of dissertations at the University of Trieste (Disciplinary Scientific Area ING-IND/22)

Mechanical Engineering [757] - Master's Degree Program

1.	**E. Billé** Ottimizzazione dei parametri di processo per la Modellazione a Deposizione Fusa di Polietere-etere-chetoneUniversità di Udine, Dipartimento Politecnico di Ingegneria e Architettura Master's Degree in Mechanical Engineering a.y. 2021-2022

Tutoring students for thesis preparation at the 京都工芸繊維大学 - Kyoto Institute of Technology (Disciplinary Scientific Area ING-IND/22)

1.	**M. Ciniglio** Analysis of the effects of low-temperature environmental degradation on mechanical properties of Biolox® delta femoral heads through Fractographic study and Raman spectroscopic analysis. Università Ca' Foscari Venezia, Dipartimento di Scienze Molecolari e Nanosistemi Master's degree in bio and nanomaterials science and technology a.y. 2018-2019
2.	**D. Fainozzi** Raman and X-ray Photoelectron Spectroscopy Studies of Silicon Nitride Ceramics Related to Osteointegration and Bacteriostasis Processes. Università di Trieste, Dipartimento di Fisica Master's Degree Course in Physics a.y. 2016-2017
3.	**F. Lerussi** PEEK and composite with the addiction of Silicon Nitride Powders: properties and osteoconductive behavior. Università Ca' Foscari Venezia, Dipartimento di Scienze Molecolari e Nanosistemi Master's degree in bio and nanomaterials science and technology a.y. 2016-2017
4.	**F. Boschetto** STUDY OF OSTEOINTEGRATION PROCESSES ON DIFFERENT MODULATED SURFACES OF SILICON NITRIDE CERAMICS USING OSTEOSARCOMA (SAOS-2) AND MESECHYMAL (MSC) STEM CELLS. Università Ca' Foscari Venezia, Dipartimento di Scienze Molecolari e Nanosistemi Master's degree in bio and nanomaterials science and technology a.y. 2015-2016
5.	**M. Zanocco** Raman spectroscopic analysis of zirconia toughened alumina ceramic (ZTA) in presence of different metal stains and ZTA retrieval femoral heads. Università Ca' Foscari Venezia, Dipartimento di Scienze Molecolari e Nanosistemi Master's degree in bio and nanomaterials science and technology a.y. 2015-2016
6.	**E. Casagrande** Influence of different ceramic femoral heads on the oxidative degradation of Highly Crosslinked Polyethylene liners. Università Ca' Foscari Venezia, Dipartimento di Scienze Molecolari e Nanosistemi Master's degree in bio and nanomaterials science and technology a.y. 2015-2016

Tutoring students for the preparation of doctoral dissertations at the University of Udine (Disciplinary Scientific Area ING-IND/22)

1.	**J. De Munari** Characterization of materials to be used in professional food service equipment, using microwave as heating source. Università di Udine In collaboration with Electrolux Professional S.p.A. - PhD in Science Of Energy And Environmental Engineering - cycle XXXIV
2.	**F. Rigonat** Characterization of washing environments and their impact on appliances and textiles in professional laundry systems. Università di Udine In collaboration with Electrolux Professional S.p.A. - PhD in Science Of Energy And Environmental Engineering - cycle XXXIV

Collaboration in the preparation of doctoral theses at other universities.

(Disciplinary Scientific Area ING-IND/22)

1.	**Matteo Zanocco** Role of surface texture and off-stoichiometry on the structural, biogenic and antibacterial properties of inorganic. biomaterials Kyoto Institute of Technology
2.	**N. Paccotti** SERS active Ag/silicon-based nanostructures for biosensing applications. Politecnico di Torino
3.	**C. Multari** Magneto-plasmonic nanoparticles for photothermal therapy. Politecnico di Torino
4.	**F. Boschetto** VIBRATIONAL ASSESSMENTS OF BACTERIAL STRAINS RESPONSIBLE FOR PERIPROSTHETIC JOINT INFECTIONS AND A NEW ANTIBACTERIAL COMPOSITE FOR SPINAL IMPLANTS. Kyoto Institute of Technology
5.	**M. Cazzola** Multifunctional surfaces for implants in bone contact applications. Politecnico di Torino

Teaching activities in Technical-Scientific English for Bachelor's and Master's Degree students at Kyoto Institute of Technology

a.y. 2016-2017 **a.y. 2017-2018**	**Teaching technical and scientific English for students** The main objectives of the teaching activities were: teaching how to research accurate sources for one's research, how to conduct a detailed bibliographic analysis, how to set up a technical report or scientific article, and how to prepare a presentation in anticipation of a seminar or conference. Throughout the teaching, special attention was paid to the consolidation of technical-scientific grammar and terminology.

SCIENTIFIC ACTIVITY

Research topics

1. Innovative "green" materials for the management and storage of hydrogen and other fuels with reduced environmental impact

   The research aims to define the degradation mechanisms produced by contact between hydrogen and materials constituting storage containers. The research, carried out in collaboration with FABER, is concerned with studying materials currently in use and developing new ones with reduced environmental impact. Within this project, materials suitable for resisting different types of degradation are studied. The research also deals with functionalizing the surfaces of reinforcements to improve the mechanical efficiency of the composite. Among the research goals is the development of nano-structured coatings capable of mitigating material degradation.

2. FASTHER - Development of multifunctional eco-friendly painted coatings

   This research topic is developed from the activities carried out by the University of Udine - Polytechnic Department of Engineering and Architecture in synergy with PLT GmbH and Electrolux Professional S.p.A. within the framework of the INTERREG ITALY-AUSTRIA 2014-2020 project entitled "Development of multifunctional environmentally friendly painted coatings." The research activity aims to search for new powder coating products with reduced environmental impact through the use of nanoadditives that promote barrier and anticorrosive properties of the coating and at the same time increase thermal and electrical conductivity.

3. THALASSA - TecHnology And materials for safe Low consumption And low life cycle cost veSSels And crafts

   This topic stems from a PON (National Operational Program Research and Innovation) project managed by MIUR and involves several universities throughout Italy. The research developed at the Polytechnic Department of Engineering and Architecture of the University of Udine has two main objectives: the study of welding of high-performance bimetallic systems and the development of systems for corrosion monitoring of painted ship structures. The results obtained allowed the identification of a method for monitoring the degradation of the painted system using a threshold parameter measured by electrochemical impedance spectroscopic measurements. The threshold parameter makes it possible to identify the functional state of the system and allows easy recognition of any critical issues. The results obtained in the second topic brought numerous insights into the corrosion behavior and durability of metal joints depending on the parameters by which they are obtained.

4. Study of non-stick coatings with high durability and improved healthiness and hygiene for "food service" applications

   This research topic was funded by the Autonomous Region Friuli-Venezia Giulia through the project "Innovative equipment for "Food Service" applications: study of non-stick coatings with high durability and improved healthiness and hygiene (SSD: ING-IND/22) funded on a competitive call by the Autonomous Region of Friuli Venezia Giulia - project "HEaD HIGHER EDUCATION AND DEVELOPMENT OPERATION 2 UNIUD" (Operation Code FP1619942003, funding channel 1420AFPLO2) - European Social Fund - Investment in Growth and Employment - Operational Program 2014/2020". The research developed at the Polytechnic Department of Engineering and Architecture, in collaboration with Electrolux Professional, was concerned with investigating the aging and degradation mechanisms of PTFE-based composite materials for non-stick coatings in the "food-service" field. The study led to the selection and set-up of accelerated aging techniques to produce accurate simulations of the degradation phenomena occurring during the service-life of the materials studied. The morphological and chemical characterization operated on the pre- and post-aging samples made it possible to identify the main mechanisms of degradation and leading to the loss of the anti-stick characteristics of the polymeric materials used.

5. Characterization of degradation mechanisms of materials used in food service and professional-grade washing systems (in collaboration with Electrolux Professional)

This research activity is conducted in collaboration with Electrolux Professional and studies the characterization of degradation mechanisms of materials used in professional food service equipment and professional washing systems. This topic delves into the study of degradation phenomena of materials used by Electrolux in the two specific application areas mentioned above. This activity was the subject of two PhDs in Energy and Environmental Engineering Sciences, XXXIV cycle: Characterization of materials to be used in professional food service equipment, using microwave as heating source (J. De Munari) and Characterization of washing environments and their impact on appliances and textiles in professional laundry systems (F. Rigonat). In both PhDs, I collaborated in the execution of the experimental tests (SEM/EDXS, ATR-FTIR, Raman analysis).

6. Development of geopolymer coatings with anticorrosive and biocompatibility function

The purpose of the research activity, carried out within the Polytechnic Department of Engineering and Architecture at the University of Udine, in collaboration with the University of Padua and the Kyoto Institute of Technology, is to evaluate the barrier and biocompatibility properties of geopolymer-based coatings. The coatings, obtained by 'dip-coating' technique, are obtained by both acid and basic routes. They were then first tested on cold-rolled low-C steel sheets and aluminum sheets (AA6060 series) to verify the anticorrosive properties of these coatings. In the second part of the research, the biocompatibility of geopolymers was investigated, since their composition is very similar to that of the mineral part of bone, by creating coatings on Ti6Al4V and Mg alloy AZ31 substrates.

7. Study of degradation due to corrosion (stiction) in automotive brake systems

Study of degradation due to corrosion (stiction) in automotive brake systems

This research topic is carried out in collaboration with ITT Italia s.r.l, a manufacturer of brake pads for brake systems. This activity studies the phenomenon of stiction, which is the bonding of pad material to the disc. This phenomenon typically occurs after applying the parking brake for prolonged times and in the presence of aggressive environments. The bonding between disc and pad (stiction) is due to the corrosive attack of the brake disc, typically made of gray cast iron. The research activity was initially aimed at studying the mechanism of stiction. At this stage of the research, a test methodology was developed aimed at reproducing the phenomenon of stiction in the laboratory. This made it possible to study this phenomenon under controllable and reproducible conditions. Subsequently, research activity was directed to the study of the effect of pad compound constituents (friction material, solid lubricants, fillers, etc.) on stiction behavior. More recently, research activity evaluates the introduction of specific additives (stiction packages) into the pad compound in order to reduce the susceptibility to the stiction phenomenon.

Brake system degradation phenomena have also been studied in a second research, carried out mainly at the Kyoto Institute of Technology, through Raman and FTIR investigation techniques. The spectroscopic variations identified in the two analysis techniques were associated with four precise degradation phenomena: tribolayer formation, crystal pull-out phenomena, C-N bond breaking, and barite dissolution leading to the formation of ammonium sulfate or potassium sulfate. The role of potassium titanate has been linked through these tests to the change in brake system performance.

8. Surface functionalization of materials used in prosthetics

This research activity carried out mainly at the Physics of Ceramics Laboratory of the Kyoto Institute of Technology in collaboration with Kyoto Prefectural University of Medicine, Osaka University, Amedica Co. And Shinsei Co. was divided into two main strands: the first involved the functionalization of biocompatible titanium alloys while the second focused on modulating the surface chemistry of non-oxide ceramics to stimulate osteoinductive activity

and at the same time decrease bacterial proliferation on these surfaces.
The first line of research was developed by operating the functionalization of a titanium alloy (Ti6Al4V) with phenolic extracts obtained from green tea leaves. Tea polyphenols, in fact, have osteoinductive properties and promote mineralization. Successful functionalization was verified by surface characterization techniques (Raman and FTIR spectroscopy, XPS). Cultivation of KUSA-A1-type mesenchymal stem cells on the titanium surface showed differentiation into osteoblasts of the cell population and strong production of extracellular matrix, as demonstrated by analysis using light and fluorescence microscopy. The results of this study showed that functionalization of the metal surface may be a promising method to improve osseointegrability of prostheses made of these materials.
The second part of the research, allowed us to study the influence of the surface stoichiometry of Si3N4 on the biocompatibility of the material. Si3N4 is a non-oxide ceramic used for the production of spinal implants. The study carried out in this line of research has first and foremost linked the osteoinductive and antibacterial response of the material with the surface chemistry of the ceramic itself. The surface chemistry and morphology of the material were altered by chemistry and by laser patterning, creating non-stoichiometric surfaces of the material from time to time. It was verified that excesses or deficiencies of nitrogen can significantly alter the biological response to the material, that osteoblasts can partially take up some of the Si3N4 to incorporate it and form 'modified' apatite.Questa attività di ricerca svolta prevalentemente presso il laboratorio di Fisica dei Ceramici del Kyoto Institute of Technology in collaborazione con la Kyoto Prefectural University of Medicine, l'Osaka University, Amedica Co. E Shinsei Co., si è divisa in due filoni principali: il primo ha riguardato la funzionalizzazione di leghe biocompatibili di titanio mentre il secondo si è concentrato sulla modulazione della chimica superficiale di ceramici non ossidi per stimolare l'attività osteoinduttiva e allo stesso tempo diminuire la proliferazione batterica su queste superfici.

9. Degradation and wear phenomena of prosthetic components

This research topic has been carried out mainly at the Physics of Ceramics Laboratory of the Kyoto Institute of Technology in collaboration with several universities (including Kyoto Prefectural University of Medicine, Tokyo Medical University, Osaka University, and Istituto Ortopedico Rizzoli of Bologna) and several companies (including Amedica Corporation, Otsuka Chemical, and Shinsei) to study the degradation phenomena that occur during the service life of different prosthetic components of polymeric, ceramic, and metallic nature. At first, numerous hip prostheses and explanted spinal implants (retrieval) were studied to investigate the wear and biocompatibility phenomena occurring on each biomedical component. In particular, the Ceramic-Ceramic, Ceramic-Polymer, and Ceramic-Metal interfaces were studied. An algorithm combining data from microscopic analysis with models obtained by Computer Aided Design (CAD) was also developed to automate, speed up and model in 3D the failure analysis performed on components explanted from patients. Next, accelerated aging tests were developed to study the influence of surface chemistry of oxide and nonoxide ceramics on polymeric components of prostheses, the effect of environmental chemistry on phase transformation phenomena in Zirconia-containing ceramics.

10. Production and study of composite materials for biomedical use

This research topic, conducted at the Physics of Ceramics Laboratory of the Kyoto Institute of Technology in collaboration with Kyoto Prefectural University of Medicine, Osaka University, Amedica Co. And Otsuka Chemical Co. was divided into two strands by attempting to create two composite materials: a ceramic-ceramic composite and a polymer-ceramic composite.

In the case of the ceramic-ceramic composite, an attempt was made to combine the strong osteoinductive and osteoconductive properties of Bioglass® with those of Si3N4. Bioglass®, due to its composition very similar to that of bone minerals, stimulates the growth of bone tissue that is highly mineralized but almost devoid of organic matrix. Si3N4, on the other hand, stimulates cell proliferation and leads to the formation of a collagenous

matrix. It was possible to verify that by controlling the ratio the ratio of bioglass to Si3N4, it is possible to control the rate of mineralization and osteoconduction of bone tissue formed in the vicinity of implants.

In the case of the ceramic-polymer compound, on the other hand, an attempt was made to combine the osteoinductive and antibacterial properties of silicon nitride with the processability of PEEK. This polymer is easily machinable and makes the installation of a spinal implant less complex, but at the same time it is a bionerte material. In contrast, implanting a ceramic spinal prosthesis creates a more favorable environment for bone growth but is also a higher risk surgical procedure. The creation of a PEEK matrix composite containing Si3N4 particles demonstrated a marked improvement in the amount of mineralization occurring on the surface of the composite and antibacterial properties, compared with polymer alone.

11. Study of tooth and bone decay phenomena by Raman spectroscopy

This study was carried out at the Physics of Ceramics Laboratory of the Kyoto Institute of Technology in collaboration with several institutions (including Kyoto Prefectural University of Medicine, Osaka University, University of Trieste, Politecnico di Milano, and Istituto Ortopedico Rizzoli in Bologna) to study demineralization phenomena through Raman spectroscopy. The research was divided into two parallel strands: in the first, an attempt was made to create an algorithm to detect early signs of osteoporosis in murine femoral bone sections. The results of this study showed changes in both bone calcium phosphates and collagen-based elastic material, linking changes in mechanical properties of osteoporotic bone to changes in certain Raman bands of the organic part. In the second strand, however, the effect of particularly aggressive environments on tooth enamel mineralization was studied. Several teeth of human origin were immersed in low pH environments (simulated with commonly commercially available sweet drinks) at increasing times. The study produced an algorithm capable of detecting early demineralization phenomena even when damage is not yet detectable by simple visual inspection.

12. Study of corrosion behavior of materials produced through additive manufacturing

This research topic concerns the study of the correlation between microstructure and corrosion behavior of materials produced through additive manufacturing. In particular, electron beam melting (EBM) and selective laser melting (SLM) techniques are considered. This work is performed on different types of materials such as 316L steel, aluminum alloys, titanium alloys, and cobalt alloys. The effect of the "as printed" surface and heat treatment of alloys are also evaluated. Research activities concerning the Ti6Al4V alloy are carried out in collaboration with Limacorporate S.p.A., which employs EBM technology for the production of trabecular titanium implants. As part of the collaboration with this company, SLM technology was also considered and materials produced by different 3D molding machines were compared. This research topic makes use of collaboration with the LAMA laboratory of the University of Udine, where specimens are produced by SLM technique (specifically, 316L stainless steel and Ti6Al4V).

Partecipazione a progetti di ricerca

1. PON 2014-2020 AZIONE IV.6 GREEN
   "Innovative "green" materials for the management and storage of hydrogen and other fuels with reduced environmental impact"
   Scientific Responsible: Prof. Lorenzo Fedrizzi
   Scientific Disciplinary Sector: ING-IND/22

2. "HEaD HIGHER EDUCATION AND DEVELOPMENT" OPERAZIONE 2 UNIUD (FP1619942003, canale di finanziamento 1420AFPLO2)
   "Innovative equipment for the "Food Service" sector: study of non-stick coatings with high durability and improved healthiness and hygiene"
   Scientific Responsible: Prof. Francesco Andreatta
   Scientific Disciplinary Sector: ING-IND/22

3. PON MIUR Ricerca e innovazione - Titolo di progetto: ARS01_00293 THALASSA - TecHnology And materials for safe Low consumption And low life cycle cost veSSels And crafts
   "Welding study of high-performance bimetallic systems and development of systems for corrosion monitoring of painted ship structures."
   Scientific Responsible: Prof. Lorenzo Fedrizzi
   Scientific Disciplinary Sector: ING-IND/22

4. Contratto di ricerca tra il Dipartimento Politecnico di ingegneria e Architettura dell'Università di Udine e ITT Italia s.r.l.
   "Studio dei fenomeni di stiction tra i materiali delle pastiglie e dei rotori dei freni nei sistemi di frenata automobilistici"
   Responsabile scientifico: Prof. Francesco Andreatta
   Settore Scientifico Disciplinare: IND-IND/22

Collaborations with national and international research groups

京都工芸繊維大学 – Kyoto Institute of Technology, Ceramic Physics Laboratory

Kyoto, Japan
Research Group of Prof. G. Pezzotti
The research activity was part of a broad collaboration to study the degradation phenomena occurring in artificial prosthesis components. In particular, it has been used to study the interactions that occur at the interface between the various materials that make up a hip prosthesis.

京都大学 – Kyoto University, Bio-macromolecular Science

Kyoto, Japan
Research Group of Prof. K. Akiyoshi
The research activity carried out in collaboration with several universities in Kyoto City concerns the use of next-generation glucan-based materials to construct scaffolds of polysaccharide origin and verify their biocompatibility using other polymers of protein origin as references.

京都府立医科大学 – Kyoto Prefectural University of Medicine, Graduate School of Medical Science

Kyoto, Japan
Research Group of Prof. N. Kanamura
Research activity with KPUM involved the study of demineralization phenomena that occur

in dental enamel following exposure to aggressive environments. The analysis, using spectroscopic techniques, of the tooth surface allowed the definition of an algorithm for the detection of early degradation phenomena.

東京医科大学 – Tokyo Medical University, Faculty of Medicine
Tokyo, Japan
Research Group of Prof. K. Yamamoto
This collaboration concerns the retrieval study of prematurely extracted hip prostheses. Specifically, the activities carried out under this collaboration involved the characterization of phase transformation phenomena within the Zirconia-Toughened Alumina.

Istituto Ortopedico Rizzoli, Laboratorio di Tecnologia Medica
Bologna, Italia
Research Group of Prof. S. Affatato
This collaboration involved the study, through spectroscopic techniques, of the structure of bone tissue following degenerative diseases such as osteoporosis. Analysis of the Raman signal from healthy bones and osteoporotic bones allowed early identification of the degradation phenomena that occur due to the disease.

Politecnico di Torino, Dipartimento Scienza Applicata e Tecnologia
Torino, Italia
Research Group of Prof. E. Verné
Research activities carried out in collaboration with the Polytechnic University of Turin were mainly concerned with the study of the biocompatibility of surface treatments based on polyphenols (extracted from green tea leaves) on the surface of a Ti6Al4V titanium alloy.

Università Ca' Foscari di Venezia
Venezia, Italia
Research Group of Prof. A. Benedetti
The research activities carried out together with Ca' Foscari University of Venice dealt with theoretical modeling and simulation of aging phenomena of artifacts in HAZ. The aim of the research was to reconcile predictive laws and real cases, which normally tend to diverge as the time scale advances.

Laboratorio LAMA – Università di Udine
Udine, Italia
Research Group of Prof. M. Sortino
Activities on materials produced by additive manufacturing techniques make use of collaboration with the LAMA laboratory where part of the samples are produced by Selective Laser Melting (SLM) technique.

Collaborations with companies

Faber S.p.A.
Cividale, Italia
Scientific research carried out together with FABER S.p.A. studies the degradation phenomena occurring inside gas storage containers, particularly hydrogen.

Electrolux Professional S.p.A.
Pordenone, Italia
The research activity carried out together with Electrolux Professional S.p.A. has mainly dealt with the degradation phenomena occurring in polymers of industrial interest, in particular it is possible to mention: PTFE-based coatings in the "food-service" sector that degrade as a result of chemical, thermal and physical stresses, natural and man-made textile fibers that deteriorate as a result of repeated washing cycles. This collaboration is also carried out within funded projects such as the HEaD project and the FASTHER project.

ITT Italia s.r.l.
Barge (CN), Italia
The studies carried out in collaboration with ITT Italia s.r.l. concerned the phenomenon of disc-pad bonding due to the corrosive attack of the brake disc, typically made of gray cast iron. The study of the phenomenon under controllable and reproducible conditions allowed to investigate the effect of the constituents of the pad compound (friction material, solid lubricants, fillers, etc.) on the behavior at stiction.

PLT GmbH
Ebenthal, Austria
The research activity in collaboration with PLT GmbH is concerned, within the framework of the FASTHER project, with the development and characterization of organic coatings containing nanoadditives on aluminum substrates. The objective of the research is to verify both the corrosion behavior and the improvement of thermal and electrical conductivity of these substrates, applied by powder coating.

Limacorporate S.p.A.
Udine, Italia
The research activity on the characterization of materials produced by additive manufacturing techniques (EBM and SLM) makes use of the collaboration with Limacorporate, which is a Friulian company active in the biomedical sector. In particular, the research activity concerns the correlation between microstructure, mechanical properties and degradation phenomena (corrosion, wear) of materials used for the fabrication of prosthetic implants.

Shinsei Co.
Kyoto, Japan
Collaboration with Shinsei Co., has enabled the morphological and chemical modification of ceramics and metal alloys to functionalize these materials through laser patterning techniques.

Otsuka Chemical Co.
Osaka, Japan
Scientific research carried out in synergy with Otsuka Chemical Co. focused on producing a PEEK-based polymer-ceramic composite with α- and β-Si3N4 particles. The aim was to create a hybrid material that was easy to process but had the biocompatibility properties of ceramic.

Amedica Co.
Salt Lake City, Utah, USA
The work carried out in collaboration with Amedica Co. was aimed at studying and improving the biocompatibility properties of Si3N4. Among the various topics explored in depth were: modulation of surface chemistry and its functionalization, cellular response, and antibacterial behavior.

Participations in international and national conferences as speaker or co-author

***Rondinella A.**, Zanocco M., Tubaro E., Rahimi E., Andreatta F., Capurso G., Maschio S., Fedrizzi L.* Effect of geopolymer-based coatings on magnesium biocorrosion EUROCORR 2022, Berlin, 28 August - 1 September 2022
*Andreatta F., Offoiach R., **Rondinella A.**, Calabrese L., Proverbio E., Capurso G., Fedrizzi L.* Monitoring of corrosion protection by organic coatings on very large testing areas. EUROCORR 2022 Berlin, 28 August - 1 September 2022
*Dorbolò L., Offoiach R., **Rondinella A.**, Andreatta A., Capurso G., Buffa G., Campanella G., Fedrizzi L.* Corrosion behaviour of welded systems for marine applications EUROCORR 2022 Berlin, 28 August - 1 September 2022
*Lanzutti A., Sordetti F., Marin E., Andreatta F., Carabillo A., Querini M., Porro S., **Rondinella A.**, Magnan M., Fedrizzi L.,* The use of ALD and PVD coatings as defect sealants to increase the corrosion resistance of thermal spray coatings EUROCORR 2022 Berlin, 28 August - 1 September 2022
***Rondinella A.**, Zanocco M., Tubaro E., Rahimi E., Andreatta F., Capurso G., Maschio S., Fedrizzi L.* Effetto dei rivestimenti a base geopolimerica sulla biocorrosione del magnesio 39° Convegno nazionale AIM Padova, 21-23 September 2022
*Capurso G., Zanocco M., Dorbolò L., Offoiach R., **Rondinella A.**, Andreatta F., Buffa G., Campanella D., Fedrizzi L.* Comportamento a corrosione di giunti saldati per applicazione nel settore navale 39° Convegno nazionale AIM Padova, 21-23 September 2022
***Rondinella A.**, Andreatta F., Dorbolò L., Offoiach R., Capurso G., Buffa G., Campanella G., Fedrizzi L.* Study of the corrosion behaviour of welded systems for marine industry applications NAV 2022 Genova, 15-17 June 2022
*Andreatta F., Lanzutti A., **Rondinella A.**, Salatin A., Fedrizzi L.* Corrosion behavior of Ti6Al4V produced with different additive manufacturing techniques EUROCORR 2021 Virtual event, 20-24 September 2021
*Andreatta F., Lanzutti A., **Rondinella A.**, Salatin A., Fedrizzi L.* Comportamento a corrosione della lega Ti6Al4V prodotta attraverso diverse tecniche di additive manufacturing Giornate nazionali sulla corrosione e protezione 2021 Virtual event, 29 June – 2 July 2021
***Rondinella A**., Furlani E., Dell'Antone L., Marin E., Boschetto F., Andreatta F., Fedrizzi L., Maschio S.* Production, mechanical behavior, and antibacterial properties of geopolymer coatings AIMAT 2021 Cagliari, 15-18 September 2021
***Rondinella A**., Furlani E., Andreatta F., Fedrizzi L., Maschio S.* Production and optimization of geopolymer-based coatings I GIOVANI E LA CHIMICA IN FRIULI VENEZIA GIULIA 30 September 2021
***Rondinella A.,** Marin E., McEntire B., Bock R., Sonny Bal B., Zhu W.L., Yamamoto K., Pezzotti G.* Bioceramics are Not Bioinert: The Role of Oxide and Non-Oxide Bioceramics on the Oxidation of UHMWPE Components in Artificial Joints BIOCERAMICS30 Nagoya, Japan, 26-29 October 2018
*Marin E., **Rondinella A.**, Boschetto F., Zanocco M., McEntire B., Sonny Bal B., Pezzotti G.* Understanding Silicon Nitride's Biological Properties: From Inert to Bioactive Ceramic BIOCERAMICS30 Nagoya, Japan, 26-29 October 2018

Bock R., Pezzotti G., Zhu W.L., Marin E., ***Rondinella A.****, Boschetto F., McEntire B., Sonny Bal B.,* Compounded PEEK-Sintered silicon nitride composite exhibits enhanced osteoconductivity and resistance to biofilm formation International Society for Technology in Arthroplasty (ISTA) 31st Annual Congress London, England, 10-13 October 2018.
Sonny Bal B, Bock R., ***Rondinella A.****, Marin E., Zhu W.L., Adachi T., McEntire, B, Pezzotti, G.* Osteoinductive Properties of Silicon Nitride, Alumina and Titanium Poster, ORS 2017 Annual Meeting San Diego, 19-22 March 2017