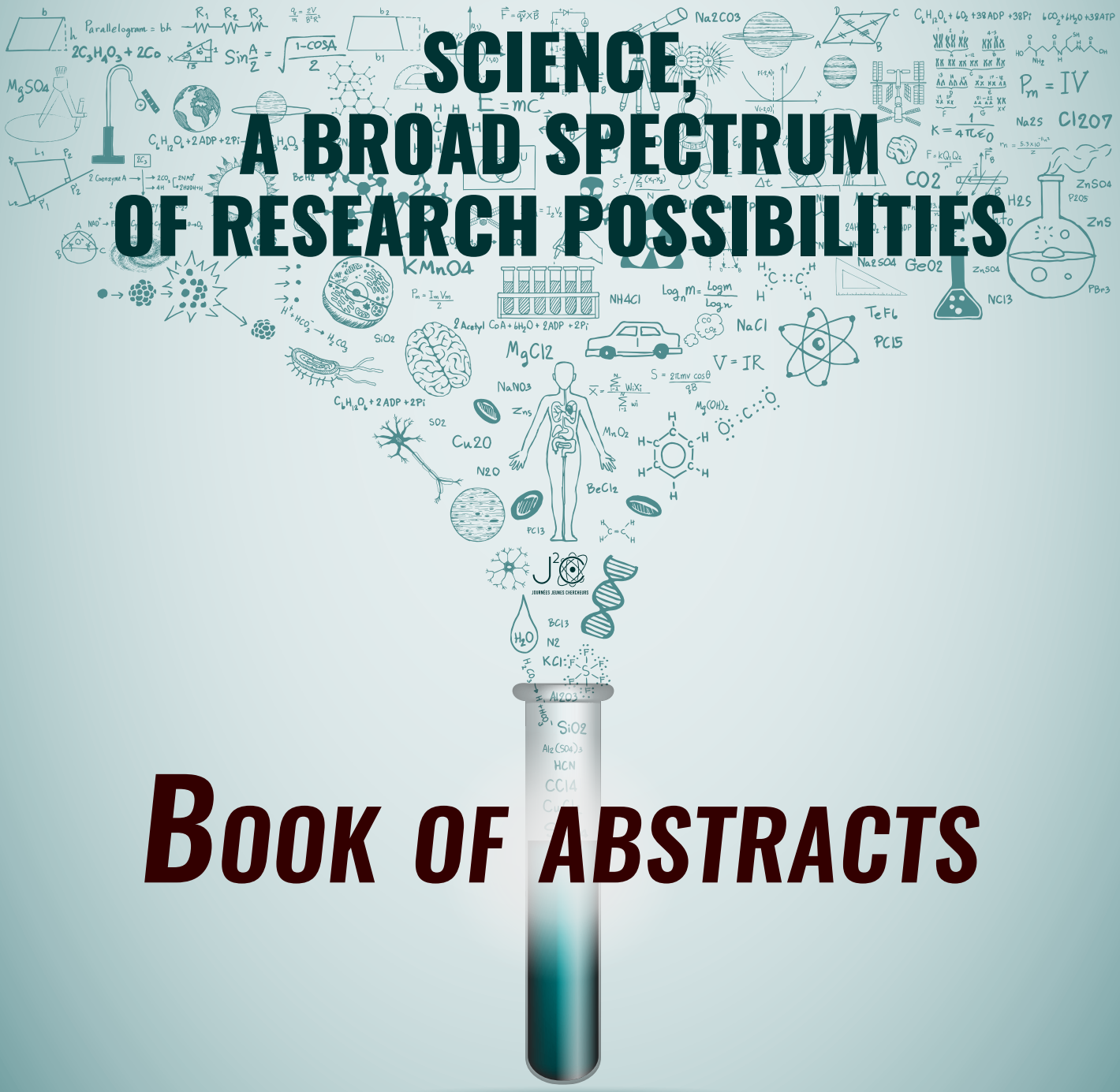
4th edition

Journées Jeunes Chercheurs

Young Researchers' Days

SCIENCE, A BROAD SPECTRUM OF RESEARCH POSSIBILITIES



BOOK OF ABSTRACTS

cnrs · Université d'Orléans · université de Tours · INSA Institut National des Sciences Appliquées Centre Val de Loire · GREMI · Cemhti · ICMN Interfaces Confinement Matériaux et Nanostructures · PCM2E · PRISME Laboratoire Pluridisciplinaire de Recherche Ingénierie des Systèmes, Mécanique, Énergétique

Edifice 2.0 Réinventer la formation à l'université · Investir l'avenir · ED 551 MIPTIS Mathématiques, Informatique, Physique Théorique et Ingénierie des Systèmes · ED 552 EMSTU Énergie - Matériaux - Sciences de la Terre et de l'Univers · Cosmetosciences Recherche & Industrie, innovons ensemble · Crous Orléans Tours · Fédération de Recherche MatV2L Matériaux Val De Loire Limousin · Rotary Orléans · Société Française de Physique

This is the short version of the booklet for print use only.
Full abstracts with all authors, references, and figures can be found at:
https://j2c.sciencesconf.org/

Contents

About

Welcome to the 4^{th} Young Researchers' Days (*Journées Jeunes Chercheurs* | J²C 2022), the flagship conference organized ***by*** and ***for*** young scientists in the Centre-Val de Loire region.
Putting in place a face-to-face conference edition in these times of Covid pandemic has been very challenging. We saw it as the first opportunity to meet again altogether as a community after the cancellation of the 2020 edition in Tours. We wanted to offer again the opportunity for young scientists and researchers to meet, talk in person, discuss, exchange ideas and find solutions towards the production of original technologies and devices. Travelling, however, is still not possible or safe for everyone and the hybrid format of 2022 will also give the chance to attendees who cannot join the event in person to participate online at the J²C 2022. It requires the setup of both live presentations and recording/streaming for oral presentations. Moreover, a hybrid poster session with online and physical presenters will be organized.
We hope that this conference will be an additional step towards the return to normality and that the next editions will be held in the standard face-to-face format, which would be a very positive sign for our society.

Journées Jeunes Chercheurs | J²C | Young Researchers' Days

The conference *Journées Jeunes Chercheurs* (J²C) aims to bring together theoretical and experimental researchers working on the state of the art in the scientific field.

The event focuses on the promotion of scientific research, organized by students for young researchers, whether they are interns, doctoral students, young engineers, assistant engineers, post-docs... The conference is entirely free for the participants in order to allow all those who wish to participate.

The event is held over two days to give participants the opportunity to attend a wide range of oral and poster presentations, to share their knowledge and opinions. This year's theme is "***Science, a broad spectrum of research possibilities***", deliberately broad and diverse in order to encourage the gathering of a maximum of young researchers. These days also enable to enhance the technical know-how of the different laboratories represented by the young scientists.

J²C: Yesterday, today, and tomorrow

The previous editions took place respectively in 2018, 2019 and 2021, gathering more than 80 participants around the themes "*Matter and Plasma*", "*Energy, Environment and Matter*" and "*Science, benefits from diversity*". These first editions were a great success, allowing the establishment of contacts between students and different laboratories (Orleans, Tours, Blois, Bourges). Looking back to this very positive feedback, the 2022 organizing committee wishes to extend the possibility for all laboratories of the Centre-Val de Loire region to meet together. This will allow to create a constructive synergy between the different scientific fields and laboratories involved.

Organizing committee

Soumya Atmane	GREMI PhD Student
Khashayar Bagheri	CEMHTI PhD Student
Anas Berka	PRISME PhD Student
Rim Ettouri	GREMI PhD Student
Lamiae Hamraoui	GREMI PhD Student
Elane Kouadou	GREMI PhD Student
Jack Nos	GREMI/IMN PhD Student
Raphael Ogabi	PRISME PhD Student
Zlanseu Ruth Tan	CEMHTI PhD Student

Timetable

CT: Contributed Talk, RT: Round Table.

Monday, 28^{th} March

8:30–9:15	**Registration**		
9:15–9:45	**Welcome Remarks & Opening Speech**		
9:45–10:00	CT	**Guerra Timothée** CEMHTI, Orléans	Effective Properties of Resonant Nanoparticles: Link Between Incoherent Flux and Diffusion
10:00–10:15	CT	**Soni Sandeep Kumar** PRISME, Bourges	Sliding Mode Approach for Formation Control of Perturbed Second-Order Autonomous Unmanned Systems
10:15–10:30	CT	**Da Silva Isidro** CEMHTI, Orléans	A High AMA : the Grail to Use 165Er in Imaging and Therapy Auger Applications
10:30–11:00	**Coffee**		
11:00–11:15	CT	**Rembert Flore** ISTO, Orléans	Development of Geoelectric Monitoring on Microfluidic Chips for the Study of Critical Zone Processes
11:15–11:30	CT	**Ridouard Amandine** CEMHTI, Orléans	Extent of Structural Disorder in Glass and Transparent Ceramic from Advanced Solid-State NMR Spectroscopy
11:30–11:45	CT	**Farhat Youssef** GREMAN, Tours	Estimation of Reverberation Time in Multi-layer Media
11:45–12:00	**Announcements**		
12:00–14:00	**Lunch**		
14:00–14:15	CT	**Lourhzal Oumayma** ICMN, Orléans	Electrochemical Sensors Based on Carbon for the Detection of Micropollutants
14:15–14:30	CT	**Mestre Eloïse** GREMI, Orléans	Electrical Characterization of an Argon/CO_2 and Helium/CO_2 Plasma Jet for Wound Healing
14:30–15:00	**Coffee & Group Photo Shoot**		
15:00–16:15	**Poster Session with Coffee**		
16:15–16:30	CT	**Samba Paixan** ICMN, Orléans	Porous Carbons Synthesis from Waste Biomass by Hydrothermal Process
16:30-16:45	CT	**Taleb Abed Albaset** ICMN/GREMI, Orléans	Development of Environmental Sensors Coupling Graphene and Field Effect Transistor
16:45-17:00	CT	**Elguendouze Sofiane** LIFO, Orléans	Towards More Explainable Deep Learning Models for Image Captioning
17:00–17:30	**Conclusion & Announcements**		
17:30–22:30	**Social Activity & Conference Dinner**		

CT: Contributed Talk, RT: Round Table.

Tuesday, 29^{th} March

9:30–10:00	**Reception**		
10:00–10:15	CT	**Ermini Ilse Maria** CEMHTI, Orléans	Real Time FT-IR Observation of Materials During Their Cooling from Molten State
10:15–10:30	CT	**Shetty Prathika Prathap** GREMI, Bourges	Formation of Blast Wave Due to Laser Breakdown
10:30–10:45	CT	**Hamza El Yamani** LaMé, Tours	Characterization of the Mechanical Behaviour of a Thermal Insulating Polyisocyanurate Foam
10:45–11:15	**Coffee**		
11:15–11:30	CT	**Mareus Rubenson** GREMI, Orléans	Study of Columnar Growth and Texture Development of Reactively Sputter-Deposited TiN, HfN and ZrN Thin Films at Oblique Angles
11:30–11:45	CT	**Antoissi Mohamed** ICMN/GREMI, Orléans	Removal of the Herbicide 2,4-Dichlorophenoxyacetic Acid from Aqueous by Adsorption onto Functionalized Activated Carbons Coupled to Non Thermal Plasma
11:45–12:00	CT	**Andriano Gaétan** PRISME, Orléans	Temporal Stability of the Large Amplitude Pulsed Plane Poiseuille Flow
12:00–14:00	**Lunch**		
14:00–15:15	RT		***Impact of Covid on Research***
15:15–15:30	**Coffee & Group Photo Shoot**		
15:30–15:45	CT	**Lamoot Ludovic** PRISME, Orléans	Effect of Injector Size on the Spray Characteristics: Preliminary Experimental Work on the Effect of the Cavitation
15:45–16:00	CT	**Bazzaoui Haytem** CEMHTI, Orléans	Prediction and Synthesis of La-Doped $Ca_5Ga_6O_{14}$ Melilite-Like Structure for New Interstitial Oxide Ion Conductors
16:00–16:30	**Coffee**		
16:30	**Poster and Oral Prizes & Closing Ceremony**		

Compact Poster List

Eletrical Investigation of a Plasma Reactor Devoted to the Disposal of Antibiotics
Tian Tian, *GREMI*, *Orléans*

A Carbon Fiber Cloth /Hydroxyapatite Composite Biomaterial as a Patch used for Bone Repair
Florian Olivier, *ICMN*, *Orléans*

Behavior of Silica Films Subjected to Weathering in Aqueous Media
Farah Inoubli, *CEMHTI*, *Orléans*

Design and Synthesis of Polytopic Constructs with Affibodies
Eric Kaya, *CBM*, *Orléans*

Enzymatic Kinetics of Extracellular Matrix Remodeling: Analytical and Biophysical Characterizations of Synthetic Models
Josipa Cecic Vidos, *CBM*, *Orléans*

MSSL: Memory Safe Synchronous Language
Darine Rammal, *LIFO*, *Orléans*

Numerical and Experimental Studies of Pristine and Cluster containing Silane-Hydrogen Capacitively Coupled Plasmas Used for Silicon Epitaxial Growth
Tinghui Zhang, *GREMI*, *Orléans*

Pore-Clogging in Porous Media
Laurez Maya Fogouang, *ISTO*, *Orléans*

Skin Permeability Modulation Thanks Cold Atmospheric Plasma (CAP) Treated Liquid (PTL) for Cosmetic Application
Amaury Rouillard, *GREMI*, *Orléans*

Smart Laser Engraving System for Wide Band Gap Materials
Alex Capelle, *Decor World Services | GREMI*, *Orléans*

Synthesis and Characterisation of the New Strontium Silicate Compound $Sr_2Si_3O_8$
Euan Duncan, *CEMHTI*, *Orléans*

The Wettability Alteration in Porous Media
Mojtaba Norouzisadeh, *ISTO*, *Orléans*

List of Abstracts – Talks

Monday 28^{th} March

Effective Properties of Resonant Nanoparticles: Link Between Incoherent Flux and Diffusion

Timothée Guerra[1], ***Olivier Rozenbaum***[1], ***Jean-Paul Hugonin***[2], ***Cédric Blanchard***[1]

[1] Conditions Extrêmes et Matériaux : Haute Température et Irradiation (CEMHTI - UPR3079), Centre National de la Recherche Scientifique, Orléans, France
[2] Laboratoire Charles Fabry – Institut d'Optique Graduate School, Centre National de la Recherche Scientifique – Université Paris-Saclay, Paris, France

In modelization and specifically in homogenization theory, where particles are small compared to the wavelength, the issue of representative volume is of utmost importance. These two notions combined lead to longer and more challenging simulations. Moreover, homogenization being based on statistical quantities, such as the coherent flux scattered by an ensemble of realizations in response to a thermal radiation, it is important to study the relation between these quantities and the representative volume in resonant domains, domains where properties are usually interesting. We present here the results of simulation on the electromagnetic behavior of agglomerates containing up to 1500 nanometric particles. Owed to the resonances aforementioned, we observe significant deviations compared to effective medium theories (Maxwell-Garnett, Bruggeman...). In particular, the manifestation of an effective permeability, uncorrelated to size effects is evidenced. Furthermore, although homogenization is believed to work only when particles act as dipoles, we show here that actually this is not mandatory. Finally, we question the idea that the incoherent flux is a good indicator of the diffusion of the medium by creating highly diffusing medium with small incoherence, or the opposite.

Sliding Mode Approach for Formation Control of Perturbed Second-Order Autonomous Unmanned Systems

Sandeep Kumar Soni[1], ***Siyuan Wang***[1], ***Driss Boutat***[1]

[1] Laboratoire Pluridisciplinaire de Recherche en Ingénierie des Systèmes, Mécanique, Energétique (PRISME - EA 4229), Université d'Orléans – Institut National des Sciences Appliquées (INSA) - Centre Val de Loire, Bourges, France

A sliding mode approach for leader-following formation control of perturbed second-order autonomous unmanned systems (AUSs) under directed topology. The leader velocity is assumed to be constant. The formation controller performs two objectives: (i) it obtains the position formation control of all the followers, (ii) it achieves the velocity consensus of all the followers. Using Lyapunov stability theory, we have presented the finite-time convergence of sliding surface and asymptotic stability of the closed-loop system. Finally, a numerical example with comparative results demonstrates the efficacy of the proposed method.

A High AMA : the Grail to Use 165Er in Imaging and Therapy Auger Applications

Isidro Da Silva[1]

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165Er is a radionuclide used in imaging applications (X-rays emission: bimodality SPECT/MRI) or in therapy (pure Auger emitter: dosimetry studies).
For these applications, a high apparent molar activity (AMA) in MBq/nmole is required for radiolabeling molecules with 165Er at 100% yield. It means a high purity of 165Er is necessary. Several parameters impacting its quality have been studied in this work: target, irradiation, separation, metal impurities. 165Er was produced by irradiation of Ho target with proton (11 to 16MeV) or deuteron (13 – 17.5MeV) beam. Various Ho target parameters (thickness, diameter, quality of Ho) have been evaluated for its design using spot-welding method. Radiochemical separation Ho/165Er has been optimized using a protocol of three columns filled with extraction resins (LN2 and DGA-b). AMA value was determinated by radiolabeling DOTA solution at various concentration with final batch of 165Er.

Development of Geoelectric Monitoring on Microfluidic Chips for the Study of Critical Zone Processes

Flore Rembert[1,2], ***Arnaud Stolz***[3], ***Sophie Roman***[1], ***Damien Jougnot***[2], ***Cyprien Soulaine***[1]

[1] Institut des Sciences de la Terre d'Orléans (ISTO - UMR 7327), Université d'Orléans – Centre National de la Recherche Scientifique – BRGM, Orléans, France
[2] Milieux Environnementaux, Transferts et Interactions dans les hydrosystèmes et les Sols (METIS - UMR7619), Sorbonne Université – Centre National de la Recherche Scientifique, Paris, France
[3] Groupe de Recherches sur l'Energétique des Milieux Ionisés (GREMI - UMR7344), Université Orléans – Centre National de la Recherche Scientifique, Orléans, France

The critical zone is the near-surface environment where most of the drinking water resources and continental life are hosted. Its study requires an interdisciplinary approach based on the characterization of the mechanisms involved between air, water, soil, living organisms and the rock matrix. Geophysical methods propose the development of appropriate techniques for the monitoring of hydrological and biogeochemical processes in a non-intrusive and low-cost manner. Among the existing techniques, geoelectrical methods have already proven their ability to monitor such processes. However, their interpretation is often approximate, as it is based on the superposition of several phenomena, the source mechanisms of which are often microscopic (e.g., surface charge, fluid-fluid and fluid-mineral interfaces, pore clogging). As part of my postdoctoral research at the ISTO and in partnership with the GREMI, I focus on the development of geoelectrical monitoring methods for microfluidic chip acquisitions. This approach at the micrometer scale allows to work in well-controlled conditions, with real-time monitoring by high speed microscopy. This work, coupled with pore network numerical simulations, will allow a better understanding of the geoelectric signatures of the studied processes, in order to improve their interpretation on larger scales.

Extent of Structural Disorder in Glass and Transparent Ceramic from Advanced Solid-State NMR Spectroscopy

Amandine Ridouard[1], ***Cécile Genevois***[1], ***Michael J. Pitcher***[1], ***Mathieu Allix***[1], ***Dominique Massiot***[1], ***Franck Fayon***[1]

[1] Conditions Extrêmes et Matériaux : Haute Température et Irradiation (CEMHTI - UPR3079), Centre National de la Recherche Scientifique, Orléans, France

Over the last years, various advanced solid-state NMR methods have been proposed to obtain detailed short and longer-range structural information in disordered systems. Here, we have used this advanced NMR methods to probe the structure and describe the extent and nature of disorder in two systems. We will describe the synthesis and characterization of novel transparent polycrystalline $SrGa_2Si_2O_8$ ceramic obtained by full and congruent crystallization from the parent glass. By using ^{29}Si homonuclear through-bond multiple-quantum NMR experiments and ^{71}Ga very-high field NMR spectra, it was possible to characterize and quantify chemical disorder in the metastable transparent ceramic and in the parent glass.
We will discuss the structure of complex glasses in SiO_2-Na_2O-Ga_2O-Nb_2O_5 system which is phase separated. In that case, $^{29}Si/^{71}Ga/^{23}Na/^{95}Nb$ and several double-resonance NMR experiments complemented with TEM microscopy have been employed to study the nature of disorder in homogeneous and nanostructured glasses having potential applications in optics.

Estimation of Reverberation Time in Multi-layer Media

Youssef Farhat[1], ***Julien Bustillo***[1], ***Hossep Achdjian***[1], ***Marie-Nawal Sabra***[2], ***Doumit Zaouk***[2], ***Jerome Fortineau***[1]

[1] Groupe de Recherche en Matériaux, microélectronique, Acoustique, Nanotechnologies (GREMAN - UMR7347), Centre National de la Recherche Scientifique – Université de Tours, Tours, France
[2] Applied Physics Laboratory, Faculty of Sciences 2, Lebanese University, Jdedeit, Lebanon

Ultrasonic methods are commonly used for testing materials that use sound waves along the direct path between the emitter and the receiver providing local information about medium properties. An alternative method, known as a coda, depends on the reverberating signals that have travelled the entire medium to provide global information about media. Furthermore, this method is highly sensitive to any variations in boundary conditions. In-room acoustic, these reverberated signals are averaged using the Schroeder integration method to extract the reverberation time (RT) from the decaying energy curve. However, this technique works only for one propagation mode. Previous studies adapted Sabine by considering room acoustic analogues to a solid medium where two propagation modes occur. Then, the discrete attenuation of the walls can be equivalent to the boundary conditions of the solid. In this work, an analytical method has been established to estimate the acoustic intensity in solid medium taking into account the mode conversion. Then, the (RT) of the simulated signals is estimated and compared with experimental measurements. Finally, an experimental setup is composed of five piezoelectric patches, which are randomly distributed on an aluminium block, one as an emitter, and the others as receivers to perform experimental (RT).

Electrochemical Sensors Based on Carbon for the Detection of Micropollutants

Oumayma Lourhzal[1], ***Céline Grillot***[1], ***Jimmy Nicolle***[1], ***Valerie Bertagna***[1], ***Christine Vautrin-Ul***[1]

[1] Interfaces, Confinement, Matériaux et Nanostructures (ICMN - UMR7374), Centre National de la Recherche Scientifique – Université d'Orléans, Orléans, France

Anthracene is a prioritary micropollutant of water but there are no commercial sensors for anthracene in water, and very little studies deal with the development of an electrochemical sensors for this pollutant. We have developed a novel electrochemical sensor, based on functionalized carbon materials, allowing in-situ analyzes of water quality, in real time, and presenting good performances of selectivity and sensitivity as well as robustness in accordance with the (WFD). This work, deals with the development of a Molecularly Imprinted Polymer (MIP) sensor1,2. The study is focused on: i) electropolymerization of MIP, ii) pollutant extraction phase and iii) electrochemical analysis in an aqueous medium. The sensor is characterized by different techniques such as AFM, SEM, and XPS. With a view to optimizing the detection performance (limit of detection, limit of quantification) of the MIP sensor. We will also discuss the sensibility of the MIP sensor for the anthracene detection in nano-molar concentration in natural waters.

Electrical Characterization of an Helium/CO_2 Plasma Jet for Wound Healing

Eloïse Mestre[1], ***Titaina Gibert***[1], ***Sebastien Dozias***[1], ***Hervé Rabat***[1], ***Claire Douat***[1]

[1] Groupe de Recherches sur l'Energétique des Milieux Ionisés (GREMI - UMR7344), Centre National de la Recherche Scientifique – Université Orléans, Orléans, France

Since more than ten years, cold plasma at atmospheric pressure is investigated for medical purposes. Indeed, it's a close room temperature medium producing UV radiations, electrical field and a large population of reactive species which together has anticancer, sterilizing and wound healing effect.
In large quantities, carbon monoxide (CO) is a lethal poison. In our lungs it binds to hemoglobin and takes the place of dioxygen (O_2) by forming carboxyhemoglobin ($COHb$) and participates in tissue asphyxiation.
However, medical studies have shown that at lose doses, meaning less than 10% $COHb$ in the blood, CO has anti-inflammatory, vasodilatory, anti-apoptotic and anti-proliferative properties and could thus be used for wound healing. [1]
Plasma is able to produce CO from the dissociation of CO_2. The idea is to use a plasma jet to produce a small amount of CO to combine the beneficial effects of plasma and CO.
This talk will be focused on the electrical characterization of helium and argon plasma jets as a CO sources for biomedical use. The influence of the amount of CO_2, the frequency, and the gas flow rate on the discharge's properties will be investigated.

References

[1] Emile Carbone, Claire Douat. Carbon Monoxide in Plasma Medicine and Agriculture: Just a Foe or a Potential Friend?. *Plasma medicine*, 2018, 8 (1), pp.93-120.

Porous Carbons Synthesis from Waste Biomass by Hydrothermal Process

Paixan Samba[1], ***Sébastien Schaefer***[1], ***Benoît Cagnon***[1]

[1] Interfaces, Confinement, Matériaux et Nanostructures (ICMN - UMR7374), Centre National de la Recherche Scientifique – Université d'Orléans, Orléans, France

In order to contribute to the valorization of agricultural residues, four raw materials from lignocellulosic biomass (rapeseed straw, sunflower husks, hemp and Japanese knotweed stems) were studied in order to produce porous carbons. At first, these agricultural residues as well as all the lignocellulosic precursors of biomass (cellulose, hemicellulose and lignin) were subjected to a hydrothermal treatment (HTC). HTC consists in thermal treatment of organic matter in aqueous medium and under self-generated pressure. HTC allows both conversion of lignocellulosic biomass into hydrochar and the development of microporosity. In this study, HTC was carried out at a temperature of 180 ∘C for 24 h. Comparative thermogravimetric analyzes (TGA) between the raw materials and their hydrochars show a prominent degradation of hemicelluloses. Then, the elemental analysis (CHNOS) highlights the increase of carbon content in the hydrochars. In order to obtain the final porous carbons, the hydrochars were treated at 900 ∘C under N_2. Textural properties such as specific areas were determined using adsorption manometry (N_2, 77 K). Hydrothermal synthesis was also carried out in presence of phosphoric acid in order to increase the textural properties of the final carbons. These materials will be tested in an advanced oxidation process for water treatment.

Development of Environmental Sensors Coupling Graphene and Field Effect Transistor

Abed Albaset Taleb[1,2], ***Arnaud Stolz***[1], ***Jimmy Nicolle***[2], ***Nadjib Semmar***[1], ***Christine Vautrin-Ul***[2]

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[2] Interfaces, Confinement, Matériaux et Nanostructures (ICMN - UMR7374), Centre National de la Recherche Scientifique – Université d'Orléans, Orléans, France

The development of analytical techniques has revealed the presence of many micropollutants in surface and groundwater in connection with the intensification of anthropogenic activities. These micropollutants can have harmful consequences on the environment and more particularly on humans. They therefore pose a major environmental problem, especially since they are often not eliminated by conventional water treatment techniques. The environmental directives established by the European Union in the field of water pollution impose frequent physicochemical controls at many points. It is essential to develop new analytical methods better suited to in-situ analysis in aquatic environments. In this presentation we will therefore present the progress of our work on the development of environmental sensors based on a graphene-based FET configuration. The different design steps will be presented from the transfer of graphene to the lithography of the transistor in a clean room and the electrical characterizations of the transistors obtained. The characterizations by Raman and XPS spectroscopy of the graphene samples at each stage of the design will also be presented in order to allow monitoring of the surface chemistry as well as the rate of defects in the samples which are two key parameters of the reactivity of graphene.

Towards More Explainable Deep Learning Models for Image Captioning

Sofiane Elguendouze[1]

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Machine learning (ML) algorithms, namely DNNs, have witnessed tremendous progress in terms of the relevance of results and model complexity. However, the high complexity of these models makes them perceived as black-boxes, which means that they lack transparency for humans, preventing them from understanding and interpreting their results. Explainability has emerged as a new area of research aimed at finding a kind of trade-off between high performance and substantial explainability of models. Image captioning (IC) is one of the most studied domains in ML, which aims at automatically and efficiently generating descriptions (Captions) for images. It lies at the intersection of two well-known fields of ML, Computer Vision and Natural Language Processing. Most IC architectures are black-box models, which further emphasizes the need for explainability for these architectures. This talk will first place the general context of explainability in IC and discuss the various challenges that need to be addressed, and then present a new explainability approach that helps make further steps toward more interpretable IC models.

Tuesday 29^{th} March

Real Time FT-IR Observation of Materials During Their Cooling from Molten State

Ilse Maria Ermini[1]

[1] Conditions Extrêmes et Matériaux : Haute Température et Irradiation (CEMHTI - UPR3079), Centre National de la Recherche Scientifique, Orléans, France

A new device allowing real time observation of materials during their cooling, from the molten state to low temperature has been developed. This possibility originates from the implementation of a Rapid Scan feature on a FT-IR emissometer designed to probe materials submitted to extreme temperature conditions. Original time-resolved emissivity dependence during the phase transition are reported for the first time.
The resulting out of equilibrium, dynamic, new data have been compared to the equilibrium, static, classical measurements to demonstrate the reliability of the new technique.
The proposed method has high possibilities to be applied to different materials to enable the observation of fast structural transformations during liquid to solid phase change through the evolution of the dielectric function.

Formation of Blast Wave Due to Laser Breakdown

Prathika Prathap Shetty[1], ***Steve Rudz***[1], ***Jean-Luc Hanus***[2], ***Stéphane Pellerin***[1], ***Jean-Marc Bauchire***[1]

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When compared to traditional ignition methods (such as spark plugs for example), laser ignition has significant advantages (better control over timing and location of the deposited energy). To ignite a reactive mixture using this technique, one needs to have immense knowledge in the characterization of deposited energy. The study focuses on the characterization of the mechanical energy deposition observed with a blast wave formation in various gases owing to laser breakdown. Blast waves are produced by Nd:YAG laser breakdown in argon, air, CO2 at different pressures (250 mbar, 500 mbar, 1000 mbar, 1500 mbar). Experiments are carried out with various incident laser energies (15 mJ, 30 mJ, 60 mJ, 100 mJ, 200 mJ). The images are captured using a fast imaging and shadowgraphy technique. After that, a Matlab code is used to extract the blast wave trajectory as a function of time from the obtained image data. The shock energy is calculated using the Jones model. To produce an accurate result, Jones' original theory (i.e., strong shock at t = 0 s) is discussed.

Characterization of the Mechanical Behaviour of a Thermal Insulating Polyisocyanurate Foam

Hamza El Yamani[1], ***Jean-Luc Hanus***[1], ***Huabin Zeng***[1], ***Patrice Bailly***[1], ***Gaëtan Prod'homme***[2], ***Benjamin Le-Roux***[2]

[1] Laboratoire de Mécanique Gabriel Lamé (EA7494), Université de Tours – Institut National des Sciences Appliquées (INSA) - Centre Val de Loire, Tours, France
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The industrial risk management, on Seveso sites and their surroundings against accidental or malicious explosions, requires managing the protection of buildings from dynamic loadings such as shockwaves. The use of sacrificial claddings systems, composed of insulating materials and metals, seems to be an interesting lead, combining building protection and energy efficiency.
In this work, a polyisocyanurate foam, which is a plastic thermal insulating material, was studied. The mechanical characterization under dynamic loadings of this very low-density material remains mostly incomplete to this day.
Unconfined and confined compression tests for quasistatic loadings are carried out using a universal compression machine. A follow-up by a high-resolution camera associated with digital image correlation technique are useful to identify the mechanical properties, to observe the strain heterogeneity and to track the propagation of compaction waves in the material.
The "Split Hopkinson Pressure Bars" device is used for the study of the mechanical response's sensitivity to the speed loading. Unconfined and confined compression tests are also conducted using this device. These tests highlight the strain rate dependency of the plateau stress. A high-speed camera associated with digital image correlation technique also allows us to observe the strain heterogeneity and to determine the compaction wave celerity.

Study of Columnar Growth and Texture Development of Reactively Sputter-Deposited TiN, HfN and ZrN Thin Films at Oblique Angles

Rubenson Mareus[1]

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In this work, Oblique Angle Deposition (OAD) was used for deposition thin films of TiN, HfN and ZrN by reactive magnetron sputtering on Si (001) substrates inclined at different tilt angles α=5○, 35○, 65○, 75○and 85○ with respect to the surface normal of the target material. The morphology of the layers and microstructural properties, such as crystal structure, texture, were studied for a working pressure of 0.3Pa at 300○C. The films were characterized by SEM and the analyzed microstructures are columnar. This analysis also showed that the porosity of the layers increases with the increase of α and that the thickness of the layers decreases with α. The pole figures were made by X-ray diffraction for the (111) and (200) crystallographic planes. All films had a cubic, NaCl-type crystal structure with an [111] out-of-plane orientation and exhibited a biaxial texture for $\alpha \geq 35$. The effect of temperature was also studied in the case of TiN, and an increase of +10○ was observed when the temperature increased from 25○ to 500○C. The evolution of β versus α will be discussed for TiN and compared to existing empirical laws and those simulated from a kinetic Monte Carlo (kMC) model.

Removal of the Herbicide 2,4-Dichlorophenoxyacetic Acid from Aqueous by Adsorption onto Functionalized Activated Carbons Coupled to Non Thermal Plasma

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Contamination by herbicides, such as organophosphorus compounds (glyphosate, aminomethylphosphonic acid, 2.4 D), of groundwater resources intended for drinking water supply is very significant. Currently, for 2.4 D, conventional treatment processes do not always produce water that complies with regulations. It is therefore necessary to develop innovative processes for the efficient removal of this compound and its metabolites. This thesis aims to develop a cost-effective and efficient hybrid advanced oxidation process for water and wastewater treatment by coupling several processes for the mineralisation of 2.4 D in batch and dynamic modes. The coupled process will consist of Non-Thermal Plasmas (NTPs)/iron-impregnated activated carbons (CA-Fe). In this project, we are interested in the characterisation of carbonaceous materials and their implementation in plasma reactors, the electrical and optical characterisation of discharges as well as chemical diagnostics with the aim of optimising the treatment of the pollutant and the products generated. Enough optimization, the first results show the efficiency of the coupling Non-Thermal Plasmas (NTPs)/iron-impregnated activated carbons (CA-Fe).

Temporal Stability of the Large Amplitude Pulsed Plane Poiseuille Flow

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Pulsating flows are of particular importance in the control of flows and the transition to turbulence for industrial applications. The pulsation can either stabilize or destabilize our flow depending on the Womersley number, which characterizes the ratio between the thickness of the Stokes boundary layer (oscillating component) and the thickness of the viscous boundary layer associated with the Poiseuille profile, and, on the other hand, the amplitude of the pulsation.
In order to explore a wide range of parameters, two techniques are combined: the Floquet analysis and the asymptotic WKB (Wentzel-Kramers-Brillouin) method.
For high Womersley numbers, stability is analysed using a matrix Floquet method including all the harmonics of our perturbations that couple the stability modes to the first harmonic of the basic flow. For low Womersley numbers, the pulsation period of the basic flow being much longer, we notice a decoupling between the pulsation frequency and the instability frequency, which allows us to implement the WKB method.
The tools presented in this study allow the identification of flow regimes and the laminar/transitional boundary for automotive applications for mixing in confined media.

Effect of Injector Size on the Spray Characteristics: Preliminary Experimental Work on the Effect of the Cavitation

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The objective of this work is to highlight the influence of cavitation in an injector on a turbulent flame in terms of temperature, heat flow, geometry, flame color, release of gaseous species. To obtain this objective, a preliminary fluidic work is carried out in order to characterize the conditions for which the phenomenon of cavitation appears inside an injector. Three different flow injectors of the DELAVAN brand were used to highlight the influence of the diameter of the outlet hole on the characteristics of the spray. The results showed that the 2.0 80W injector has a greater cavitation compared to other injectors given the characteristics of the spray (lower angle, extended penetration length).The perspectives of this preliminary study will be to understand the phenomenon of cavitation in an injector by means of transparent injectors manufactured in PMMA according to the internal geometry of the injectors presented in order to visualize the cavitation and to be able to relate the cavitation number with a measurement of the vacuum rate by image processing. A NEXGEN burner will be used to characterize the influence of cavitation on a turbulent flame using the same parameters that were determined by this preliminary study.

Prediction and Synthesis of La-Doped $Ca_5Ga_6O_{14}$ Melilite-Like Structure for New Interstitial Oxide Ion Conductors

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Reducing the working temperature of solid oxide fuel cells (SOFC), to improve their durability and running costs, remains a big task in today's research. To do so, developing new ionic conductor materials operating at intermediate temperatures 500-800^oC is needed. The gallate melilite structures, shows a wide variety of potential applications, with arising optical, magnetic refrigeration and ionic conductivity properties. The $Ca_5Ga_6O_{14}$ crystallises in an orthorhombic cell (S.G. *Cmc*2), adopting a melilite-related structure. By using DFT we predicted La-doping to be the most stable way of introducing interstitial oxide into the structure with the formula $La_xCa_{5-x}Ga_6O_{14+x/2}$. Investigations on the synthesis of the $La_xCa_{5-x}Ga_6O_{14+x/2}$ by solid state reaction showed that the structure can only accommodate $x \leq 0.25$, showing an increase of the sample conductivity by almost two orders of magnitudes at 800^oC (6.10^{-7} S.cm^{-1} *vs* 2.10^{-5} S.cm^{-1} for $x = 0$ and $x = 0.25$ respectively). Here we report the structural characterization of the $La_{0.25}Ca_{4.75}Ga_6O_{14.125}$ compound using laboratory powder x-ray diffraction, neutron powder diffraction and transmission electron microscopy. Due to the concentration of the interstitial oxide being very low (0.89%), analysis by maximum entropy method and density functional theory calculations were performed to help identification of the interstitial oxide position in the unit cell.

List of Posters

Poster Session

Eletrical Investigation of a Plasma Reactor Devoted to the Disposal of Antibiotics

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Non-thermal plasma is studied worldwide for water pollution control, due to its significant advantages in degrading organic contaminants in water, including antibiotic molecules. In this communication, we present a plasma reactor dedicated to the degradation of antibiotics in water, which is a coaxial dielectric barrier discharge (DBD) on the water falling film configuration with a quartz tube as dielectric, producing a plasma at atmospheric pressure. The high voltage has a square and sine waveform with the amplitudes in the range of 11 kV to 15 kV and frequency between 300 Hz and 1.5 kHz. The water falling film flows along the outside of the central tube (grounded electrode) with a flow rate of 240 mL/min, while air or oxygen has a flow rate of 100 mL/min at standard conditions. We performed a series of electrical investigation of this discharge using ultra-pure water with/without antibiotics and the measurements show, for instance, that the power injected into the plasma increased linearly with the voltage amplitude and the frequency in the indicated ranges.

A Carbon Fiber Cloth/Hydroxyapatite Composite Biomaterial as a Patch used for Bone Repair

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This work is focused on the use of activated carbon fiber cloths (ACC) as biomaterials to be efficient in the field of bone regeneration. The commercial ACC used was selected after biological tests showing its good affinity with human osteoblasts. To improve the ACC biological properties, different treatments were performed. At first, the ACC surface was coated with biocompatible calcium phosphate (CaP) phases using a sono-electrodeposition process. A control of the process parameters allows getting a biomimetic calcium-deficient hydroxyapatite (CDA) coating. Then, the CDA coating was doped with bioactive strontium ions leading to biomimetic strontium-substituted CDA coating. After that, we took advantage of the ACC microporosity to adsorb bioactive molecules such as aspirin. Finally, four types of ACC-based biomaterials were implanted in a bone defect performed in a femoral rat. After 1, 2 and 3 weeks of *in vivo* tests, the bone defects were investigated by X-ray micro-computed tomography to analyze the kinetic of bone regeneration. It is shown that the ACC use improves the bone regeneration and the kinetics are accelerated in the case of CDA and Sr-CDA coatings on ACC surface and in presence of adsorbed aspirin. The interest of ACC as efficiency drug delivery system is demonstrated.

Behavior of Silica Films Subjected to Weathering in Aqueous Media

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Amorphous SiO_2 films are of great use in many technological fields. CVD process allows exploring various chemical pathways such as TEOS-O_2(O_3) gas mixtures for production of pure SiO_2. Detailed investigation of process conditions operating at moderate temperature (360 - 650○C) and at atmospheric pressure resulted in a large variety of such films. Ageing experiments have been carried out at 90○C in aqueous solution at pH 5 for silica films elaborated at different temperatures for a total duration of 250 days. These films have been analyzed at different stages of the leaching experiments for chemical and structural description. The IBA (Ion Beam Analyzes) techniques showed a loss of thickness of the films depending on the deposit temperature, that has been quantified. IR and IBA measurements revealed an enrichment with hydrogen and a slight increase of the O/Si ratio in our films which is more pronounced for the lowest deposition temperature. Diffusion profiles have been established thanks to ToF-SIMS measurements. Finally, the evaluation of film surfaces by AFM showed an increase in roughness heightened for low deposition temperatures. Our monitoring of film behavior has also been supported by nanoindentation that confirmed the good resistance of silica films elaborated above 500○C.

Design and Synthesis of Polytopic Constructs with Affibodies

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Affibodies (AfB) are small proteins (6–7 kDa) that have an amino acid sequence folded into three alpha helices. These molecules are chemically robust and can tolerate high temperatures and more extreme pH. Affibody molecules are able to bind protein targets with high affinity and selectivity, with short circulation times, which reminds the binding of monoclonal antibodies and antibody fragments. Therefore, these properties allow us to consider AfB for applications in the field of bioimaging, diagnostic and/or therapy. The latter action of affibodies can be directly carried out by blocking receptor-ligand interactions. In order to increase the binding efficiency of AfB, we propose to assemble several AfB into one well-defined macromolecular construct. The connection of AfB to polytopic linkers will be realised through biortohogonal chemistry. In addition, suitable fluorophores can be specifically introduced into the backbone in order to facilitate biophysical characterization. Starting with di- ou tritopic constructs, we aim to optimize the length and rigidity of linkers. We will carefully evaluate the potential of such constructs for binding receptors on the surface of cancer cells. Our work will thus contribute to the development of new strategies for cancer immunotherapy.

Enzymatic Kinetics of Extracellular Matrix Remodeling: Analytical and Biophysical Characterizations of Synthetic Models

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The effect of macromolecular crowding drew the attention of many scientists investigating the mechanism and the activity of different enzymes. Since the enzymatic assays are mostly studied in diluted conditions differing from the cytoplasm or the extracellular matrix where enzymes are naturally expressed and active, it is important to find the media that are convenient for laboratory experiments and can sufficiently mimic cell environments. One of the objectives of the "X-CROWD" project is to characterize and describe the influence of crowding media on the activity of three enzymes found in the extracellular matrix: hyaluronidase, elastase, and collagenase. These enzymes play an important role in the remodeling of extracellular matrix components thus indicating various pathological conditions and mediating the process of tumor formation. Enzymatic kinetics will be thus followed by different methods such as spectrophotometry and capillary electrophoresis in the absence and presence of different crowding media. Moreover, DLS, NMR, and other related tools will be applied to investigate the interactions between substrates, enzymes, and the media (crowders). This PhD project will be mainly carried out at the Center for Molecular Biophysics but also involves the international co-tutelle with the Memorial University of Newfoundland where PFG-NMR measurements will be performed.

MSSL: Memory Safe Synchronous Language

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Rust is considered to be a major step forward in industrial programming languages that utilizes state of the art features of the Type system. It provides memory safety and thread safety through its novel mechanisms such as ownership, moves and borrows.
The ownership system establishes a clear lifetime for each value and therefore does not necessarily require garbage collection. Having these advanced features, Rust is a high performance language specialized with a low level fine-grained control of C and C++, and does not entail a garbage collection. In this work, we set out to capture the essence of this property model by developing a type system account of Rust's borrow checker. To this end, we present MSSL, a Memory Safe Synchronous Language close to source-level Rust. In particular, we introduce a novel extension of this type system dedicated to embedded reactive systems which will statically guarantee memory and thread safety, as well as detect common concurrency errors without the need to use garbage collection all that while maintaining performance.

Numerical and Experimental Studies of Pristine and Cluster containing Silane-Hydrogen Capacitively Coupled Plasmas Used for Silicon Epitaxial Growth

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Based on an existing 1-D fluid model, the model has been further developed to study Radio-Frequency (RF) capacitively-coupled silane/hydrogen plasmas and account for silicon thin film deposition processes. In particular, the surface chemistry including recombination, etching, and deposition reactions have been coupled to the fluid model via a set of reaction probabilities. The 1-D fluid model was also coupled with a sectional model and transport equations to account for the formation of nanoparticles within the plasma and the evolution of both size and charge distributions of the nanoparticles. To make the coupled 1-D fluid-sectional model computationally efficient, a time-splitting method was implemented.
Both numerical and experimental studies of the effects of gas pressure (1 to 3.5 Torr) and silane concentration (2 to 10%) on the deposition rate of silicon thin films in a standard plasma enhanced chemical vapor deposition (PECVD) reactor demonstrated that the deposition rate as determined from the optical modelling of UV-visible spectroscopic ellipsometry measurements agrees well with the modeling results. SiH_3 radicals are found to be the main contributor to the computed deposition rates, whereas H^{3+} ions play the main role in the etching process.

Pore-Clogging in Porous Media

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In new energy vectors (e.g. geothermal) and storage of gas (e.g. CO_2, H_2) in deep geological formations, the injection of fluids in the subsurface mobilizes fines particles that can detach, precipitate, or deposit and even lead to the clogging of pores near the well. The consequence of particles pore-clogging is a permeability reduction leading to a drastic decrease of the well bore productivity and injectivity, which reduces geothermal exploitation lifespan, and sometimes seals the well up to its premature abandonment. We use high-resolution modeling at the pore-scale to investigate the pore-clogging mechanisms. We use computational and experimental microfluidics to understand the collective hydrodynamic, colloidal and geochemistry effects of the reactive transport of micro-particles in the formation of clogs in porous media. First, we consider pore-clogging at the entrance of an individual pore, and then in a network of pores representative of the complex micro-structure of geological porous media.

Skin Permeability Modulation Thanks Cold Atmospheric Plasma (CAP) Treated Liquid (PTL) for Cosmetic Application

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Recent evidences have demonstrated the potential of CAP and CAP treated liquids in modulating the permeability of cells membranes and tissues. Since active cosmetic ingredients efficacy is controlled by their diffusion in the skin, new possibilities open for the use of CAP in cosmetic applications. In the present work, we developed a device capable of providing a continuous spray of CAP-treated liquid controlling its RONS production. The final aim of the project is to study the correlation between plasma–treated liquid properties and their skin's penetration. The liquid (distilled water in this) is treated thanks to a He DBD plasma jet (10 kV_{peak}, 20 kHz) and then nebulized through a piezoelectric membrane. This allows to produce a continuous flow of treated water (2 mL/min) with significant concentrations of H_2O_2 (10 mg/L), NO_2^- (5 mg/L) and NO_3^- (25 mg/L). The delivery in aerosol form allows the prompt application on a surface area of several cm of diameter. Beyond the simple design of the plasma treated aerosol device developed in this work, and the efficient generation of long-lived species, work is in progress to assess the delivery of short lived highly oxidant droplets on targets relevant for biomedical applications.

Smart Laser Engraving System for Wide Band Gap Materials

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This project aims to master light-matter interaction to selectively engrave wide band gap materials, like glasses and ceramics. This research project aims at mastering the mechanisms of laser-matter interaction to achieve selective ablation of complex materials, such as glasses and high-value ceramics, leading to a 'high resolution' engraving in surface and volume by laser sources available at GREMI and at the industrial partner DWS. The objective is therefore to set up a prototype in the form of a unique system that will allow the characterization of ceramic materials as input, the printing of a learning engraving and the scoring of the engraving according to aesthetic criteria. These three elements will feed a database that will be used by a machine learning algorithm to quickly converge on the desired engraving.

Synthesis and Characterisation of the New Strontium Silicate Compound $Sr_2Si_3O_8$

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A new compound, $Sr_2Si_3O_8$, has been found following a computationally-guided exploration of the SrO-SiO_2-Al_2O_3 system. This novel composition is metastable, and has been made through glass crystallisation and aerodynamic levitation (ADL) methods. A high crystallisation, in excess of 85%, opened up the possibility of doping rare earth metals such as Eu2+/3+ into the material to generate luminescence properties. These properties are yet to be examined, however researching similar compositions (e.g. $Ba_2Si_3O_8$) has shown that they could be promising. So far, synthesis of $Sr_2Si_3O_8$ has been optimised, with a 12-hour 850∘C heat treatment giving the best crystallisation results without thermally decomposing the compound. These samples were then analysed by PXRD with the TOPAS Rietveld refinement software, which showed the compound to have a monoclinic unit cell. Barium and calcium have also been independently doped into the sample to try and further improve the crystallisation and stability of the material, to allow microstructural analysis. The discovery of metastable $Sr_2Si_3O_8$ proves that glass-crystallisation synthesis can be harnessed to computational approaches to isolate new materials even in well explored phase diagrams. The main goal for this project is to explore other phase diagrams by these methods, discovering new compounds with potentially useful properties.

The Wettability Alteration in Porous Media

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Liquids passing through porous material such as rock, filter, soil or even body organs have been the subject of numerous studies and modeling. These studies aim to improve the understanding of the mechanism involved in flow in porous media such as what happens in petroleum reservoirs, soil remediation, and carbon capture and storage (CCS) in geological reservoirs. The length scale of the conduits in these materials, called capillaries, is often in the order of millimeters to a few hundred nanometers. In these scales, when there is more than one liquid in the conduit, the capillary effects become significant. The capillary force is represented conventionally by the wettability for the liquids-conduits system. Recent studies show that the conventional description of the wettablity measured in the lab could be different than the actual environment, where there is a change in pressure, temperature and the concentration of salt in the liquids. This is specifically important for the CCS. These changes are linked to the inter-molecular forces. We are developing a model that accounts for these changes by using the inter-molecular forces and improving the capillary force description in the model; Consequently obtaining a more clear and realistic frame of what happens in CCS.

List of Participants

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El Gadha Chayma
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Guerra Timothée
Guilbert Mathieu
Hamraoui Lamiae
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Hassani Abir Nesrine
Ibi Mayele Jeremie
Ibrahim Sara
Inoubli Farah
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Kaya Eric
Kouadou Elane
Lamoot Ludovic
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Rembert Flore
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Rouillard Amaury
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Soni Sandeep Kumar
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Tan Zlanseu Ruth
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Tocquer Mathieu
Violet Alix
Yacouba Abdoul Nasser
Ye Fanchao
Zhang Tinghui

Useful Information

Talks will be held at the **Conference Hall-Auditorium** of the Hôtel Dupanloup. It is situated on the first floor of the former episcopal palace of the city, and has independent access from the rest of the building (through stairs located at the ground floor, main entrance of the Hôtel Dupanloup).

Coffee breaks and lunches will be offered in the Hall-Cocktail Room in front of the main entrance of the conference hall.

The **poster session** will be held on Monday on the **ground floor** of the Hôtel Dupanloup.

Wi-Fi will be available during the conference. The Hôtel Dupanloup provides access to an eduroam network.

The **conference dinner** and **activity** will be held at the "Jump Virtual Arena", located at *25 avenue de la Libération*, 45000, Orléans.

Hôtel Dupanloup in Orléans: Alliance of the past and the future

The Hôtel Dupanloup is the former episcopal palace of Orléans, a building dating back to the 17^{th} century, which has been home to the International University Center for Research since the beginning of 2014.

In the 17^{th} and until the end of the 18^{th} century, the building had a residential function, housing the private apartments of the bishop of Orleans on the first floor. The synodal meetings were held in a large room located on the first floor...

The end of the 18^{th} century was synonymous with the French Revolution. The religious building was confiscated in 1793, then rented to private individuals. It was not until the very beginning of the 19^{th} century (1801) that the building was used as a bishop's palace again, for more than a century.

How to get to the Hôtel Dupanloup?

The Centre International Universitaire pour la Recherche (Hôtel Dupanloup) is a university building located less than 10 minutes walk from the Orléans train station.

The address is: **1 rue Dupanloup, 45000 Orléans** and can be reached by :

- **Tram:** line B, stop *Cathedral* or *Halmagrand* at 350 and 400 m respectively from Dupanloup,
- **Bus:** line O (stop *Dupanloup*),
- **Bus:** lines 2, 3, 4, 5, 6, 7, 25, 40, 42 (stop *Halmagrand* at 500 m).


Rue Eudoxe Marcille
Orléans
PAUL
Consulat du Portugal
d'Orléans pour la...
Parking Place d'Arc
Quick Orléans
Train Station
McDonald's
Campanile Orléans
Parc Pasteur
Rue Eugène Vignat
MANETCO
Lycée Polyvalent Jean Zay
Paroisse Saint Vincent
Rue du Champ Rond
Rue de Java
Rue de Bellebat
Rue Jules Lemaître
D97
Rue d'Alsace Lorraine
Halmagrand Stops
Tribunal Judiciaire
Rue des Anglaises
Rue Fernand Rabier
Rue Théophile Chollet
Av. Jean Zay
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Rue Croix de Malte
Rue des Bons Enfants
Rue Louise Weiss
Rue Sainte-Anne
Parking Indigo Orléans Le Martroi
Parking Théâtre
Cathedral Stop
Rue d'Escures
Mairie d'Orléans
Dupanloup Stop
Rue des Bouteilles
Bd Aristide Briand
Musée des Beaux-Arts d'Orléans
Hôtel Groslot
Hôtel Dupanloup
Agence TAO
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