BOOKLET

OF

ABSTRACTS

TUESDAY APRIL 15TH

COFME

International COnference on Functional Materials and Renewable Energies

Tuesday April 15th

08:00	***Welcome coffee and conference registration***		
09:00	***Opening Ceremony***		
10:00	***Keynote*** Amin Bennouna ***Morocco: Was Mid-2022 to End-2024 Just 'Another Window of Opportunity' or A Lasting Transition to More Renewable Electricity?***		
	Coffee Break		
	ENERGY CONVERSION TECHNOLOGY	***RENEWABLE ENERGY SOURCES***	***MATERIALS AND MECHANICS FOR ENERGY***
11:00 **11:15**	***Invited conference*** Abderrazzak Douhal ***Dual-Emissive Zero-Dimensional Mn-Based Hybrid Halide for Photonic Applications***	***Invited Conference*** Jamal Fajoui ***Recoverability of Mechanical Properties of Bio-Based Balsa Wood Core Composite Sandwich Structures Under Long-Term Cyclic Hygrothermal Aging Conditions***	***Invited Conference*** Hélène Brault ***Luminescence Thermometry: an Overview of the Potential of Metal-Organic Frameworks***
11:30	***44*** Yasmina Riffi Temsamani ***Recent Advances in Water Desalination Processes Using Renewable Energy***	***43*** Ngueya Essallami ***Seawater Desalination with Renewable Energy: Innovative Solutions for Sustainability***	***25*** Abdellatif El-Habib ***Enhanced Electrochemical Performance of CeO_2 Thin Films Through Zn and In Doping***
11:45	***46*** Chaimae Younes ***Enhancing Solar Power Desalination: An integrated CPV/T, MED-TVC, and Adsorption Desalination System***	***33*** Zian Oubamou ***Wind Energy production by means of diffusion stochastic process. Parameters estimation***	***15*** Ekaterine Chikoidze ***Ultra-Wide Band Gap oxides for energy electronics application***
12:00	***48*** Soukayna Oubourhim ***Literature Review on Advancements in Solar Absorption Refrigeration for Sustainable Cooling Systems***	***13*** Olivier Goncalves ***Study of the influence of culture conditions on the productivity of lipids exuded by a diatom for biodiesel production (Algadvance project)***	
12:15	***89*** Mohamed M'madi Hassane ***Hybrid Absorption-Compression Refrigeration Systems: A Technological Leap for Low-Temperature Thermal Resource Utilization and Energy Efficiency***	***68*** Moad El Kamili ***Smart Building Electrical Energy Optimization Trough Neural Network Techniques***	***Invited Conference*** Mohammed Boujtita ***Flexible Electroluminescent Devices: From The Laboratory To A Large-Scale Fabrication***

Keynote Lecture

Morocco: Was Mid-2022 to End-2024 Just 'Another Window of Opportunity' or A Lasting Transition to More Renewable Electricity?

Amin Bennouna

Research Themes

Energy: Renewable Energy Technologies, Energy Systems, Energy Efficiency, Energy Management, Energy Economics, Energy Modelling, Feasibility Studies, Building Simulation.
Solar Thermal
Materials Science: Solid State Physics, RF Sputtering, Thin Films, Optics.

Research Community Involvement & Leadership

- Won a Moroccan National Research Prize Distinction in 2009.
- Led two energy companies (1996-2005 and 1999-2018).
- Held several positions in the Moroccan Solar Industry Association from 1996 until 2016.
- He coordinates a network of 250 Moroccan energy researchers after having led an 'Innoproject' solar energy research carried by all the Moroccan Universities with IRESEN funds (2014-2018).
- He managed two multilateral European 'Medcampus' projects with EU funds (1990-1994).
- He built an energy scenario (2007) for Morocco'2030.
- He signed more than 200 papers.
- He is presently updating his "Monograph of energy in Morocco" (first edition in 2011).

Invited Talk | Dual-Emissive Zero-Dimensional Mn-Based Hybrid Halide for Photonic Applications

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Zero-dimensional (0D) organic-inorganic hybrid halides have gained attention for their exceptional optical properties. [1] Among them, manganese (Mn)-based compounds stand out as environmentally friendly and cost-effective materials for applications in optical anti-counterfeiting, photodetectors, photosensors, X-ray scintillators, and LEDs. [2, 3] Here, we report on the synthesis and characterization of a novel 0D Mn-based halide, (t-Butylammonium)$_3$MnBr$_5$ (1). The as-synthesized material exhibits a dual-band, temperature-dependent, and moisture-sensitive photoluminescence spectrum with a quantum yield of 34%. At room temperature, the emission arises from free excitons (FE, green emission via $^4T_1 \rightarrow {}^6A_1$ transition) and self-trapped excitons (STEs, red emission), facilitated by solvent interactions. STE formation occurs within 17 μs, leading to an equilibrated excited state with a ~135 μs lifetime. At higher temperatures, a red-shifted emission band emerges due to a structural transformation to an octahedrally coordinated Mn^{2+} phase. Integrated as a phosphor layer in a down-converter LED, 1 demonstrates tuneable CIE coordinates and 86% stability after 8 hours of continuous operation. These findings provide insights into solvent-induced lattice transitions affecting Mn-based luminescent perovskites and highlight their potential for photonic applications such as lighting and photosensing.

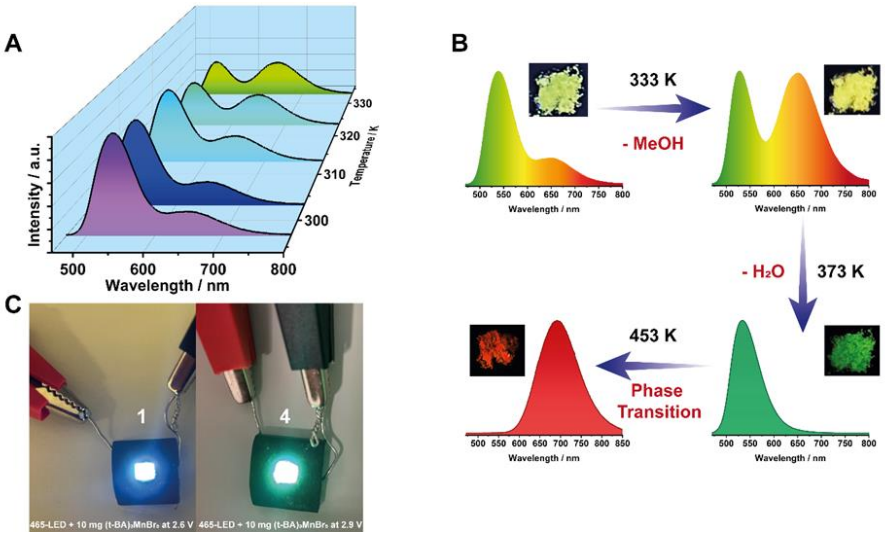

Fig. 1. Spectroscopy, mechanism, and application of **1**. **A)** Temperature-dependent of 1-as-synthetized dual green and red emissions. **B)** Schematic representation of the observed changes in the emission spectra of 1 upon increasing the temperature (up 453 K). The photos show the real emission color of powder under the 4 different conditions. **C)** Real photos of the down-converter LEDs fabricated by depositing a certain amount of 1 polycrystals onto a blue 465nm-LED chip upon applying at 2.6 and 2.9 V.

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Recent Advances in Water Desalination Processes Using Renewable Energy

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Keywords: Water desalination process; thermal desalination; membrane-based desalination; renewable energies; environmental impact.

Water scarcity is one of the most pressing global challenges, intensifying with the growing demand for freshwater and the impacts of climate change. Seawater desalination has emerged as a viable solution to address this issue, offering a reliable alternative to traditional water sources. This review provides a comprehensive overview of current desalination technologies, including thermal process, membrane-based, and emerging hybrid methods. It also explores the integration of renewable energy sources such as solar, wind, and geothermal energy into desalination systems to mitigate their environmental impact, reduce energy consumption, and enhance economic feasibility. The state of seawater desalination powered by renewable energy is assessed globally, highlighting key advancements, challenges, and emerging trends. Special attention is given to Morocco, a country actively implementing renewable-powered desalination projects to address its severe water scarcity, while also aligning with its ambitious renewable energy and sustainability goals. By examining Morocco's initiatives, this review identifies the opportunities, technical barriers, and policy challenges associated with scaling up renewable-powered desalination in other water-stressed regions. However, despite its potential, desalination poses significant environmental concerns, particularly the disposal of concentrated brine into marine ecosystems, which can harm biodiversity and water quality. This review concludes by analyzing these ecological challenges and proposing innovative strategies to mitigate the harmful effects of brine discharge.

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Enhancing Solar Power Desalination: An integrated CPV/T, MED-TVC, and Adsorption Desalination System

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Abstract. The global water scarcity crisis is a pressing concern affecting billions of people and threatening ecosystems. Desalination technologies present a promising solution by transforming seawater into potable water. This research proposes an innovative hybrid desalination system that combines a multi-effect-distillation thermal vapor compression (MED-TVC) system and an adsorption desalination system powered by solar energy. The system utilizes a Concentrated Photovoltaic Thermal (CPV/T) system for energy generation.

This research emphasizes on a hybrid desalination system integrating Concentrated Photovoltaic Thermal (CPV/T) technology, multiple-effect-distillation Thermal Vapor Compression (MED-TVC), and adsorption desalination [1]. The CPV/T system deploys solar energy to generate electricity and heat [2], which are utilized for preheating seawater. The water is subsequently treated in a multiple-effect-distillation TVC system [3], where the vapor compression mechanism enhances energy efficiency and freshwater production, he generated heat is utilized to drive the MED-TVC process, while excess heat is directed to the adsorption desalination system. Electricity from the CPV/T is used for hydrogen production, enhancing system sustainability. The research aims to maximize the performance ratio and minimize overall energy consumption and exergy losses, optimizing the desalination process.

Preliminary simulations using C++ indicate that the integration of these technologies significantly improves the performance ratio, enhances exergy efficiency, and reduces overall energy consumption compared to traditional desalination methods. The use of renewable energy from the CPV/T system ensures sustainability.

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Literature Review on Advancements in Solar Absorption Refrigeration for Sustainable Cooling Systems

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Keywords: Solar cooling, absorption cycle, heat and mass transfer optimization, hybrid solar cooling technologies, energy efficiency, sustainable cooling.

Solar-powered absorption refrigeration systems offer a sustainable and energy-efficient alternative to conventional cooling technologies by utilizing solar thermal energy rather than mechanical compression. These systems operate through thermochemical processes, commonly using lithium bromide-water ($LiBr-H_2O$) or ammonia-water (NH_3-H_2O) as working fluids to generate cooling without reliance on compressors. Ongoing research aims to enhance heat and mass transfer efficiency, optimize thermodynamic cycles, and integrate hybrid configurations to improve overall performance. By combining solar thermal collectors with absorption refrigeration, these systems achieve more effective solar-to-cooling conversion, particularly in regions with abundant sunlight. Advancements in heat exchanger design and working fluid selection contribute to higher reliability and efficiency. Hybrid models, such as the integration of the Organic Rankine Cycle (ORC) with absorption cooling, have been developed to improve energy recovery and stabilize performance under varying solar conditions. Furthermore, advanced control strategies are being implemented to manage energy distribution and ensure continuous operation. These innovations position solar absorption refrigeration as a viable solution for residential, commercial, and industrial cooling applications, promoting sustainability. This paper provides an extensive literature review and discusses recent advancements, highlighting opportunities for future development and potential applications of solar-driven absorption cooling technology.

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Hybrid Absorption-Compression Refrigeration Systems: A Technological Leap for Low-Temperature Thermal Resource Utilization and Energy Efficiency

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In a world facing the urgency of climate change, the challenges of reducing our carbon footprint while meeting energy demands have become more pressing than ever. In this context, traditional absorption cooling systems stand out as a promising option, offering the potential to utilize industrial waste heat, harness renewable energy, and reduce greenhouse gas emissions. However, despite their potential, these systems face major obstacles, particularly related to the intermittency of thermal resources and the low temperature of associated heat sources, which hinder their economic viability and ability to operate continuously. To overcome these challenges, an innovative approach has emerged: the hybrid absorption compression refrigeration system. This novel concept integrates a compressor between the evaporator and the absorber in a double-effect system using the LiBr/H_2O pair, opening new possibilities for efficiently utilizing low-temperature thermal resources and compensating for the intermittency of energy sources such as solar energy. Thermodynamic analysis is conducted to determine optimal operating conditions. The results are promising: the hybrid system not only significantly improves the overall coefficient of performance (COP) compared to traditional systems but also allows continuous operation, even at heat source temperatures below 90°C, where conventional solutions reach their limits, all while reducing electrical energy consumption.

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Invited Talk | Recoverability of Mechanical Properties of Bio-Based Balsa Wood Core Composite Sandwich Structures Under Long-Term Cyclic Hygrothermal Aging Conditions

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This paper characterizes the influence of long-term cyclic hygrothermal aging behavior on mechanical properties of bio-based balsa core sandwich structures through experimental investigation of moisture diffusion cycles, moisture-induced swelling effects, bending strength and stiffness, as well as the damage modes in skins, skin/core interfaces and the balsa core. The structural strength and stiffness were found to be retained at 90 % of the initial state after two complete moisture absorption-desorption cycles, indicating that the elastic properties of the balsa core sandwich structure can be rapidly recovered during a desorption process of 7 days. Moreover, it was demonstrated that damage mechanisms including balsa wood core shear cracks and glass fiber breakage of skins would propagate more quickly due to the long-term hygroscopic aging behavior. These findings are crucial for the development of bio-based plant fiber core composite sandwich structures applied in offshore wind turbines and marine industry to reduce their carbon footprint and contribute to the recycling economy.

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Seawater Desalination with Renewable Energy: Innovative Solutions for Sustainability

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Abstract. Seawater desalination is essential for addressing freshwater scarcity, especially in arid regions. Technologies like reverse osmosis (RO) and multi-effect distillation (MED) enable freshwater production but face challenges such as high energy consumption, costs, and environmental impacts. Integrating renewable energy sources, including solar, wind, and geothermal power, offers a sustainable alternative by reducing fossil fuel dependence and lowering emissions. However, issues like high initial costs, energy intermittency, and system complexity remain challenges. Recent advancements in hybrid systems, energy-efficient materials, and AI-based optimization enhance desalination efficiency and sustainability. These innovations contribute to securing a reliable and eco-friendly water supply for the future.

Importance of Seawater Desalination

Seawater desalination has become essential to tackle the global scarcity of freshwater, especially in arid regions like the *Middle East* and *North Africa*. Rapid population growth, urbanization, and climate change have increased the demand for water, surpassing the limited renewable resources available for drinking, agriculture, and industry. Technologies like reverse osmosis and multi-effect distillation have been key in converting saline water into fresh water. However, these methods face significant challenges, including high energy consumption, elevated costs, and environmental issues like greenhouse gas emissions and brine waste management.

Integrating renewable energy sources, such as solar, wind, and geothermal energy, presents a promising solution to reduce fossil fuel dependence, lower environmental impacts, and improve the sustainability of desalination systems. These energy sources are particularly valuable for remote areas without access to conventional infrastructure. Nevertheless, challenges persist, including the high cost of renewable technologies, variability in energy supply, and technical complexities in integration.

Innovative systems powered by renewable energy offer a pathway to sustainable water production. Advances in hybrid system designs, energy-efficient materials, and artificial intelligence are paving the way for more optimized and eco-friendly solutions. These innovations hold great potential to meet freshwater needs while minimizing environmental impacts, ensuring a reliable water supply for future generations

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Wind Energy Production by Means of Diffusion Stochastic Process. Parameters Estimation

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Abstract. The objective of this work is to model wind energy production via a stochastic diffusion process. From Ito's stochastic differential equations, we obtain the transition probability density function and the moments of this process (in particular the trend function). The parameters are estimated considering a discrete sampling of the process paths and using the maximum likelihood methodology.

Keywords. Stochastic model, diffusion process, maximum likelihood method, parameter estimation.

Stochastic Model and Probabilistic Study

A stochastic differential equation could describe the evolution of wind energy production P(t) as following:

$$dP(t) = \mu P(t)dt + \sigma P(t)dW(t)$$

Where:

- μ is a drift term representing the average trend.
- σ is the volatility or sensitivity to fluctuations.

The solution to this SDE is given by:

$$P(t) = P(s)\exp\left(\left(\mu - \frac{\sigma^2}{2}\right)(t-s) + \sigma\big(W(t) - W(s)\big)\right), \qquad t \geq s$$

The process $P(t)$ follows a log-normal distribution with parameters m_t et ${\sigma_t}^2$ where:

$$m_t = \log(P(s)) + \left(\mu - \frac{\sigma^2}{2}\right)(t-s), \qquad \sigma_t^2 = \sigma^2(t-s)$$

The probability density function of $P(t)$ is:

$$f_{P(t)}(p) = \frac{1}{p\sqrt{\sigma^2(t-s)2\pi}}\exp\left(\frac{-(\log(p) - m_t)^2}{2\,\sigma_t^2}\right), \qquad p > 0$$

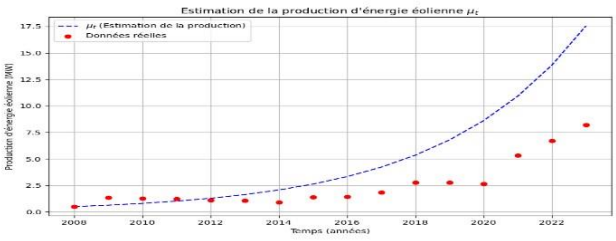
Parameter Estimation and Application: ML methodology

Using the data on wind energy production in Morocco, we obtain the following parameter estimates by the Maximum Likelihood Method: $\widehat{\sigma^2} = 0.10147$, $\hat{\mu} = 0.23749$.

Fig. 1. Morocco data energy

"Country Name",	"Country Code",	"Indicator Name",		"Indicator Code"		1960	1961	1962
1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2023											
"Morocco",	"MAR",	"Electricity production from renewable sources, excluding hydroelectric									
(% of total)",	"EG.ELC.RNWX.ZS"										
		0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0,497551116	1,369134654	1,273383656				
1,224514417	1,123976278	1,067910835	0,921264599	1,40222144	1,449416342						
1,849136912	2,783879689	2,767335839	2,663252241	5,341942	6,693105128						
8,192731992											

Fig. 2. The illustration of the trend function $\mu_t = E(P(t)/P(s) = p)$.



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Study of the influence of culture conditions on the productivity of lipids exuded by a diatom for biodiesel production (Algadvance project)

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Oleaginous microalgae are a source of oil-rich biomass (or triacylglycerol, TAG), a class of energetically dense molecules generated by esterification of fatty acids (FAs) on a glycerol scaffold. FAs have diverse structures, which can be of interest to different industry sectors, from very long chain polyunsaturated FAs for food, health and cosmetics, to monounsaturated/saturated FAs for commodity chemistry and biofuels. Oil from algae is thus one of the promising renewable alternatives to fossil hydrocarbons. Nevertheless, the economic viability of algal biomass for commodity markets requires addressing three long-standing challenges: first, engineering and strain development, simultaneously improving biomass and oil productivity; second, innovation in cultivation systems, harvests and processes, again increasing biomass productivity and energy efficiency; and third, understanding and mastering scale-up, mastering the limitations that result in lost gains. The issues addressed in the AlgAdvance project include knowledge generation on carbon capture and metabolism in microalgae, including lipid metabolism, cell division and stress resistance; strain development, including methods optimized to address societal acceptance (non-GMO); development of strategies to identify and control performance-limiting factors after transfer to a pilot scale, with a particular focus on adaptation to outdoor operation; and finally laboratory-to-pilot and pilot-to-laboratory analysis cycles to better understand the limitations of biological systems and processes. The transfer of strains and processes developed in the framework of AlgAdvance is foreseen at the end of the project and will be anticipated through existing partnerships.

Smart Building Electrical Energy Optimization Trough Neural Network Techniques

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Keywords. Smart Building (SB); Neural Networks (NN); Intelligent Control Algorithm (ICA); Energy Efficiency Optimization; Real-Time Control (RTC); Sustainable Building Energy Systems.

This study presents an innovative approach to optimizing electrical energy usage in smart buildings using neural network techniques. The proposed methodology focuses on two main objectives: (i) enhancing energy efficiency through intelligent load management and (ii) ensuring reliable operation of building systems by predicting energy demand patterns.

A neural network-based control algorithm was developed and integrated with the building's electrical systems, enabling real-time energy optimization. This approach was validated through implementation in a smart building environment, using a prototype for real-time monitoring and control. A thorough analysis, including simulations and experimental testing, demonstrated the effectiveness of the system in reducing energy consumption while maintaining operational stability, making it a promising solution for sustainable building energy management.

Invited Talk | Luminescence Thermometry: An Overview of the Potential of Metal-Organic Frameworks

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Temperature is a basic physical parameter that is essential in both science and industry areas. One of most promising non-invasive technique to measure the temperature relies on ratiometric luminescent thermometers where the absolute temperature is optically determined via the measurement of the intensities of two transitions of distinct emitting centers. If the first studies on luminescence thermometry refer to inorganic compounds such as oxides, fluorides or sulfides, metal-organic frameworks (MOFs) recently appeared as promising candidates [1,2]. MOFs are crystalline hybrid materials built-up from metal ions as nodes linked by bridging ligands. They have attracted great interest due to their versatile chemistry, high surface areas and chemical functionality. The luminescence of MOFs can be generated in different ways, by using luminescent metal nodes (such as lanthanide cations), luminescent organic linkers, or luminescent guest species (organic dyes, metal complexes...). Consequently, many combinations are possible to elaborate ratiometric MOF luminescent thermometers.

Currently, many efforts are focused on lanthanide-based luminescent MOFs (Ln-MOFs), which are built on Ln^{3+} ions or clusters. The organic linker are chromophore molecules which absorb in the UV range, acting as sensitizers for Ln^{3+} ions via an energy transfer from their triplet excited state energy to the emitting energy states of Ln^{3+} ions. Therefore, most of Ln-MOFs reported to date for luminescence thermometry are based on the Eu^{3+}-to-Tb^{3+} emission ratio between the transitions $^5D_4 \rightarrow {}^7F_5$ and $^5D_0 \rightarrow {}^7F_2$ of the Tb^{3+} and Eu^{3+} ions, respectively. Here, we will propose an overview of our recent results on mixed lanthanide-based MOFs luminescent thermometers, and we will discuss the different strategies to modulate the thermometric performances, such as operating temperature range or relative thermal sensitivity [3-4].

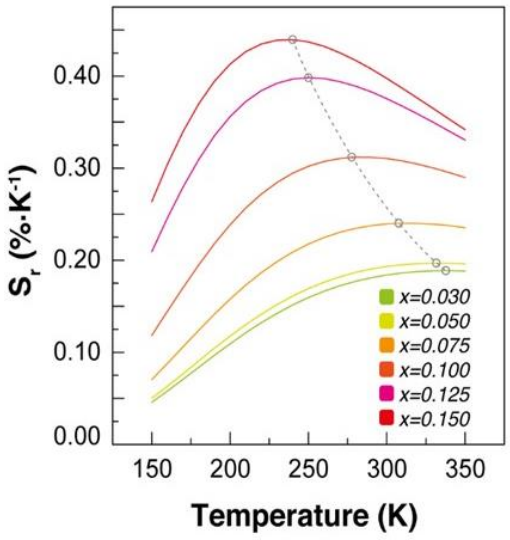

Fig. 1. Relative thermal sensitivity for the mixed compounds $[Tb_{1-x}Eu_x(CH_3COO)(1,3\text{-bdc})(H_2O)]$ in the 150–350 K range [3].

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Enhanced Electrochemical Performance of CeO_2 Thin Films Through Zn and In Doping

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This study synthesized undoped and doped CeO_2 nanocrystals (CZn6 and CIn8) on glass and ITO substrates using spray pyrolysis. XRD analysis confirmed that doping with Zn and In preserved the CeO_2 crystalline structure while modifying microstructural parameters. The band gap redshift, observed in the optical properties, demonstrated doping's effect. Raman spectroscopy showed structural defects, indicated by shifts in the F_{2g} peak and changes in α and β mode intensities. SEM imaging revealed a decrease in particle size with doping, enhancing electrochemical properties by increasing surface area and providing more active redox sites. Electrochemical analysis showed that doping improved performance, with In doping yielding the highest specific capacitance. These properties, along with the material's ion storage capacity and minimal optical modulation, suggest that doped CeO_2 films are promising for use as passive counter electrodes in electrochromic devices.

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Ultra-Wide Band Gap Gallium Oxide for Energy Electronics Application

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Currently, a significant portion (~50%) of the global warming emissions such as CO_2 are related to energy production and transportation. As most energy usage will be electrical (as well as transportation), the efficient management of electrical power is thus central to achieve the XXI century climatic goals. Ultra-wide bandgap (UWBG) semiconductors are at the very frontier of the electronics for energy management or *energy electronics*. A new generation of UWBG semiconductors will open new territories for higher power rated power electronics and solar-blind deeper ultraviolet optoelectronics. Gallium oxide - Ga_2O_3 (4.5-4.9 eV), has recently emerged pushing the limits set by more conventional WBG (~3 eV) materials such as SiC & GaN as well as for transparent conducting oxides (TCO). Here, we review the state-of-the-art and prospects of some ultra-wide bandgap oxide semiconductor arising technologies as promising innovative material solutions towards a sustainable zero emission society. [1]

While there are several *n*-type transparent semiconductor oxides (TSO) for optoelectronic applications their required *p*-type counterpart oxides are known to be more challenging. We have demonstrated that Ga_2O_3 is also the intrinsic (or native) *p*-type TSO. The achievement of hole mobility in excess of 10 cm^2/Vs and (high temperature) free hole concentrations in the ~10^{17} cm^{-3} range**.** [2] The incorporation of Zinc impurity effects the electronic properties of Ga_2O_3 thin films grown by MOCVD technique in a very divers way. When Zn is <1%, ie. doping case and "alloying" case resulting to $ZnGa_2O_4$ (Eg ~ 5 eV) spinel structure [2]. We have shown that doping with amphoteric Zinc a *p*-type β-Ga_2O_3 thin films shortens free carrier mean free path (0.37nm), resulting in the ultra- high critical electrical field of 13.2 MV/cm (see Figure 1). [3] Therefore, the critical breakdown field can be, at least, four times larger for the emerging Ga_2O_3 power semiconductor as compared to SiC and GaN.

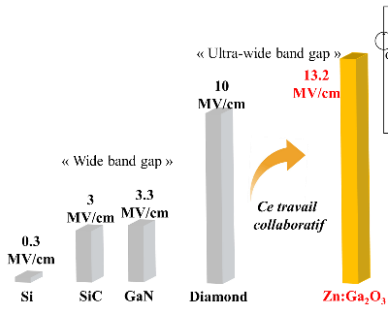

Fig.1

Ga_2O_3 is an ultra-wide band gap oxide, very promising for implementations in photonics (phosphors, deep-ultraviolet photodetectors, phototransistors, solar cells), and ultra-high-power electronics.

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Invited Talk | Flexible Electroluminescent Devices: From The Laboratory To A Large-Scale Fabrication

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The growing demand of inks based on nanoparticles compliant with flexible lighting devices has attracted many attentions. In this context, we developed flexible and printed electroluminescent devices (Fig. 1) with versatile configurations operating under alternative current (ACEL) to stimulate doped ZnS phosphors for light emission. In the field of printed electroluminescent devices, we focused on the conception and fabrication of economically viable printed electroluminescent devices by discussing new routes that may easily be transposable to industrial scale and compliant with the principle of DNSH 'do no significant harm'. By examining a series of high dielectric permittivity inks or by adding dielectric nanoparticles into insulating inks, the printed ACEL devices display variable brightness for the markup under outdoor conditions. The performances of the ACEL devices in terms of brightness, voltage and frequency were carried out by using iterative optimization of multipe layers by printing process. The in crease of the content of dielectric nanoparticles into the ZnS phosphor printed layer improves significantly its luminescence. Our results show that the luminescence is strongly dependent on the intensity of field applied on the ZnS phosphor layer, on the dielectric content and on the thickness of insulator layers. The relationship between the luminescence and electrical characteristics of the ACEL devices were examined as function of the nature of various conductive, dielectric and electophosphor inks. The present work brings an interesting strategy to design and build ACEL devices with scalable and reliable fabrication, it paves the way for various future applications.

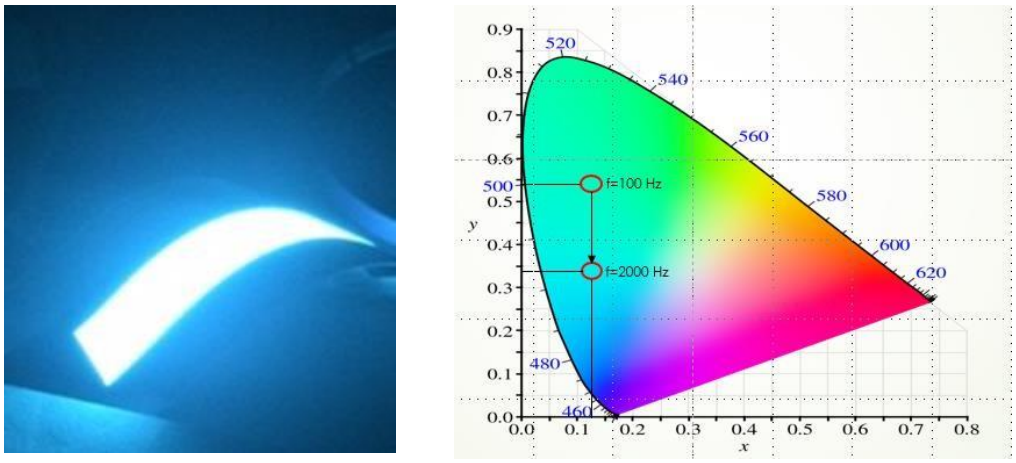

Fig. 1. Printed Electroluminescent Device: Versatile Geometrical Configuration

Projet R&D Collaborative – Partenariat Public/Privé - Région Pays de la Loire 2021-2024 – Coordinateur scientifique (M. Boujtita)
Projet : SEBE pour « Support Electroluminescent de Balisage Extérieur - Labellisé et accompagné par le Pôle S2E2

14:00	***Keynote*** Jean Le Bideau ***Towards Safe and All-Solid Energy Storage Devices with Liquid-Like Performances***		
	RF ENERGY HARVESTING	***SMART ENERGY SYSTEMS***	***MATERIALS AND MECHANICS FOR ENERGY***
14:45	***20*** Ahmed Bakkali ***A New Configuration Diplexer for RF Harvesting Applications***	***Invited Conference*** Elhoussin Elbouchikhi ***Advanced Energy Management for Islanded Microgrids: Strategies for Resilient and Sustainable Power Systems***	***Invited Conference*** Hélène Debeda ***Piezoelectric Vibration Energy Harvesters (PVEH): strategies to improve performance and lower environmental impact***
15:00	***17*** Ayoub Elmai ***A New Configuration of a Microstrip RF-DC Rectifier for RF Energy Harvesting Applications***		
15:15	***4*** Mohamed Guermal ***A New Design of a Wideband Fractal Antenna for RF Energy Harvesting Applications at 5.8 GHz***	***53*** Yohan Fretel ***Electrochemical Assessment of the HQ-TTF-HQ Triad Salts as Electrode Materials for Li-Organic Batteries***	***75*** Mohammed Chaqouri ***Influence of disc vane geometry on cooling rate acceleration during single-stop-braking***
15:30	***27*** Walid En-Naghma ***Experimental assessment of a circularly polarized printed antenna array design for enhanced power harvesting***	***66*** Abdessamad Idouanaou ***Influence of Leaf Area Index and Plant Height on Green Roof Carbon Footprint in Moroccan Residential Buildings in Hot Climates***	***72*** Jamal Fajoui ***Recoverability of mechanical properties of bio-based balsa wood core composite sandwich structures under long-term cyclic hygrothermal aging conditions***
15:45	***22*** Soufiane El Maimouni ***A Novel Configuration of a Reconfigurable Planar BandPass Filter For Wireless Power Transfer***	***82*** Alexandru Vulpe ***Hybrid Recurrent Neural Network and Decision Tree Scheduling for Energy-Efficient Resource Allocation in Cloud Computing***	***28*** Mustapha Hassa ***Free and forced linear vibrations of two beams carrying a point mass coupled by an elastically system***

Keynote Lecture

Towards Safe and All-Solid Energy Storage Devices with Liquid-Like Performances

Jean Le Bideau**

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Abstract. With the widespread use of batteries and supercaps, their increased performance and safety is of growing in importance. It is also a main challenge to develop energy storage devices with naturally abundant, eco-friendly and cheaper elements. Among other parts, the electrolyte is a concern regarding safety, performance, as well as risks and technological difficulties due to their liquid state. Ionogels electrolytes represent a route to biphasic materials, for the use of ionic liquids (ILs) for safer and all solid devices. Confining ILs within host networks enhances their averaged dynamics, resulting in improved charge transport.

With the widespread use of batteries and supercaps, their increased performance and safety is of growing in importance. Among other parts, the electrolyte is a concern regarding safety, performance, as well as risks and technological difficulties due to their liquid state. Ionogels electrolytes represent a route to biphasic materials, for the use of ionic liquids (ILs) for safer and all solid devices. Confining ILs within host networks enhances their averaged dynamics, resulting in improved charge transport. Fragility, short relaxation times, low viscosity, and good ionic conductivity, all them appear to be related to the IL / host network interface. The presence of ILs at interface neighborhood leads to the breakdown of aggregated, structured regions that are systematically found in bulk ILs. This “destructuration”, as well as segregative interactions at interface, coupled with percolation of the bicontinuous solid/liquid interface, make these materials very competitive among the existing solid electrolytes [1].

Such approach could provide (i) a route to lower locally the viscosity of ILs, and (ii) an easier pathway for diffusion of charged species. Several types of ionogels demonstrate this effect, taking into account of fully inorganic, hybrid, polymeric or organic-inorganic host networks. This “all solid” approach can be applied to several electrochemical energy storage sources, including lithium batteries and supercapacitors [2,3].

While looking for enhanced energy and power, as well as naturally abundant, eco-friendly and cheaper elements, one avenue for this is the enhancement of ion diffusion, particularly for efficient and safe solid-state-like electrolytes, and for different ions such as lithium (Li^+) and magnesium (Mg^{2+}), sodium (Na^+), zinc (Zn^{2+}) [4]. Unravelling the origin of better cation diffusion in confined ionic liquids (ILs) in a polymer matrix (ionogels) was compared to that of the IL itself. Ionic conductivity measured by EIS for ionogels (7.0 mS.cm-1 at 30°C) is very close to the conductivity of the non-confined IL (8.9 mS.cm-1 at 30°C), i.e. 1-ethyl-3-methyimidazolium bis(trifluorosulfonyl)imide (EMIM TFSI). An even better ionic conductivity was observed for confined EMIM TFSI with high concentrations (1M) of lithium or magnesium salt added. The improved macroscopic transport properties could be explained by the higher self-diffusion, measured by PFG NMR, of each ion at the liquid-to-solid interface induced by the confinement in poly-vinylidenedifluoride (PVDF) or EO-based polymer (in this last case with phosphonium-FSI-Li) polymer matrix [2]. Upon confinement, the strong breaking down of ion aggregates enables a better diffusion especially for TFSI anion and strongly polarizing cations (e.g. Li^+, Mg^{2+}). The coordination number, obtained by in-depth Raman study, of these cations in the liquid phase confirmed that metal cations interact with the polymer matrix. Moreover, from the NMR study, it is a major result that the activation energy for diffusion is lowered (Fig. 1) [2].

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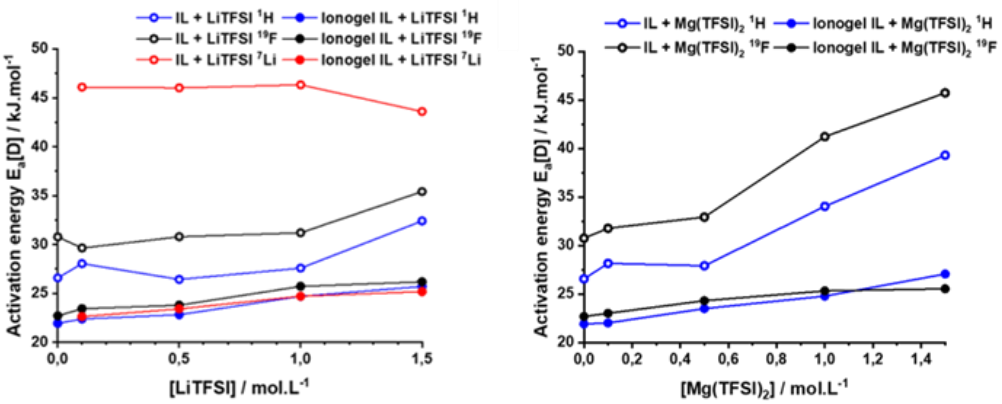
Ionogel electrolytes thus represent an opening towards safe, all-solid energy storage devices allowing usage of eco-friendly and abundant metal ions such as zinc or sodium.

Fig. 1. Activation Energy for non-confined (open) and confined ILs (full) for Li+ and Mg2+ systems, resp…



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ID 20

A New Configuration Diplexer for RF Harvesting Applications

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This study presents an improved microstrip diplexer designed specifically for radio frequency (RF) energy harvesting. Diplexers are essential components in multi-band harvesting systems, enabling the simultaneous capture and conversion of ambient RF energy from multiple frequency bands, thus significantly increasing overall energy capture. This design uses two band-pass filters, centered at 5.8 GHz and 2.26 GHz, fabricated on a 1.6 mm thick FR-4 substrate (dielectric constant 4.4, loss tangent 0.025). A detailed analysis of the filters' structure and performance demonstrates their effectiveness in converting ambient RF energy. The diplexer efficiently separates these frequency bands, enabling independent processing and rectification of the harvested energy at each frequency. This separation is crucial for maximizing energy harvesting efficiency by preventing inter-band interference and facilitating the use of optimized rectifier circuits for each band. Simulated S-parameters demonstrate key performance characteristics, including good impedance matching (low S11), minimal insertion loss (high S21 and S31), and high inter-port isolation (low S23 and S32), all critical for effective RF energy harvesting. Keywords: RF energy harvesting, diplexer, band-pass filter, isolation, energy harvesting efficiency.

A New Configuration of a Microstrip RF-DC Rectifier for RF Energy Harvesting Applications

Ayoub Elmai [1], *Jamal* Zbitou[1,2], *Yassin* Laaziz[1] *and Nouha* Chahboun[1]

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This study details the design of a 2.45 GHz microstrip RF-DC rectifier for RF energy harvesting. Utilizing a differential rectifier topology and microstrip patch antennas, the design eliminates the need for a power splitter and voltage adder, thus reducing ohmic losses and leakage. The proposed configuration enhances power conversion efficiency by optimizing the rectification process and minimizing losses through an improved microstrip-based design.

The prototype, fabricated on FR-4 with a thickness of 1.6mm a dielectric constant of 4.4, and a loss tangent 0.025 substrate, achieved a peak power conversion efficiency of 73.69%.

A New Design of a Wideband Fractal Antenna for RF Energy Harvesting Applications at 5.8 GHz

Mohamed Guermal [1], *Jamal* Zbitou[1,2], *Ridouane* Er-rebyiy[3], *Fouad* Aytouna[1,2], *Aziz* Oukaira[4] *and Otman* Oulhaj[5]

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Keywords. Fractal Antenna, RF Energy Harvesting, Wideband Antenna, Coplanar Waveguide Antenna (CPW).

This study presents the design and analysis of a fractal-based wideband antenna for RF energy harvesting applications operating around 5.8 GHz. The proposed antenna is based on a coplanar waveguide (CPW) feeding line, which enhances impedance matching and facilitates easy integration with RF circuits. The design is mounted on an FR4 substrate with a dielectric constant of 4.4, a loss tangent of 0.025, and a thickness of 1.6 mm. The fractal geometry is introduced to improve the bandwidth, gain, and radiation efficiency while maintaining compactness. Full-wave electromagnetic simulations are conducted using CST Microwave Studio and ADS electromagnetic solvers, demonstrating a wide input impedance bandwidth. The results confirm that the proposed antenna operates efficiently in the Industrial, Scientific, and Medical (ISM) band, making it a suitable candidate for wireless power transfer (WPT), low-power IoT devices, and sensor networks.

Experimental Assessment of a Circularly Polarized Printed Antenna Array Design for Enhanced Power Harvesting

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The optimal design of microstrip antennas plays a pivotal role in enhancing the performance of energy-harvesting devices. This study presents an innovative circularly polarized antenna array operating in the 5.8 GHz frequency band. Fabricated on a flame-retardant (FR4) substrate with a dielectric constant of 4.4, this proposed array is designed and optimized using CST MWS software. Validation through comparison with measured results highlights the antenna's exceptional performance. The proposed design achieves a peak gain of 12.92 dBi, a high directivity of 13 dB, a radiation efficiency of 97.77%, and an axial ratio of 0.62 dB. Furthermore, it demonstrates excellent impedance matching at 5.8 GHz, with a measured reflection coefficient of -17.74 dB and input impedance of 47.42-j12.42 Ω, ensuring compatibility with a 50 Ω excitation port. This compact, efficient, and high-gain antenna array provides a promising solution for high-performance energy-harvesting applications.

A Novel Configuration of a Reconfigurable Planar BandPass Filter For Wireless Power Transfer

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Keywords. Split ring resonators, SRR, bandpass filter, BPF, variable capacitance, reconfigurable BPF.

This study presents an innovative approach to optimizing electrical energy usage in smart buildings using neural network techniques. The proposed methodology focuses on two main objectives: (i) enhancing energy efficiency through intelligent load management and (ii) ensuring reliable operation of building systems by predicting energy demand patterns.

A neural network-based control algorithm was developed and integrated with the building's electrical systems, enabling real-time energy optimization. This approach was validated through implementation in a smart building environment, using a prototype for real-time monitoring and control. A thorough analysis, including simulations and experimental testing, demonstrated the effectiveness of the system in reducing energy consumption while maintaining operational stability, making it a promising solution for sustainable building energy management.

This paper presents the design and analysis of a novel microstrip bandpass filter (BPF) using square split ring resonators (SRRs) as resonating elements. The proposed filter architecture comprises a modified microstrip line section coupled to microstrip lines on either side, with an integrated SRR positioned centrally. The SRR elements are strategically designed and optimized to achieve the desired frequency response. The filter is fabricated on an FR-4 substrate with a thickness of 1.6 mm, a dielectric constant of 4.4, and a loss tangent of 0.025. It features a compact size of 9 x 26.3 mm². This study will initially present the simulation results of the designed filter. Subsequently, the filter will be transformed into a tunable configuration. one approach will be investigated a reconfigurable structure where the variable capacitance is varied to adjust the bandwidth while maintaining the filter's physical dimensions, The integration of capacitance enables dynamic tuning capabilities for the bandpass filter. This design represents a significant advancement in filter technology, with promising applications in next-generation communication systems that require high levels of flexibility and performance. This filter is designed for wireless power transmission and is compatible with applications operating in the vicinity of 2.4GHz to 2.5GHz.

Invited Talk | Advanced Energy Management for Islanded Microgrids: Strategies for Resilient and Sustainable Power Systems

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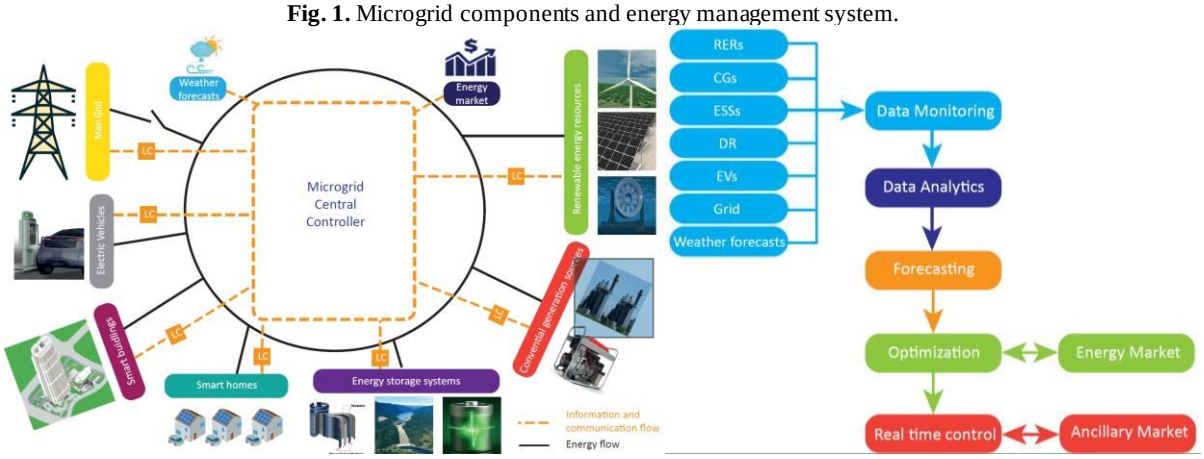
Abstract. The widespread deployment of renewable energy resources is pivotal for meeting the growing global energy demand, reducing environmental pollution, and fostering socio-economic sustainability. This integration has led to the development of microgrids—localized energy systems capable of autonomous operation in islanded mode during grid outages. Central to the efficient functioning of microgrids is the Energy Management System (EMS), which optimizes the use of Distributed Energy Resources (DERs) in a secure, reliable, and coordinated manner. EMS addresses challenges such as the intermittency of renewable generation and fluctuating load demands through the integration of energy storage systems, demand response strategies, and uncertainty quantification methods. In this context, this conference examines energy management in an islanded AC microgrid on Ouessant Island, France. It focuses on strategies for balancing generation and demand, maintaining power quality, and enhancing system stability in the presence of renewable energy variability. The case study highlights practical solutions for addressing the operational challenges of islanded microgrids, offering a pathway toward more sustainable and self-sufficient energy systems in remote locations.

Islanded Microgrid Energy Management

Islanded microgrids, capable of autonomous operation during utility grid failure, enhance energy resilience in remote areas. A key component is the Energy Management System (EMS), which optimizes Distributed Energy Resources (DERs) to ensure secure and reliable operation (Fig. 1). EMS solutions tackle challenges such as renewable energy intermittency and load fluctuations through energy storage integration, demand response strategies, and uncertainty management. To illustrate these concepts in practical applications, a case study of islanded microgrid for Ouessant Island in France will be analyzed.

Fig. 1. Microgrid components and energy management system.



Energy Management in Islanded AC Microgrid

This study focuses on the optimal operation of an islanded microgrid designed for Ouessant Island in the Brittany region of France. The microgrid comprises a photovoltaic (PV) system, a tidal turbine, a diesel generator, and a lithium-ion battery storage system as depicted by Fig. 2. To ensure economic feasibility, the proposed energy management strategy incorporates multiple cost factors, including battery degradation costs, the levelized cost of energy from renewable sources, diesel generator operating and emission costs, and network constraints.

The optimization problem formulated for the microgrid operation is inherently non-linear and non-convex, which may lead to convergence to a local optimum. To address this, the problem is relaxed and reformulated as a convex second order cone programming (SOCP) model, enabling a globally or near-globally optimal solution.

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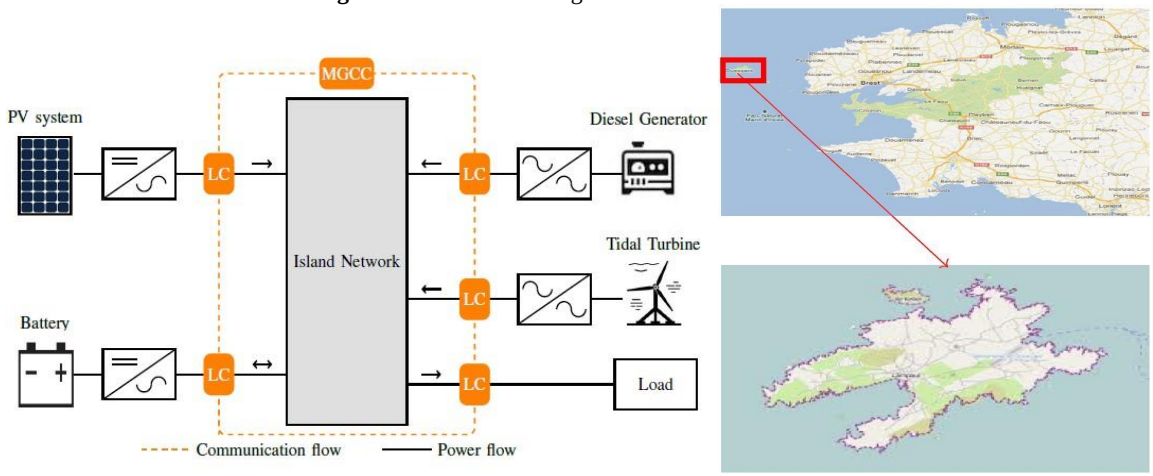
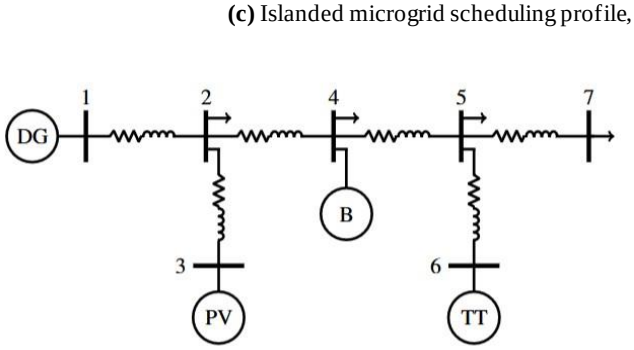
Fig. 2. Islanded AC microgrid for Ouessant Island.



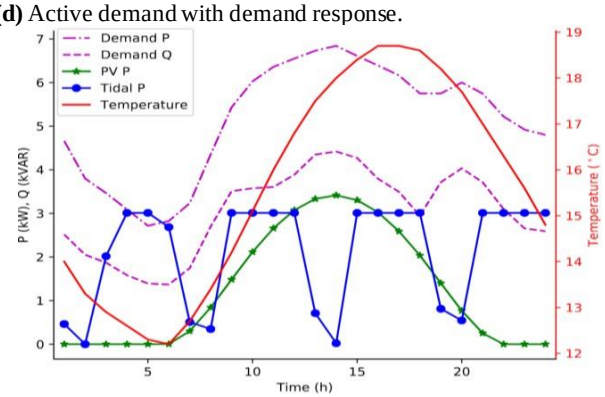
Simulation Results

Numerical simulations depicted in Fig. 3 demonstrate the effectiveness of the proposed approach in minimizing both operating and emission costs. Results indicate that the convex EMS formulation achieves an optimality gap of less than 1% while significantly reducing computational complexity, making it a practical and efficient solution for islanded microgrid operation.

Fig. 3. Main numerical simulations: **(a)** 7-bus microgrid test network, **(b)** PV, tidal turbine, load, and temperature data for July, **(c)** Islanded microgrid scheduling profile, **(d)** Active demand with demand response.



(a)



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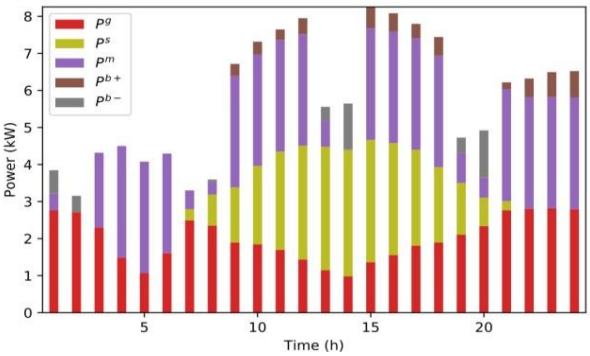

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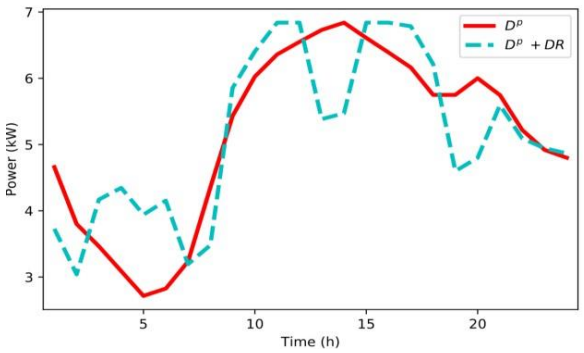

(d)

Conclusion

This conference will provide valuable insights into the latest advancements in microgrid energy management, contributing to the development of more resilient and sustainable energy systems for remote and non-interconnected areas.

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Electrochemical Assessment of the HQ-TTF-HQ Triad Salts as Electrode Materials for Li-Organic Batteries

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In order to reduce our dependence towards fossil-fuel, the demand in batteries is rapidly increasing. To meet this demand, lithium-ion batteries (LIBs) are advantageous in terms of energy density and cyclability but the use of critical resources such as nickel, cobalt and lithium and their recyclability will be major issues as the world moves towards electromobility. Organic electrode materials (OEMs) offer an alternative to avoid the use of critical resources, considering that they are only based on naturally abundant chemical elements (C, H, O, N, S). These materials are potentially cost-effective, sustainable and have high design flexibility.[1] Even if OEMs may possess good specific capacity (due to their low molecular mass), their redox potential and energy density still need improvements as compared to inorganic electrode materials. There are three types of electrochemical storage mechanisms based on redox-active organic centers: n-type, p-type and bipolar. The n-type system involves cation compensation and the formation of anionic species. In contrast, the p-type system operates inversely, with anion compensation and the formation of cationic species. Finally, the bipolar system combines both p-type and n-type behaviours within a single material, allowing for the reversible insertion of both cations and anions (Fig. 1a). The triad molecule Q-TTF-Q, consisting of two p-benzoquinone (Q) groups and one tetrathiafulvalene (TTF) bridge (Fig. 1b) could act as a bipolar type electrode material, combining two n-type Q groups (cationic compensation) and one p-type TTF group (anionic compensation).[2] Recently, Kato *et al.*[3] reported the use of Q-TTF-Q as material in half-cells vs Li^+/Li. However, they did not reach the full theoretical capacity and observed poor stability upon cycling due to solubility issues in liquid electrolyte media. Within this context and based on previous works made by our group,[4,5] our aim was to reinvestigate the electrochemical performances of Q-TTF-Q in Li-organic cell by also studying the fully reduced state (*i.e.* (Li_4)[HQ-TTFHQ]) for the sake of comparison. Subsequently, by swapping 2 lithium ions with Zn^{2+} as a spectator cation, a second material (Li_2,Zn)[HQ-TTF-HQ] was synthesized in order to improve the potential of the n-type system and reduce the solubility in the electrolyte. In this communication, we will present the syntheses, characterizations, and electrochemical properties in Li-half cells of Q-TTF-Q, (Li_4)[HQ-TTF-HQ] and (Li_2,Zn)[HQ-TTF-HQ] positive electrode materials.

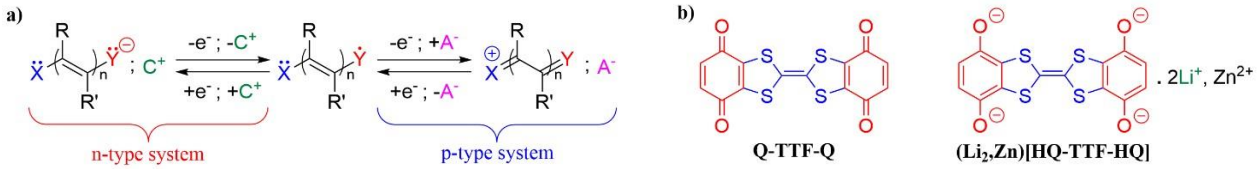

Fig. 1. a) Electrochemical storage mechanisms using redox-active bipolar system organic center, b) molecular structures of Q-TTF-Q and HQ-TTF-HQ.

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Influence of Leaf Area Index and Plant Height on Green Roof Carbon Footprint in Moroccan Residential Buildings in Hot Climates

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Green roofs are a sustainable solution to reduce energy consumption and carbon footprints, especially in hot climates. This study investigates the influence of two key design parameters, Leaf Area Index (LAI) and plant height, on the thermal performance and carbon footprint of residential buildings in Morocco. Using advanced simulation techniques, the study evaluates the impact of these parameters on electricity consumption for heating and cooling. The results show that increasing LAI and plant height reduces cooling-related CO_2 emissions by up to 3.87%, with taller plants and denser vegetation improving shading and evapotranspiration. However, during heating days, these parameters increase CO_2 emissions by up to 13.12%, due to reduced solar heat gain. Annual CO_2 emissions are reduced by approximately 1.13% when green roofs with optimized vegetation are implemented. The findings highlight the need for season specific maintenance practices, such as watering green roofs during cooling seasons and trimming vegetation during heating seasons, to balance energy performance. This study provides practical recommendations for optimizing green roof designs to support Morocco's climate goals and sustainable urban development.

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Hybrid Recurrent Neural Network and Decision Tree Scheduling for Energy-Efficient Resource Allocation in Cloud Computing

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Abstract. Efficient resource allocation in cloud computing is critical for optimizing execution time, minimizing delays, and improving system reliability. Traditional heuristic-based scheduling approaches struggle to adapt to dynamic workloads and heterogeneous virtual machines (VMs), leading to suboptimal performance. This paper proposes a hybrid scheduling framework that integrates Recurrent Neural Networks (RNNs) for execution time prediction and Decision Trees (DTs) for VM classification, enhancing resource allocation efficiency. The RNN model uses historical execution data to accurately predict task execution time, while the DT model classifies VMs based on performance characteristics, ensuring optimal task-to-VM assignments. The proposed method dynamically adapts to workload variations, reducing execution delays and improving Quality of Service (QoS) metrics. Experimental evaluations demonstrate that the hybrid RNN-DT approach outperforms traditional scheduling methods and metaheuristic algorithms, such as Genetic Algorithm and Artificial Bee Colony, in terms of execution time reduction, reliability, and delay minimization. These results show that integrating predictive analytics and decision-tree-based classification for intelligent cloud resource management can lead to less energy consumption and enhancements in Smart Energy Systems.

Results

Fig. 3 depicts the delay variation as the number of tasks increases. The proposed method achieves the lowest delay across all task levels. In contrast, the other approaches result in higher delays, with the steepest increase observed in the method with the highest computational overhead. Fig. 4 illustrates the execution time as the number of tasks increases. The proposed method consistently achieves the lowest execution time. In contrast, the other approaches require more time to process tasks, with the highest execution time observed in the method with the most computational complexity

Fig. 1. Delay vs number of tasks.

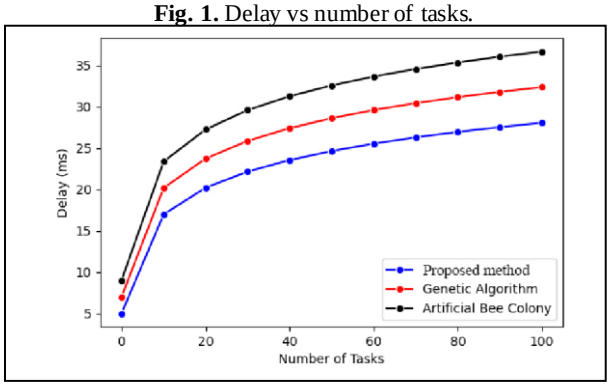
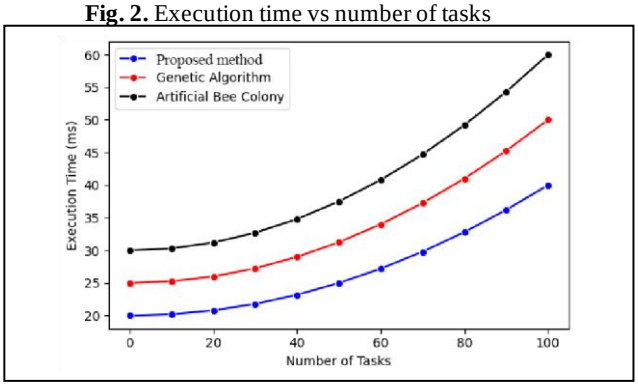


Fig. 2. Execution time vs number of tasks



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MATERIALS AND MECHANICS FOR ENERGY

Invited Talk | Piezoelectric Vibration Energy Harvesters (PVEH): Strategies to Improve Performance and Lower Environmental Impact

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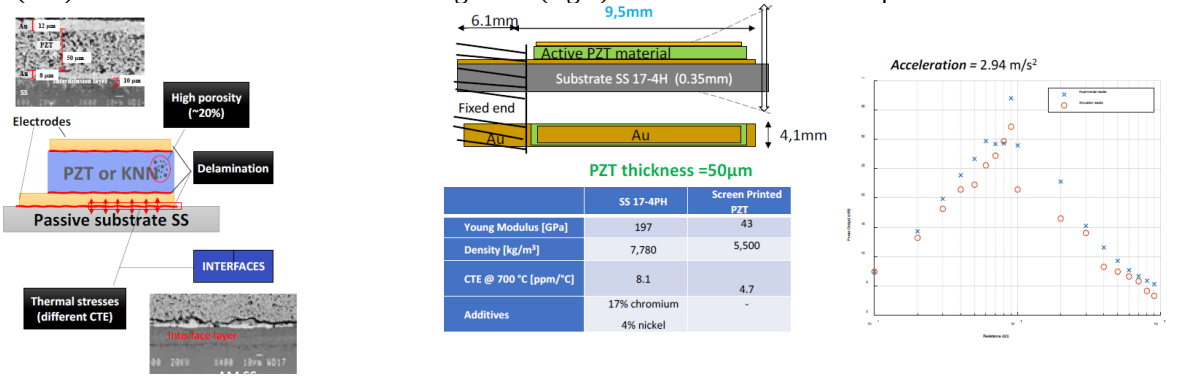
The piezoelectric effect has applications in many fields, including electronics, energy and bio-medicine. For instance, vibration energy harvesting by direct piezoelectric effect is a very attractive solution for moving towards the autonomy of devices such as sensors. Whether in terms of chemistry or manufacturing processes, environmentally-friendly approaches are at the heart of researchers' concerns. Among piezoelectric materials, (K, Na)NbO_3 is one of the lead-free challenging piezoelectrics. It is a perovskite ABO_3 oxide that share with the (Pb, Zr)TiO_3 (PZT) the propensity for volatility of the A-site cations which adversely affects its electrical performance. Conventional production of piezoceramics includes an energy consuming sintering step, typically above 1000°C for several hours. This step raises several issues related to the chemistry and the microstructure. Drastically reducing the processing temperature of ceramics is a scientific challenge, given the current trend to increase the flexibility of piezoelectric (micro/nano)-generators. Indeed, this implies the use of nanomaterials and polymers to design stretchable generators for wearables, Internet of Things or implantable biomedical applications as examples [1]. Moreover, thick piezoelectric layers, with an intermediate thickness between thin layers and ceramics, are attractive for MicroElectroMechanical Systems application such as actuators or energy harvesters. Efforts are currently focused on simplifying processes for integrating piezoelectric layers and electrodes. For example, thick-film screen-printing technology combined with the sacrificial layer technique is an attractive way of releasing the layers from their substrate because of its low cost and the wide range of targeted materials [2]. Our goal is the optimization of the screen-printing process and geometry of perovskite based thick films to design high performance energy harvesters. Also, to reduce the global thermal budget, combining screen printing with nonconventional sintering processes such as Spark Plasma Sintering is an affordable bottom up option [3] compared to conventional microfabrication techniques. Here, the challenges associated with the chemistry, design and process will be shown through examples of fully printed Piezoelectric Vibration Energy Harvester (PVEH) based on PZT. The fabrication steps of PVEH and its characterization will be described, with an optimisation of the substrate geometry supporting screen-printed piezoelectric layers. The advantages of additive manufacturing (screen printing technique or 3D printing for Stainless Steel (SS) metallic substrate) will be moreover highlighted [4]. Finally, preliminary results on the (K, Na)NbO_3 lead-free material proposed as replacements for PZT, along with solutions for reducing heat treatment time and temperature will be shown.

Fig.1. (left) Main thick film fabrication challenges and (right) Measured and simulated power of a resonant cantilever



	SS 17-4PH	Screen Printed PZT
Young Modulus [GPa]	197	43
Density [kg/m³]	7,780	5,500
CTE @ 700 °C [ppm/°C]	8.1	4.7
Additives	17% chromium 4% nickel	-

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Free and forced linear vibrations of two beams carrying a point mass coupled by an elastically system

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This study analyzes the transversal vibratory motion of two isotropic beams based on the Euler-Bernoulli theory. The upper beam carries a point mass and is subjected to a concentric harmonic excitation force coupled to the lower beam by a mechanical system modeled by a double spring-mass. The main objective is to determine the natural frequencies of free vibration, to identify the vibration modes and to study the resonance frequencies in the forced regime for this structure. The methodology adopted consists in dividing the structure into beam sections, applying boundary conditions and continuity conditions. The resulting matrix system is solved numerically using the Newton-Raphson iterative method. The results obtained are validated by comparison with previous work available in the literature. The present work provides new results that are a valuable reference for future research.

Poster | Tuning NiSi Films Properties Thanks to e-HiPIMS Regime | *ID 30*

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Abstract. In this study, we deposited NiSi thin films using sputtering in DC, HiPIMS regime and e-HiPIMS mode, that we recently developed in our laboratory in Nantes University. Modifying the ionization rate in the plasma phase has a significant effect on the film quality. Here, we compare the effect of differents excitation modes on some characteristics of deposited films.

NiSi films are extensively studied due to a wide range of applications, including microelectronics [1], protective coatings, catalysts, medical implants and energy applications [2]. These numerous applications are enabled by its resistance to oxidation and corrosion [3], as well as its good thermal conductivity. In this study, we deposited NiSi thin films using sputtering in DC and in the HiPIMS regime. HiPIMS (High Power Impulse Magnetron Sputtering) consists in generating a high-power pulsed discharge (10-100 times higher than in the DC process) over a very short duration, followed by a long post-discharge period (at least 1 ms) [4]. The high power enables the generation of a very dense and cold plasma close to the target, achieving vapor ionization rates of a few tens of percent. Increasing the ionization rate considerably improves film quality (denser films [5], better microstructure [6]) and enables deposition on complex substrates. In HiPIMS, the duty cycle, which is the ratio of the pulse width to the period, is a crucial parameter that impacts the deposition process and thin films properties. In this project, a 5-stage HiPIMS power supply was developed [7] to modify the shape of HiPIMS pulses. This regime is called e-HiPIMS (electron-enhanced HiPIMS) due to the increase in the number and energy of the electrons at the time of the added pulses. e-HiPIMS introduces added pulses at specific times during the discharge to influence the behavior of different species within the reactor (upper part of Figure 1). Indeed, optical emission spectroscopy (OES) measurements showed that different species arrive at different times during the discharge and could be better controlled by added pulses [8]: sputtering gas species (in general Ar) arrive first, followed by neutral sputtered species and finally ionized sputtered species. Precise control of added pulses timing can modify the structure and morphology of the NiSi thin films. Figure 1 shows three different morphologies observed in the films cross-sections, i.e., a classical columnar structure for the DC mode, the beginning as columnar growth in HiPIMS mode, further followed by densification of the layer in e-HiPIMS mode. In order to highlight the modifications induced by e-HiPIMS processes, NiSi thin films were characterized using ellipsometry, scanning electron microscopy (SEM), X-ray diffraction (XRD) and 4-point probe measurements. The discharge was analyzed through current-voltage measurements and OES.

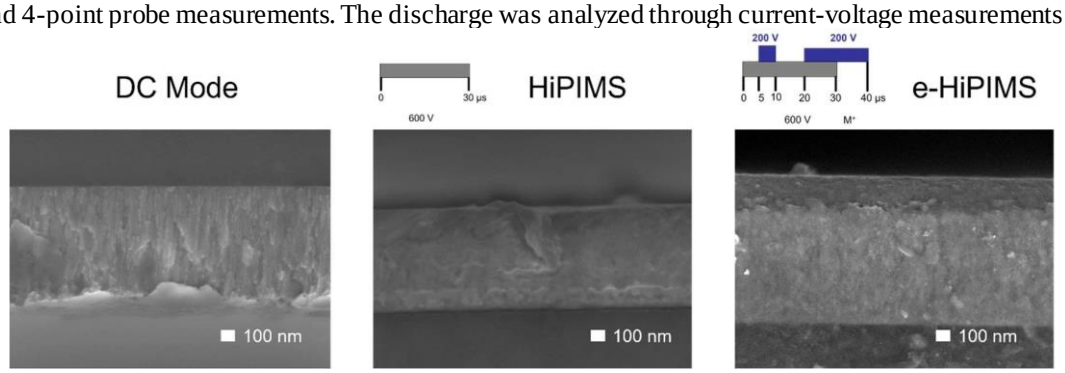

Fig 1: SEM images in cross section of NiSi thin films obtained for the 3 studied modes: DC, HiPIMS (pulse of 30 µs with -600 V applied) and e-HiPIMS (pulse of 30 µs with -600 V applied and 2 added pulses of -200 V).

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Poster | Modeling of High-Power Impulse Magnetron Sputtering (HiPIMS) Process for the Deposition of Cr Thin Films | *ID 54*

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Abstract. High-Power Impulse Magnetron Sputtering (HiPIMS) is a promising technique for depositing dense chromium thin films, essential for renewable energy applications. However, this process remains energy-intensive and requires optimization. This study presents a global kinetic model of Ar/Cr pulsed plasma to analyze the impact of key parameters—pressure, gas flow rate, and duty cycle—on plasma composition and film characteristics. Modeling of such process provides valuable insights to enhance process efficiency while minimizing energy consumption.

Renewable energies require advanced materials to improve their efficiency and durability. Chromium, in its various forms, plays a key role in this field. In concentrated solar power plants, chromium is used for the efficient conversion of solar energy into thermal energy [1]. Chromium is also used in wind turbines, for corrosion resistance and in hydrogen fuel cell electrodes, to optimize conductivity and chemical resistance [2,3]. In order to extend the use of chromium in renewable energy applications, it is relevant to develop and study thin films chromium deposition processes. High-power pulse magnetron sputtering (HiPIMS) is a physical vapor deposition (PVD) technique, used for depositing dense Chromium thin films. Its main feature is to deliver high pulse power densities, producing a very dense plasma with a high degree of ionization and highly energetic sputtered species. Recent advancements, such as enhanced HiPIMS (e-HiPIMS), allow the superposition of multiple pulses within a discharge, further amplifying the ionization of metallic species [4]. Although plasma-based deposition techniques are among the most environmentally friendly for thin films synthesis, the HiPIMS process remains an energy-intensive process, requiring significant power and the use of rare and costly gases. Modeling is a good alternative for studying the optimization of this process. In this study, we present a global kinetic model of Ar/Cr pulsed plasma to investigate the effects of HiPIMS and e-HiPIMS discharges on the properties of deposited Cr films. On a first hand, the simulations results show the effects of key process parameters, such as pressure, gas flow rate and duty cycle on plasma composition, based on previous results [5]. On the other hand, results highlight the significant effects of short pulses addition to the fundamental pulse, on the temporal evolution of the temperature and density of electrons and chromium ions.

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Poster | GRE Tubes Under Cyclic Loading: Deformation, Fatigue Thresholds and FEA Correlation | *ID 71*

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Glass fiber reinforced epoxy (GRE) composite tubes have emerged as an essential component in industries requiring high mechanical performance, corrosion resistance, and durability under cyclic loads. Their superior fatigue resistance and lightweight nature, compared to conventional metallic alternatives, make them a preferred choice in oil and gas, marine and infrastructural applications [1,2]. However, composites exhibit complex failure mechanisms when subjected to static and fatigue loads, making it necessary to investigate the mechanical performance of GRE tubes under varying operational stresses [2,3]. This study investigates the mechanical response of a GRE tube using strain sensors, subjected to cyclic loads at different force levels (2 kN, 20 kN, and 40 kN) to evaluate its deformation characteristics, fatigue response, and structural integrity. Experimental results show an incremental increase in deformation with increasing load, with the maximum force (40 kN) causing residual deformation, suggesting possible plastic strain accumulation. Results indicate that the GRE tube maintains structural stability up to 20kN, beyond which non-recoverable deformation is observed. Additionally, these experimental results will be verified using Finite Element Analysis (FEA) to further understand failure mechanisms and stress distribution. This study holds significant implications for industry and academia, guiding the optimization of GRE tube fabrication processes and increasing understanding of their cyclic loading performance. Furthermore, understanding the structural behaviour of the tube under high-stress conditions will aid manufacturers in enhancing product reliability and life expectancy, reinforcing their use in high-stress applications [4].

Fig. 1. Experimental setup for cyclic loading test on GRE tube.

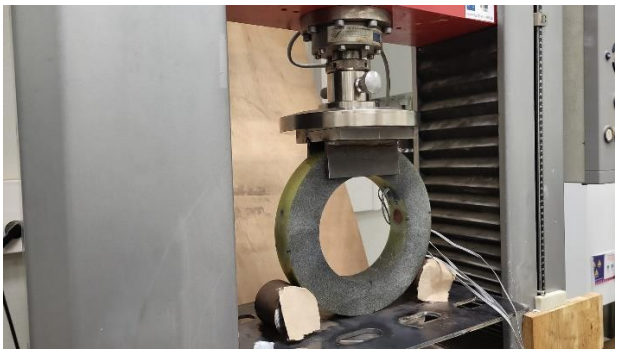
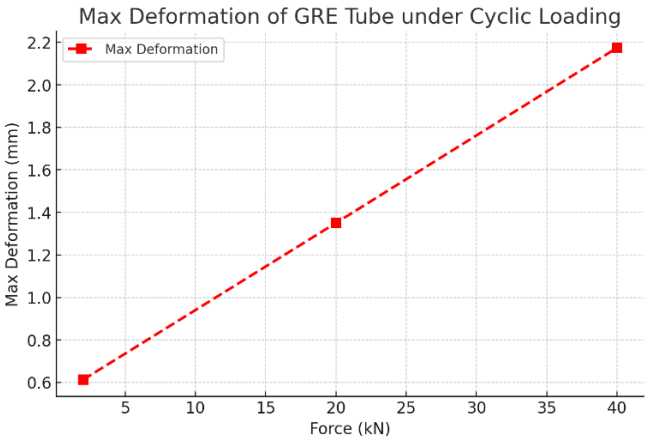


Fig. 2. Maximum deformation of GRE tube under cyclic loading.



This work is part of a PhD project funded by 3CPN. The author acknowledges the financial support provided by 3CPN for this research.

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Poster | Al Doped ZnO Based Transparent Conducting Oxides Deposited by Magnetron Sputtering Films | *ID 86*

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Thin film materials are the main elements of technological advances in several industrial applications such as microelectronics and optics devices. With the evolution of thin film technology, supported by the development of high vacuum technology, the range of applications has increased to the most technological advanced applications like protective coatings against wear and corrosion, wireless communications, integrated circuits, solar cells, flexible panel displays, micro- electromechanical systems (MEMS) and recently, biomedicine applications. In spite of such progress, the relationship among all steps of the thin film process, namely deposition parameters-structural and specific properties of the produced thin films, stands a major challenge. Most widely deposition techniques, namely physical vapor deposition (PVD), and chemical vapor deposition (CVD), are used to develop thin film materials. Among them, magnetron sputtering is a technique widely used in microelectronics and nanotechnologies for the growth of metallic, nitride or oxide thin films. Indeed, this technique allows obtaining films with particular properties from the physicochemical and structural point of view. In this work, we present the behavior of structural, electrical, and optical properties of Al-doped ZnO thin films as well as multilayered AZO/Metal/AZO structures (metal=Cu or Ag) deposited by magnetron sputtering technique.

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Poster | Sepiolite-Alginate/Fe-Ni Composites for Efficient Solid Hydrogen Storage | *ID 91*

Aya Aiadi[1], *El Houssain* Chkouri[1,2], *Pili Yeste* Sigüenza[2] *and Khalid* Draoui[1]

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The depletion of fossil fuels for energy production raises critical global concerns. Hydrogen (H2) is one of the most attractive and promising alternative energy sources due to its high energy efficiency, environmental friendliness and non-toxicity [1]. As a potent energy carrier, hydrogen plays a critical role in facilitating the transition toward a sustainable future. However, finding suitable, efficient, and economical hydrogen storage methods remains a fundamental challenge. The solid storage of hydrogen provides a crucial solution for safely and efficiently containing large hydrogen quantities, enabling its application as a clean energy source while overcoming challenges related to storage density and transportation [2]. Chemical and physical adsorption on clay materials and metal hydrides appear to be among the most promising storage options [3]. The present study investigates the development of a novel, sustainable and eco-friendly composite beads for hydrogen storage synthesized from a combination of natural sepiolite, alginate, and metallic nanoparticles. The characterization of this adsorbent has been performed using several methods such as XRD, TGA, DTG, FT-IR, XRF, SEM and N2 adsorption methods. Hydrogen adsorption experiments were conducted on both unmodified Sepiolite and Sepiolite-Alginate@Fe-Ni composite beads at temperatures of 298K, 318K, and 348K under pressures up to 100 kPa. The results demonstrate that the hydrogen uptake capacity of the sepiolite-based composite increases with increasing both temperature and pressure according to combination of chemisorption and physisorption. Conversely, unmodified sepiolite exhibits decreased adsorption capacity with increased temperature, consistent with a physisorption-dominated process. The maximum sorption capacity, achieved at 100 kPa and 348K, reached approximately 0.025 mmol/g. The modelling study demonstrates enhanced composite storage properties, highlighting significant improvements in efficiency and performance.

Acknowledgements

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16:45	***Keynote*** Abdelilah Slaoui ***Hydrogen as An Energy Carrier: Ambitions and Technologies***		
	RF ENERGY HARVESTING	***BIOMEDICAL APPLICATIONS***	***HYDROGEN***
17:30	***41*** Walid En-Naghma ***A Dual-Band Modified Monopole Antenna operating for 2.45/5.8 GHz in ISM Band Applications***	***Invited Conference*** Khadija Ouguerram ***Spirulina Liquid Extract: Benefits for Cardiovascular Disease***	***Invited Conference*** Pascal Briois ***Development and characterization of a solid oxide fuel cell obtained by thin film technologies***
17:45	***83*** Yassmine Esshaimi ***Design of RFID Tag Antenna for Logistics Applications in the Renewable Energy Sector***		
18:00	***85*** Zakaria Errachidi ***Novel UHF RFID Tag Structure Based on Polycarbonate Material, for Renewable Energy Applications***		***70*** Ilham Laghryb ***Catalyst Degradation in Proton Exchange Membrane Fuel Cells (PEMFCs): Mechanisms, Investigation Techniques, and Predictive Modelling***
18:15	***40*** Amina Aghanim ***Optimizing Q-Learning for Automated Cavity Filter Tuning: Leveraging PCA and Neural Networks***		***76*** Nouhaila Ben Abdelouahab ***Optimized Integration of Hydrogen Systems into Renewable Energy Parks***

Keynote Lecture

Hydrogen As an Energy Carrier: Ambitions and Technologies

Abdelilah Slaoui

Research Themes

Growth and Characterization of Advanced Inorganic Materials for Opto-Electronics and Energy (laser processing including deposition, ablation, doping, crystallisation…, lamp furnace heating, spinning & screen printing…).
Fabrication and test of devices (Solar Cells, Light emitting diodes, MOSFETs, TFTs,…).

Research Community Involvement & Leadership

- Presently, Coordinator of the National Research Program on low-carbon Hydrogen (PEPR-H2).
- Deputy Scientific Director for Energy at CNRS (since 2016) , overseeing energy research across France.
- Head of photovoltaic/electronic research group at PHASE, INESS, and ICUBE (CNRS labs) for 20 years.
- Coordination and participation to more than 35 national, European, and international projects on energy and photovoltaics.
- Former President of the European Materials Research Society (2010-2012) and organization of numerous international conferences and symposia on advanced materials for energy.

ID 41

A Dual-Band Modified Monopole Antenna Operating for 2.45/5.8 GHz in ISM Band Applications

Walid En-naghma [1], *Mohamed* Latrach[2], *Hanan* Halaq[1] *and Abdelghani* El Ougli[1]

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[2]Ecole Supérieure d'Electronique de l'Ouest (ESEO), Angers, France

This study proposes a dual-band monopole antenna (MA) which is printed on an FR-4 substrate with compact dimensions of $30 \times 38 \times 0.8\ mm^3$ and it operates at 2.45/5.80 GHz. This proposed MA is simulated using three software programs which are CST MWS (Computer Simulation Technology Microwave Studio), and ADS (Advanced Design System) to prove its performance by showing each software has its specific numerical method of calculation. This MA exhibits bandwidths of 2.25-2.66 GHz, and 5.63-5.97 GHz with center frequencies at 2.45 GHz and 5.80 GHz, return loss values (-26.08 dB and - 25.70 dB), and good matching with input impedance values of 47 ohms and 50 ohms using CST MWS.

Based on the simulated results obtained using CST MWS, this MA is powerful in terms of its peak gain of 2.20 dBi and 5.47 dBi at 2.45 GHz and 5.80 GHz respectively, and its peak directivity of 2.24 dB at 2.45 GHz and 5.97 dB at 5.8 GHz. Based on these findings, this proposed MA appears to be well-suited for various wireless technologies like laptops, smartphones, wireless sensor networks, and wearable and implantable devices.

Design of RFID Tag Antenna for Logistics Applications in the Renewable Energy Sector

Yassmina Esshaimi[1], *Fouad* Aytouna[1,2], *Jamal* Zbitou[1,2], Mohammed El Gibari[3] and *Ridouane* Er-rebyiy[4]

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In an era where logistical efficiency is a critical success factor, the integration of RFID technology in strategic sectors such as wind farms and solar power plants enhances automation and productivity. This paper presents the design and optimization of a miniaturized, flexible UHF RFID tag antenna with a compact size of 54 × 54 mm². The antenna is implemented on an advanced Photopaper substrate with a permittivity of 3.3, a loss tangent of 0.04, and a thickness of 0.25 mm. This proposed tag antenna is specifically matched to an Impinj Monza 1a microchip, which has an impedance of Zchip = 33 - j112 Ω at 915 MHz and a sensitivity of -9 dBm. The antenna's performance is evaluated based on key parameters such as gain, return loss, impedance matching, and read range. Simulation results demonstrate a reflection coefficient of -31 dB at 915 MHz, a gain of 0.35 dBi, and a read range of approximately 2.3.

Novel UHF RFID Tag Structure Based on Polycarbonate Material, for Renewable Energy Applications

Zakaria Errachidi [1], *Jamal* Zbitou[1,2], Mohammed El Gibari[3] and *Noha* Chahboun[1]

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[2]ENSA of Tetouan, Abdelmalek Essâadi University, Tetouan, Morocco
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In the renewable energy sector, the management of protective equipment (PPE and collective safety systems) is a crucial priority to reduce workplace risks and ensure the safety of operations. This article presents the design and optimization of a novel UHF RFID tag operating at 868 MHz, featuring an original structure inspired by a wind turbine shape. This tag is specifically designed to be integrated into industrial safety helmets made of polycarbonate, a material characterized by a dielectric constant $\varepsilon r = 2.9$ and a loss tangent $\tan\delta = 0.01$. The tag aims to enhance equipment tracking and traceability. The antenna is adapted to an Alien H4 UHF RFID chip, which has an internal impedance of $Z = 23.37 - j203.3\ \Omega$ at the chosen frequency, ensuring optimal power transfer. Simulation results demonstrate that the tag offers high readability and efficiency while respecting the mechanical and dielectric properties of polycarbonate. This study highlights the potential of innovative UHF RFID tag designs for tracking safety equipment in industrial environments, offering a robust solution to improve workplace safety and operational efficiency.

Optimizing Q-Learning for Automated Cavity Filter Tuning: Leveraging PCA and Neural Networks

Amina Aghnaim[1], *Oulhaj* Otman[1], *Aziz* Oukaira[2] *and Rafik* Lasri[1]

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[2] Faculty of Engineering, Electrical Engineering Department, Moncton University, Canada

Abstract In this work, we propose a reinforcement learning-based method for tuning the response of a 6thorder combline bandpass filter using a Q-learning algorithm. The filter, resonating at 941 MHz, is equipped with four metallic tuning screws, of which only two are considered in the tuning process to reduce computational complexity. Post-fabrication tuning remains a critical challenge in the microwave domain, as it is both time-consuming and labour-intensive. A key difficulty lies in the nonlinear relationship between screw positions and the filter's frequency response, which complicates traditional tuning approaches. Furthermore, intelligent algorithms often require a large volume of simulated data, leading to high computational costs and extended training times. However, reducing the amount of sampled data risks losing critical information, impacting model accuracy. To address this, we implement Principal Component Analysis (PCA) as a dimensionality reduction technique to enhance efficiency while preserving essential information. A feedforward neural network is employed to map tuning screw positions to PCA-reduced Sparameters, acting as a surrogate model to approximate filter behaviour. This neural network, integrated into the Q-learning framework, enables efficient action selection and reward computation. By applying PCA during the data pre-processing stage, we reduce the dataset from 401 to 20 principal components, significantly accelerating Q-learning convergence. The proposed approach, utilizing an epsilon decay strategy to balance exploration and exploitation, successfully reduces the tuning steps from 1000 to only 45, ensuring optimal performance with improved efficiency and accuracy.

Highlights of the major keys of our work

Our paper suggests a Principal Component Analysis (PCA) framework with a Q-learning approach to reduce the high dimensionality of the data while maintaining good convergence and reduced computational time and retaining relevant features. Where the main objective of the algorithm is to keep the S11 coefficient under a certain value -21dB in the entire passband.

Fig. 1. Architecture of the adopted neural network.

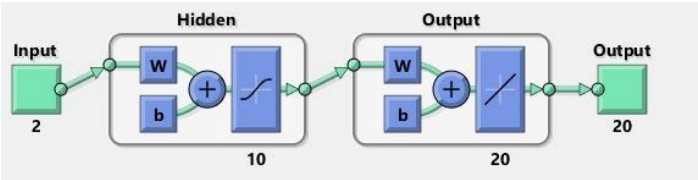
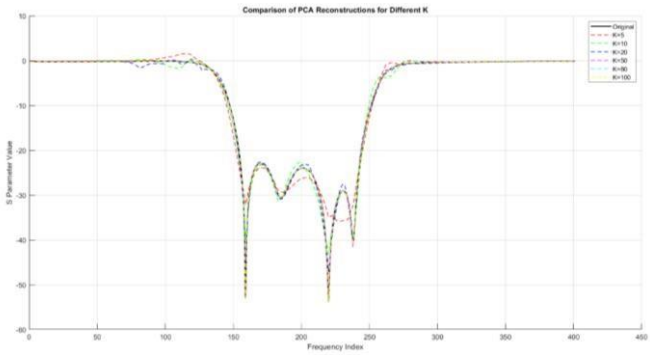


Fig. 2. Reconstructed curve of S11 coefficient under different number of PCA components.

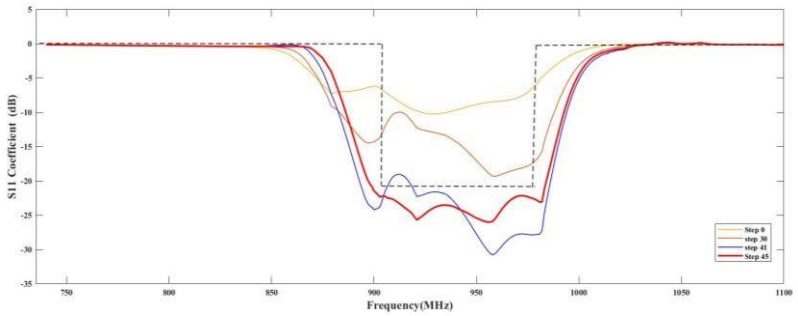


The table clearly shows how choosing the right number of PCA components is a balancing act between accuracy and efficiency. While using more components like 100 gives almost perfect reconstruction, it also increases computational cost and reduces data compression. On the other hand, too few components like 5 or 10 lose important details, making the model less reliable. Accordingly, 20 PCA components strike the perfect balance retaining 99.51% of the variance, keeping the reconstruction error low, and significantly speeding up the Q-learning process. This smart reduction in data size has helped cut down tuning steps from 1000 to just 45, making the whole process much faster without sacrificing accuracy.

Table 1. Impact of PCA Component Selection on different performances.

PCA Components	Variance Retained (%)	Reconstruction Error (MSE)	Time (s)	Compression (%)	Computational Cost
5	95.62%	0.34985	0.0057s	98.75%	Low
10	98.26%	0.13887	0.0067s	97.50%	Medium
20	99.51%	0.03922	0.0066s	95.01%	Optimal balance
50	99.97%	0.00237	0.0076s	87.53%	High
100	100%	0.000032	0.0095s	75.06%	Very High

Fig. 3. S11 Coefficient under various number of steps.



By integrating Q-learning, PCA, and neural networks, our approach automates the tuning of bandpass filters while drastically reducing computational complexity and time. The results confirm that PCA effectively reduces data dimensionality, the neural network provides an efficient predictive model, and Q-learning successfully optimizes tuning strategies, achieving a fast, reliable, and adaptive filter tuning method.

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BIOMEDICAL APPLICATIONS

Invited Talk | Spirulina Liquid Extract: Benefits for Cardiovascular Disease

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Context

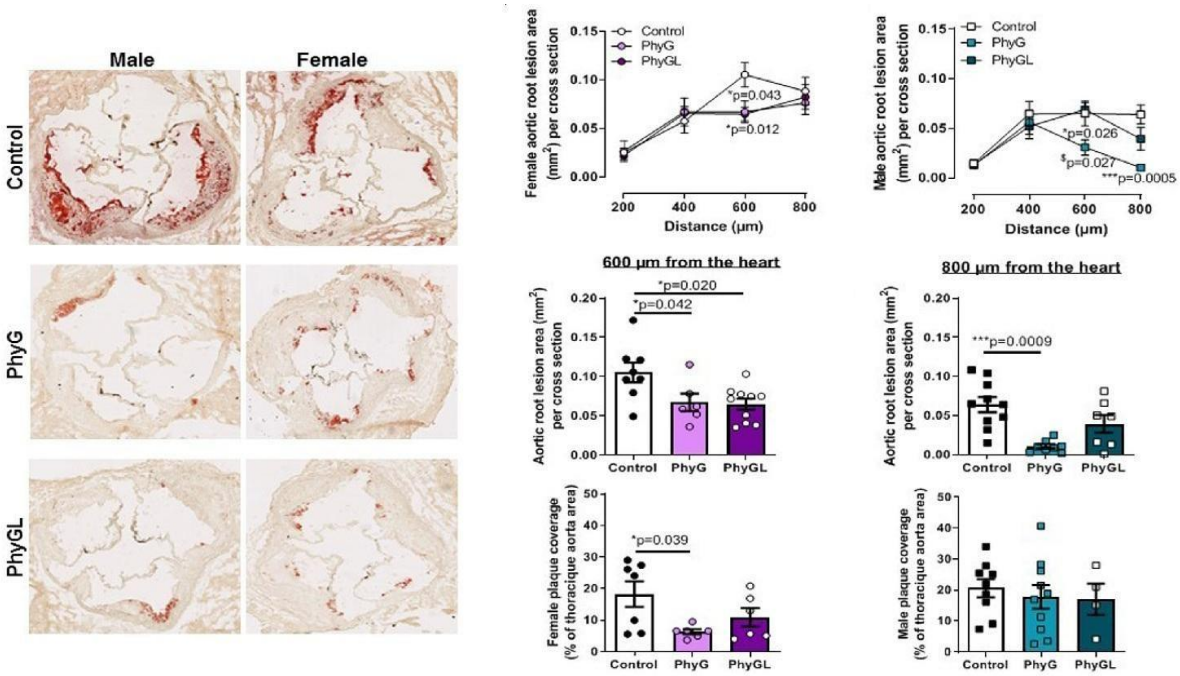
Spirulina liquid extract « Spirulysat » is obtained under environmentally-friendly conditions. This extract which is concetrated in C-phycocyanin, a powerful antioxidant, can protect offsprings against the development of atherosclerosis in cases of gestational hypercholesterolaemia. Indeed the uterine environment during gestation is characterised by very high levels of oxidative stress, presenting a high risk of developing cardiovascular disease in human and animal offspring. This study aimed to determine whether perinatal administration of a Cphycocyanine concentrate can protect genetically hypercholesterolaemic offspring against the development of atherosclerosis in in adulthood.

Methods and results

Spirulina liquid extract concentrated in C-phycocyanin was administered during gestation only (PhyG) or during gestation and lactation (PhyGL) to apolipoprotein E deficient mice. Male and female offspring were followed for up to 25 weeks. The offspring of the supplemented dams showed significantly fewer atherosclerotic lesions than the group born to unsupplemented dams, with the exception of the males supplemented during gestation and lactation. Females born to supplemented dams had a larger pool of total bile acids in the gallbladder, lower levels of hydrophobic secondary bile acids, such as lithocholic acid, associated with a lower plasma concentration of trimethylamine oxide, than mice born to unsupplemented dams. Males born to phycocyanin C-supplemented dams had higher levels of high-density lipoproteins, more soluble bile acids such as β-muricholic acids and lower plasma trimethylamine.

Conclusion

The use of liquid extract of spirulina, antioxidant-rich alga, during the perinatal period protects against the development of atherosclerosis in offspring with genetically hypercholesterolemic mice, involving sexspecific mechanisms.



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Invited Talk | Development and characterization of a solid oxide fuel cell obtained by thin film technologies

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Abstract. The desire to reduce the operating temperature of solid oxide fuel cells (SOFC) without altering their performance leads to reducing the thickness of active layers of the unit cell; it is in this context that the work presented in this study highlights thin-film technologies such as thermal spraying and PVD in order to develop functional thin layers for IT-SOFC application.

Solid oxide cells (SOCs) are electrochemical devices operating at high temperature. This technology can directly convert fuel into electricity (fuel cell mode – SOFC) or electricity into fuel (electrolysis mode – SOEC). In recent years, the interest on SOCs has grown significantly thanks to the need of massive andlow-cost production of H2, and their capability of reversible operation. The elaboration of the last generation IT-SOFCs by physical surface deposition processes is really challenging. Atmospheric Plasma Spraying (APS) process appears to be well adapted to build the porous anode layer whereas Reactive Magnetron Sputtering (RMS) technique is suitable to deposit thin and dense layer. In the present work, we have deposited a anonic conductor (GDC protective layer and YSZ electrolyte) film was applied by RMS. Then, in a second step, a complete cell was produced by developing the Ni-YSZ anode by thermal projection on a support metal supplied by Plansee, the electrolyte as well as the K_2NiF_4 structure cathode were produced by RMS

Initially, the production of the reference conductors of SOFCs such as YSZ or GDC were carried out by RMS on anodes or commercial half-cells, then the cathode was deposited by various techniques such as PLD and screen printing in order to conduct electrochemical tests in a complete cell. The optimization of the operating conditions allowed a gain of approximately 10% compared to a cell synthesized by soft chemistry technologies. The YSZ and GDC layers were developed in reactive conditions from a metal target; SEM observation shows dense and adherent layers.

In a second step, a complete cell was created using dry surface treatment technologies such as thermal spraying and PVD.SEM observation of the cross section of the cells reveals good adhesion of the layers, and that each layer has the desired morphology. Concerning the electrochemical performances, compared with mixing Pr_2NiO_4-Pr_6O_{11} (PPNO-87 S/cm at 700°C), Pr_2NiO_4 (PNO) has a better electronic conductivity of 109 S/cm at 650°C. At 750°C, the Rp of PNO cathode is 0.84 $\Omega \cdot cm^2$, while that of PPNO is 0.07 $\Omega \cdot cm^2$. This indicate that PPNO has obvious advantages in electrochemical performance, which may be derived from better morphology and the promotion of Pr_6O_{11} on the ORR of the cathode. MS/PPNO complete cell has better cell performance, and its maximum power density (P_{max}) and OCV are 1010 $mW \cdot cm^{-2}$ and 0.941V at 750°C, respectively. However, the P_{max} and OCV of MS/PNO are only 326 $mW \cdot cm^{-2}$ and 0.817 V at 750°C, respectively. The difference in performance between MS/PPNO and MS/PNO cell is due to the electrochemical activity of the cathode (PPNO2 *v.s.* PNO) and the influence of microcracks in the electrolyte layer. The MS/PPNO single cell exhibits interesting long-term performance.

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Catalyst Degradation in Proton Exchange Membrane Fuel Cells (PEMFCs): Mechanisms, Investigation Techniques and Predictive Modelling

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As the demand for sustainable energy rises, hydrogen fuel cells, especially Polymer Electrolyte Membrane Fuel Cells (PEMFCs), have become a focus due to their efficient and clean energy production. Their advantages make them an important choice for supporting the transition to renewable energy sources [1]. Despite their benefits, PEM fuel cells face challenges with platinum catalyst degradation under harsh operating conditions, such as acidic environments, high electric currents, and large potential differences [2]. These conditions gradually lead to particle growth and a loss of active surface area in the catalyst, causing a cumulative reduction in the fuel cell's overall efficiency and power output as degradation progresses [3]. This paper aims to provide a clear overview of catalyst layer degradation in PEM fuel cells by examining the main mechanisms of catalyst layer degradation, the investigation techniques used to study it, and models that predict its effects. This paper highlights important insights to support future efforts in improving fuel cell durability and efficiency by bringing together current findings. The paper points to areas for further study, such as enhancing prediction models and refining investigation methods, to advance PEM fuel cell technology to make it more resilient and cost-effective for sustainable energy use.

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Optimized Integration of Hydrogen Systems into Renewable Energy Parks

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Abstract. The Large-scale energy storage remains a major challenge for the utilization of the renewable energy sources. Hydrogen is considered as a promising solution to this issue. However, optimizing the sizing of the hydrogen production systems to be integrate into the renewable energy parks is crucial to maximizing production while minimizing the levelized cost of hydrogen (LCOH). This study presents a technoeconomic modeling approach for hydrogen systems, including the electrolyzer, compressor, storage tank, and a battery used as buffer storage. A bi-objective optimization algorithm is implemented to determine the optimal system sizing and energy management strategy. Based on the results, it was demonstrated that the use of batteries has no economic benefit but can be used to achieve a production target. In addition, several performance indicators are calculated for each pareto front solutions in order to evaluate the effect of the hydrogen systems sizing on the objective functions. Furthermore, the minimum LCOH solution is compared for different technologies to highlight the impact of the levelized cost of the energy (LCOE) and the capacity factor of the studied site on the LCOH and on the overall performance of the hydrogen plant.

System Description

Figure 1 presents the system considered in this work. The energy distribution is done by the frequency s eparation strategy according to the dynamics of the systems [1]. NSGA-II algorithm is used to define the electrolyzer size and the time constant τ that directly determine the battery needed as explained in [2]. One of the main conclusions is that the Pareto front solutions have the same tendency and may be separated into two zones for the various technologies that were examined. The initial zone is characterized by a significant increase in the hydrogen production as the size of the electrolyzer increases without the need of batteries (almost no profile smoothing). And, in the second zone the costs rise steeply with a slight increase in the production. In this region, significantly larger batteries are selected, while the size of the electrolyzer decreases. However, the LCOH varies significantly depending on the technology, as it is strongly influenced by the LCOE and the capacity factor of the energy source. The techno-economic analysis has shown that the nature and capacity factor of the input profile affect the system performance, and consequently the optimal sizing. This highlights the importance of using this developed tool for a comprehensive evaluation and as a decision-making support.

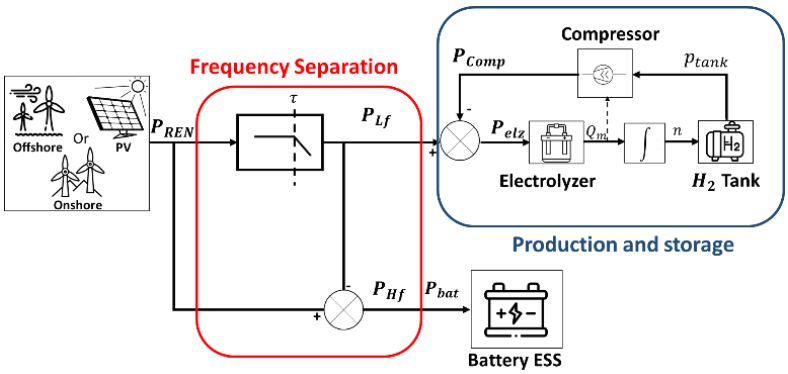

Fig. 1. Simplified schematic of the hydrogen production and storage system.

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