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Programme « Inter Carnot-Fraunhofer" (PICF)

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Project title	**DAGOIL**: Development of an enzymatic refining integrated process enable to enrich vegetable oil in diacylglycerols (DAG)

Abstract

The DAGOIL project has been defined on the basis of an original approach coupling both nutritional and technological aspects. The main purpose of this project is the verification of the health benefits of diacylglycerol enriched vegetable oil and the development of an enzymatic refining integrated process enable to produce vegetable oil with an increased DAG content.

Oil rich in DAG are produced by classic esterification of fatty ester on glycerol by chemical or enzymatic means directly on refined vegetable oils. So we propose to enrich oil in DAG directly during refining process by integration of enzymatic degumming and neutralization. Even if industrial enzymatic degumming has been developed (ENZYMAX and BUNJE Patent) according to expert specialist enzymatic neutralization deserves to be investigated for refining and also integration of both in a same process.

Moreover, in order to obtain DAG content with nutritional impact, possibility to use by-products of refining industry will be investigated. These by products rich in free fatty acids, mono and diacylglycerols such as deoditilates and soap stocks could be used to provide raw materials and in particular free fatty acids. These FFA added to the crude oil could be esterified during the refining enzymatic process to improve the yield of DAG quantity and observe nutritional effect.

Indeed, recent researches have demonstrated the nutritional potential of DAG and its positive impact on health. Nutritional interest of the new “DAGOIL” developed will be investigated and in particular innovative aspects linked to mechanism of intestinal lipolysis and absorption of DAG and the adipose tissue development in rats after DAGOIL intake (adipose mass of different depots, cell size and size distribution, plasma adipocytokines, lipolytic regulation of isolated adipocytes). In order to validate this approach and provide claims for industrial partner, it is planned to perform a pilot human studies regarding the oil produced within the frame of DAGOIL by dose activity relation.

The interest of enzymatic refining process concerns not only the

oil enrichment of DAG and its nutritional interest, but also the improvement of refining process itself (diminution of by product such as soap stock and energy consumption, avoiding contaminant production, improvement of yield and environmental impact...) comparatively to the traditional one.
The involvement of two industrials of European dimension all along the added value chain in the project confirms the market potential of the project for both oil producers and nutritional interest for food industry.
The project will focus on oil currently on the market such as canola, sunflower or soybean, oils the most use in Europe

Partners	Carnot institute LISA Fraunhofer institute IVV LESIEUR; SUD-CHEMIE
Coordinators	Xavier Pages – Carnot Institute LISA Andreas Stäbler - Fraunhofer institute IVV
ANR Grant	470 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-001

Project title	**DWST-DIS:** The Development of Multi Wafer Stacking 3D Technology for Displays and Imaging MicroSystems

Abstract

The lack of miniaturization in conventional 3D display and imaging systems limits their application fields and imaging capabilities. Responding to strong consumer demand for ultra-compact devices and global passion for “greener”, more power-efficient products, marketplace demands are also pulling 3D integration into the mainstream.

Firstly, micro-opto-electromechanical system (MOEMS) technology combining MEMS and micro-optics is well suited for manipulating light. A number of different ways can be envisioned to scanning, steering, or modulating the light beams. This technology allows a large array of micromechanical light manipulators to be batchfabricated at low cost. A number of MOEMS display and imaging products and technology demonstrators have been developed for defense, aerospace and medical markets in the form of miniature devices for projection displays, imaging devices, barcode readers, and scanners. Secondly, the use of the 3rd dimension by employing multi-wafer integration, stacking and interconnecting several functional wafers based on disparate technologies, enables the creation of truly 3D devices that are smaller, thinner and lighter in weight than existing devices.

The main goal of DWST- DIS proposal is to design, develop and validate experimentally a fully integrated prototype of vertically integrated microoptical scanner, suitable for a wide number of imaging systems such as the confocal microscopes or OCT probes. Firstly, the architecture of a single-channel scanner, implementing series of vertically stacked building blocks, combining the illumination and beam splitting functions with the 3-D transmissive scanning will be developed and tested. Then, a parallel architecture, based on arrays of smart pixels will be developed and tested too.

DWST-DIS presents high degree of innovation and technological novelty based on the association of microoptical components and micro-mechanical actuators, which are assembled together in a complete microsystem.

The first challenge of this project is the proposed 3D packaging that combines several dies vertically by using multi-wafer technology. This offers integration of complex MOEMS devices and the effective integration of various heterogeneous technologies, disposed in vertically stacked building blocks (microlens in glass or polymer, Si MEMS actuator, beam

splitter, detector) in a minimum space.
The second challenge is to optimize the design and to find the best solution for heterogeneous integration technologies to combine integrated microoptics and MEMS, which allows high-frequency raster scanning and precision focusing of optical beams. Here, some alternative technologies, offering the integrity of microactuators and a low level of residual stress will be investigated and compared.
The motivation of this French-German collaboration is to optimally implement the technical background of both Partners, each of them in the field of his own expertise and benefits from the expertise of the other. Due to the multidisciplinary nature of the collaborative approach, with research groups having high competence in MOEMS and microoptical technologies (FEMTO-ST) and MEMS assembling and packaging (FhG-ENAS), two demonstrators of on-chip microlens scanner will be proposed, providing miniaturized and low cost solutions to create highly accurate component for display or imaging systems. The collaboration between FEMTO-ST and FhG-ENAS has been a long-term alliance because the interaction has started in 2001: both groups were partners of OCMMM proposal (European programme GROWTH, FP5). The present interaction will enhance the national as well as international leadership of groups, creating a platform for the late transfer of commonly developed technology to industry, focusing the market of miniature imaging systems

Partners	Carnot Institute Femto-Innovation Fraunhofer institute ENAS
Coordinators	Christophe Gorecki –Carnot Institute Femto-Innovation Maik Wiemer - Fraunhofer institute ENAS
ANR Grant	319 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-002

Project title	**EUBECELL:** Efficient Use of Bio-Ethanol in Fuel Cells

Abstract

The principal goal of the project is to demonstrate the feasibility of an efficient and high performance direct ethanol fuel cell in the kilowatt range. Such a fuel cell could be beneficially used as source of electrical energy for a number of applications. Among these, the use within a stationary back-up power solutions and the use as range extender for all electrical vehicles seem to be the most promising. Both applications feature similar power demands in the scale of a few kilowatts and both strongly profit from the ease of use and the existing distribution infrastructure of bioethanol. Furthermore, for both applications, the overall consumption of fuel will be rather low, as in both cases the fuel cell will have only a small number of full load hours per year. This fact economically prohibits establishing a new infrastructure for a fuel like hydrogen. However, it favours the use of bio-fuels, which are a scarce resource themselves.

On the technical level the project will focus on the development of the materials needed to build a direct ethanol fuel cell with a suitable power density. The aim of the project will be to build a demonstration unit with a power output of about 0.5 kW. To achieve this goal, two concurrent approaches will be pursuit at the beginning of the project. One approach is using High Temperature Proton Exchange Membrane Fuel Cell technology (HT-PEMFC), increasing the reaction kinetics by increasing the operating temperature. The second will be the use of Alkaline Anion Exchange Membrane Fuel Cell technology (AAEMFC), increasing the reaction kinetics by increasing the pH in the reaction zone. Both approaches are known to enhance the ethanol fuel cell power density, but are not yet ready for application due to materials issue in particular with respect to membrane materials. Therefore, three partners in the consortium will focus on the development of improved membrane materials (EF, CED2 and Fumatech). The second focus will be the investigation of electrocatalysts and electrode layers with a high ethanol conversion rate for ethanol and a high CO2 current efficiency (ICT, EF). As an additional goal a reduction of the use of platinum shall be strived for. Thereby the properties of bioethanol which may differ from analytical grade ethanol will be considered using the input from Südzucker on typical bioethanol composition. In a milestone at the midterm of the project the most promising approach will be chosen for the realisation of the demonstration unit. As part of this

development membrane electrode assemblies using the new membranes and catalysts will be developed and tested in combination with different gas diffusion media, to optimise their performance. Test results with the demonstration stack will also be used to evaluate the achievable performance against performance requirements for different target applications. Using this results and the demonstration unit as tool the acquisition of follow-up projects by presenting them on trade fairs or directly to potentially interested customers

Partners	Carnot institute CED2 Fraunhofer institute ICT Fumatech GmbH Südzucker AG
Coordinators	Jacques Rozière – Carnot institute CED2 Carsten Cremers - Fraunhofer institute ICT
ANR Grant	469 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-003

Project title	**FilameNDT:** NDT for Need Based Maintenance of Civil Infrastructure – External Prestressing Strands, Embedded Stay Cables, Internal Prestressing Strands and Rods

Abstract

The infrastructure of the economically leading countries in Europe is aging. This concerns especially Germany and France as the industrial countries in Europe which represent the backbone of trade of the European Union and rely on a highly developed infrastructure. The role of life cycle management for the infrastructure becomes more and more important to each country in Europe. Furthermore, traffic loads and also loads due to changing environmental conditions (wind loads due to climate change, increasing water levels at the sea etc.) increased during the last years and will increase in the future. Repair and maintenance have to be performed which requires reliable concepts and reliable measurement data preferably gained with non-destructive methods. Furthermore, infrastructural constructions often have to be reconditioned when they are in use i.e. they cannot be torn down and build up new. Therefore, reliable diagnosis of the state of “hotspots” is required.

In the frame of FilameNDT steel wires of external tendon ducts and pre-stressing strands, prestressing rods and stay cables will be investigated. Regarding this field of application practical relevance can only be gained when easily applicable and long ranging methods can be used. Therefore, a global and a local approach are chosen. The evaluation of extended structural elements using non-contact movable systems (bulk wave and guided wave application (Piezo, Electro Magnetic Acoustic Transducers (EMAT)), Magnetic Flux Leakage (MFL), Micromagnetic

methods, Eddy Current (EC)) and that of localized elements based on elastic guided wave propagation – are complementary since they can be applied according to the various accessibility conditions of the tested objects. Within the cluster of methods evaluated and applied within FilameNDT the elastic wave propagation approach is the part where both project partners provide a sound knowledge in this methodological area whereas LCPC has additionally experience in modelling wave propagation in such cylindrically symmetric structures and acoustic monitoring systems for bridge evaluations. IZFP has gained a broad experience in sensor development including multi probe and EMAT phased array applications. The development of combinations of the different NDT techniques will be used to

enhance the diagnosis.
The overall expected result is a know-how related to the developed advanced NDT techniques for the use in the inspection and monitoring of civil structures. The success of this project will be gained by a dissemination strategy based on technical innovations, combined with guidelines describing in detail the reliable and qualified application and verified results which can be transferred to a service inspection approach (hard and software) including appropriate interfaces e. g. for commonly used bridge management systems. The conceptual design of FilameNDT (structure and connections to community) offers the possibility to bring the developments into an early stage process for a European standard.

Partners	Fraunhofer institute IZFP Carnot institute VITRES
Coordinators	Jochen Kurz– Fraunhofer institute IZFP Laurent Laguerre- Carnot institute VITRES
ANR Grant	223 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-004

Project title	**IMAGE:** Innovative printable electrode materials for high performance organic lighting devices and solar cells
Abstract	The supply of environmental friendly electrical energy is one of the most urgent challenges today. Global warming, caused by green-house gas released mainly by industrial countries, needs to be reduced. Many new technologies are under development, such as solar cells and lighting systems based on organic/polymer semiconductor materials, which have recently made great progress regarding lifetime and efficiency. This allows the appearance to the market of the first products, but only for niche applications. Nevertheless, these innovative technologies need further improvement to widen the application spectrum. The challenge and ultimate goal of the project is the replacement of conventional ITO (indium-tin-oxide) electrodes by thin film carbon nanotube/polymer composites (CNT-PC) to lower the price, ease the production, improve the conductivity and enhance the flexibility and optical behaviour. To achieve this aim the development, application and optimization of novel CNT-PC is necessary. These transparent CNT films will be structured and integrated in Organic Solar Cells (OSC) and Organic Light Emitting Diodes (OLED) and the final devices will be encapsulated and fully investigated in terms of performance and reliability. The integration of contacts and interconnections for a monolithic cell connection will be addressed as well.Finally the up scaling of organic solar module and lighting systems will be done to demonstrate the suitability of this technology and its use in a mass production capacity. We anticipate, through the present Carnot/Fraunhofer cooperation to impact greatly the nascent industry of plastic electronics and more specifically the organic/polymer based photovoltaic and lighting systems by developing new materials and processes for novel electrodes
Partners	Carnot Institute MIB Fraunhofer institute IPMS
Coordinators	Georges Hadziioannou – Carnot Institute MIB Olaf Hild - Fraunhofer institute IPMS
ANR Grant	ANR grant : 438 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-005

Project title	**Life-BC:** Lifecycle Building Card

Abstract

The rapid proliferation of 3D models and imaging systems in the construction and facility management industry offer a future where 3D “as-built” information should be available anytime and anywhere. This trend is supported by the success of BIM (Building Information Model) that supports the process of generating and managing building data during its life cycle. BIM encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components, it is broadly accepted and it has proven its high potential for the reduction of costs resulting from inadequate interoperability in construction processes. This project builds on this great success of BIM with the aim

* to extend the BIM with user captured data and to semantically enrich objects, elements and information branches for intelligent concatenation and information filtering on request according to role and area
* to establish a physical token granting access at system or data level to the extended BIM
* to connect mobile computing (Smartphone technologies) components to a central BIM repository (called “Life BC service backbone”),
* to enable horizontal and vertical data integration, reflecting on system as well as data centric issues
* to use Augmented Reality for the visualisiation of BIM data, for annotation of requests, for lifecycle documentation and monitoring of building components throughout the deployment phase
* to use Computer Vision based tracking technologies for determination of the pose of building components and room equipment
* to use open standards for a seamless integration of the developed technologies into established workflows.

In this context, it is very important to keep privacy issues in mind as the technology can e.g. be used in a building complex of private apartments. Thus the information will be linked to the “lifecycle building card”. This card will be uploaded with the relevant BIM information after the construction phase. A physical token will then be handed over to the owner along with the keys to the building which allows him to get access, retrieve information or document changes throughout the deployment phase of the building and its components. The owner will use the card to be informed about the status of the building and will update it as maintenance actions or modifications to the building occur. Thus this “eCard” of the building will keep track of several

	changes done on the object through the duration of the building life
Partners	Fraunhofer institute IGD Carnot institute CSTB New Media Yuppies GmbH
Coordinators	Ulrich Bockholt– Fraunhofer institute IGD Souheil Soubra - Carnot institute CSTB
ANR Grant	268 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-006

Project title

MOBISIC : Mobility Engineering for SiC Devices

Abstract

The reduction of the CO2 emission is an ultimate challenge from which the survival of parts of the earth will depend. Development of novel "green" energy sources like wind or solar energy parks and a significant reduction of the world-wide energy consumption is therefore of utmost importance. Of similar importance is the transition from conventional gasoline engines to automotive electric or hybrid electric vehicles. For all applications involving transport of energy from giant power plants to the user, management of power in cars, and conversion of energy, power electric devices are of utmost importance. Power devices based on materials with a large bandgap show the capability to overcome the material-dependent limits of today's power electronic devices based on silicon and, thereby, to contribute essentially to the minimization of the power dissipation.

Because of its advantageous physical properties, silicon carbide (SiC) is one of the most promising materials for future high-power, high-frequency, and hightemperature devices. Some of the most important key problems limiting the commercialization of SiC power MOSFETs are a high positive fixed charge in the gate oxide, a low threshold voltage, a low effective inversion-layer electron mobility, and a poor reproducibility of these very important parameters.

Recently, it was suggested that all these problems can be associated with carbon-related defects in the oxide and, more important, in the SiC bulk. All defects may already be present in the SiC bulk in high numbers and are significantly increased by processing such as thermal oxidation or ion implantation followed by high-temperature anneals.

In this project, the role of the carbon-related defects will be clarified experimentally by a synergistic cooperation between IISB and LAAS that builds on the expertise of IISB in SiC processing, and the transfer of characterization and simulation methodologies developed by LAAS and IISB for other materials systems. The cooperation will allow characterizing the concentration and chemical state of carbon on the nanometer scale across the SiO2/SiC interface.

Based on these measurements, a quantitative model for the segregation, diffusion and agglomeration of carbon will be developed. Dedicated electrical characterization and the correlation to the chemical carbon profiles, supported by numerical device simulations, will allow identifying the roles of the various carbon-related defects. Based on the experiments performed and on process and device simulations with the

models developed, an optimized recipe will be suggested for the processing of a demonstrator device with superior channel mobility.
By the end of this project, a thorough model will be provided which will help to increase significantly the mobility in the channel. SiC-based MOSFETs with sufficiently high mobility will help to build more energy efficient HVDC power energy transmissions or more energy efficient power converters in automotive applications and, most important, to reduce CO2 emission. Furthermore, it will promote the European automotive and electrical power industry in their effort to keep or to gain market shares, which is especially important for the economy in France and Germany

Partners	Fraunhofer institute IISB Carnot institute LAAS
Coordinators	Anton Bauer– Fraunhofer institute IISB Cristiano Fuccio - Carnot institute LAAS
ANR Grant	313 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-007

Project title	**TES-PCS:** Thermal energy storages based on phase change slurries for cooling applications
Abstract	The energy demand for cooling applications has been steadily increasing in recent years. Using thermal energy storages is an efficient way to reduce the increasing electricity consumption and to shift peak loads. Conventional cold storage and distribution systems use water or brines as heat transfer fluids to store or transfer energy with the sensible heat capacity of water. Due to the typically small temperature difference between the forward and return flow, these systems usually have a high flow rate and a large storage volume. Multifunctional heat transfer fluids consisting of a latent heat storage material as the dispersed phase and a carrier fluid as the continuous phase, known as Phase Change Slurries (PCSs), have been studied to increase the storage capacity. PCSs have a higher energy density than water by using both the sensible and latent heat capacity of the materials. The goals of this project are to develop stable and suitable PCSs for comfort cooling applications in a temperature range of 0-20°C and to investigate the application as cold storage medium for solar cooling systems with the highest efficiency. The PCSs studied within this project are paraffin/water emulsions and hydrate slurries as well as the combination of them. Paraffin/water emulsions are colloid systems where fine paraffin droplets are dispersed in water by a surfactant. CO2 hydrates are crystalline inclusion compounds formed from water and CO2 molecules. CO2 hydrates in emulsion and/or associate of hydrates with paraffin-water emulsion will be studied in order to enhance the amount of heat stored in the resulting slurry. These PCSs will be investigated in view of formation kinetics, stabilities, thermophysical properties, rheological behaviour and ecological aspects. Application tests of PCSs as cold storage media will be conducted in a solar cooling plant to evaluate their application potential. A charge state sensor will be developed and integrated into the demonstration plant to determine the solid content of the PCSs which indicates the energy density of the PCSs at different temperatures. As a result the control and the efficiency of the system can be improved by using this sensor. Additionally the performance of the PCSs will be simulated and analyzed. The knowledge of creating these PCSs gained during the project could be used to design new heat transfer fluids for many different applications
Partners	Fraunhofer institute UMSICHT Carnot institute Cemagref
Coordinators	Clemens Pollerberg – Fraunhofer institute UMSICHT Anthony Delahaye- Carnot institute Cemagref

ANR Grant	211 k€
Duration	36 months
ANR Ref #	ANR-10-PICF-008