INSIDE LABS

Research at INSA Rennes

Basic research at the service of Sustainable development

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INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES RENNES

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Basic science at the service of sustainable development

editorial

by Vincent Brunie, Director of INSA Rennes

A showcase for our academic excellence

I am pleased to launch the first issue of Inside Labs, the research magazine of INSA Rennes. The aim of this bi-annual magazine is to illustrate the academic excellence and scientific influence of our institute. While browsing through these pages, you will see to what extent our institution, in collaboration with our partners, is engaged in interdisciplinary research specifically adapted to the needs of society and companies.

In this first issue you will discover or rediscover research projects on responsible digital technology and materials for sustainable energy conducted by exceptional men and women.

I wish this magazine a long life, and I hope you will enjoy leafing through it as much as I do.

Enjoy your read!

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feature article

Basic science at the service of sustainable development

Hydrogen is going green thanks to III-V semiconductors

In 1994, when researchers at France Télécom decided to found Institut FOTON (Optical Functions for Information Technology), in order to develop research activities into optical telecommunications, they chose III-V semiconductors as the subject of their studies. Ever since, these materials have been studied from every angle. And yet, some 30 years later, they still haven't finished revealing their secrets. In 2022, at the CNRS laboratory's Institut FOTON based at INSA Rennes, the OHM team (optoelectronics, heteroepitaxy and materials) discovered some very strange properties which could allow us to produce environmentally friendly hydrogen. Charles Cornet, the person in charge of the team, gave us a rundown.

Aluminium antimonide, boron arsenide, gallium phosphide... These terms may seem rather obscure, unless you're a chemist, but they actually all relate to a group of elements called III-V materials. It's a codename which can easily be explained. These components all contain elements from group III - aluminium, boron, gallium, indium and thallium - and from group V - antimony, arsenic, bismuth and phosphorus - in Mendeleïev's famous periodic table of elements.

A family of elements full of qualities

« *III-V compounds are well known for their excellent optical properties, whether for emitting or absorbing light,* Charles Cornet explains. *After silicon, these are the most used semiconductors in industry, such as for making photodetectors, laser diodes for fibre optics for the internet, sensors for the environment or for the medical industry, and even solar panels...* » However, although they have high optical performances, III-V compounds are expensive, extremely expensive, at least 10 times more than their silicon equivalents. They are also rarer, considering that silicon is the second most abundant element in the Earth's crust. More than a quarter of the mass of the Earth's crust is actually composed of silicon, and along with oxygen, silicate minerals form 90% of the fine layer of rock floating above the Earth's mantle.

One micron of III-V on 0.3 millimetres of silicon

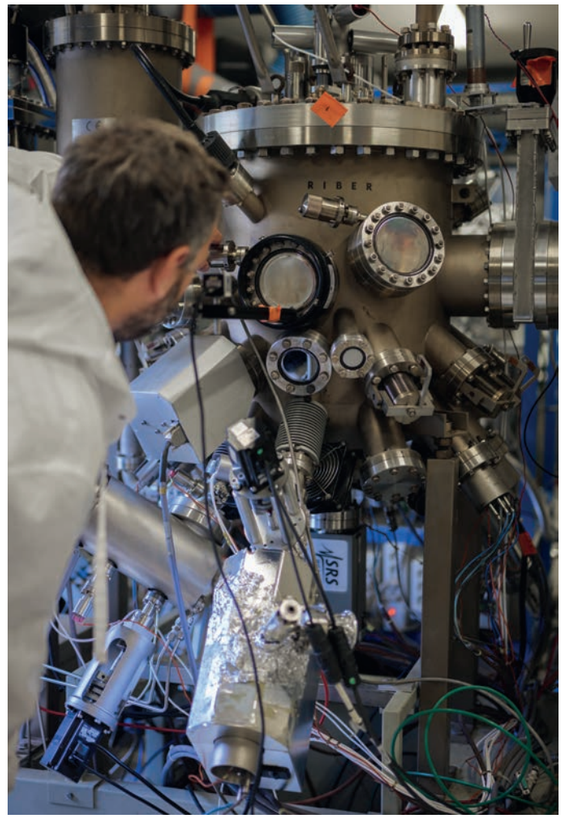
« *For a long time, researchers have been trying to reduce both the production costs and the environmental footprint of III-V semiconductors,* tells us Charles Cornet, *one solution is to use fewer quantities.* » The researchers of the OHM team at Institut FOTON have even developed a quicker and more efficient method of applying a thin one micron layer of III-V material to a 300 micron silicon substrate. The sample obtained presented electro optical qualities are as good as those of traditional III-V semiconductors, while also proving to be more environmental friendly and more cost effective.

Recognised internationally for their expertise, the team was contacted in late 2018 by University College London (UCL), which was looking to design a photo electrode. The London based chemists carried out several tests, and observed that the sample given to them by the OHM team worked much better than they had hoped. « *They wrote to us in January 2019 to tell us how excited they were,* recalls Charles Cornet. *The next day, I went to University College London to witness the astonishing results of their research: When plunged in water and exposed to light, our sample was able to produce hydrogen!* »

Hydrogen: An ideal energy carrier to fight climate change

After such promising results, Charles Cornet, Yoan Léger and Nicolas Bertru from the OHM team decided to commit themselves fully to study the properties of III-V semiconductors in order to produce decarbonised hydrogen. « *Hydrogen has huge importance for the energy sector. It can be used to produce electricity and heat on demand, while having potentially less environmental impact,* confirms Charles Cornet. *For example, by combining hydrogen and oxygen, the fuel cells of hydrogen powered electric vehicles produce the current for driving the electric motor, while only giving off water.* »

Thus, it is considered to be "the fuel of the future", and it can also be used for household heating and electricity, as a means of storing intermittent renewable energy sources, or on a large scale in power plants. Currently, however, hydrogen is mostly produced using petroleum products which emit CO_2. « *So, it's best to find other sustainable and decarbonised means of producing hydrogen, for example, by using the sun's rays on photo electrochemical cells submerged in water, which causes the water molecules to break up into hydrogen and oxygen molecules.* »



Vacuum chamber for crystal growth («Molecular beam epitaxy») used to develop the materials that compose photoelectrodes.

Picking up on 40 years of research

In 2019, although the researchers at the OHM were convinced of their findings, they still knew too little about the field. They're physicists after all, not chemists! In Rennes however, some renowned electro chemists are working at the ISCR (Rennes Institute of Chemical Sciences), as their field of expertise goes hand in hand with that of the OHM team. In order to produce green hydrogen, these physicists and chemists all helped to put together a design programme on III-V semiconductors based on research carried out in the 1980s into depositing thin layers of these materials onto silicon substrates.

One of the main problems with this technique was due to the appearing of crystalline defects in the semiconductor. « *Whereas III-V materials are organised in a very regular fashion in a plane of elements from group III in Mendeleyev's table of elements, sitting below a plane of elements from column V, followed by a plane from group III, then group V, and so on...,* explains Charles Cornet, *the defects in the crystal are composed of the same atoms but in a different order, particularly two planes of elements following one another, connected to one another.* » Yet, for years, these irregularities have been considered as making them unacceptable for use, because they lead to, for example, the degradation of performances of photovoltaic cells made of III-V materials applied to a silicon substrate. Scientists from around the world are trying to get rid of these crystalline defects at all costs.

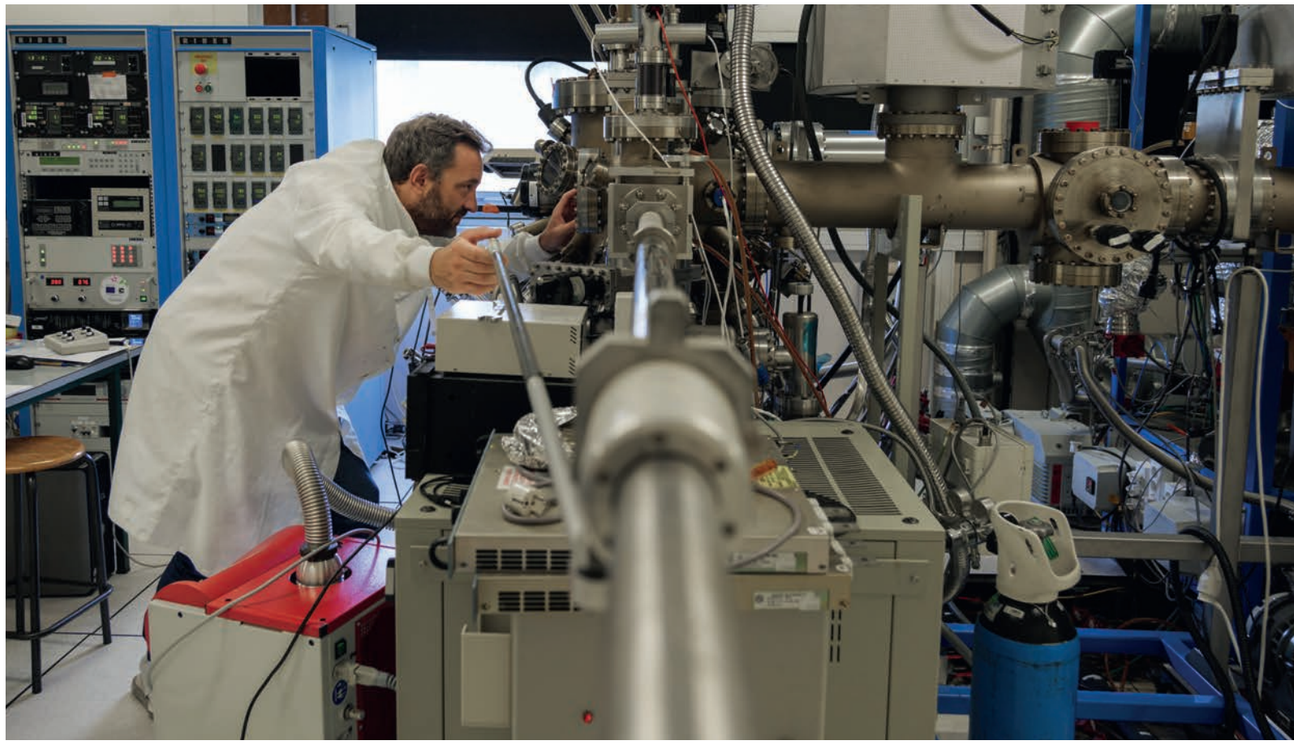
Tony Rohel, a technician in charge of developing materials by epitaxy for the production of solar hydrogen (INSA Rennes, FOTON Institute), generates the crystal growth of III-V semiconductors on silicon wafers, from which photoelectrodes are made.

The stunning qualities of the crystalline defects

The physicists and chemists from Rennes have chosen another line of research, where they studied the irregularities in the material, discovered why they appear, and described how they can be controlled. They then realised that some of them presented a unique behaviour, particularly that they could conduct an electric current. This atomic rearrangement (that we can call an “antiphase boundary” as it is no longer in phase with the rest of the III-V semiconductor) can no longer be considered to be a defect, but as a new material with new properties which are just as numerous as they are astonishing! « *Thus, materials in general are usually either metals, semiconductors or insulators,* affirms Charles Cornet. *However, the antiphase boundary behaves locally like a metal in a semiconductor. It's as if the III-V material, with its reorganised inclusions, presented the characteristics of both a metal and a semiconductor. To my knowledge, this property was unknown of until now.* » What's interesting most of all is this addition of electrical properties to the already excellent optical properties of III-V materials.

Like the sun at dawn triggering photosynthesis

But that's not all! This new material with these “defects” is capable of carrying both negative and positive charges. « *In a semiconductor, electric current is either carried via electrons, or the opposite, via the absence of electrons,* elucidates Charles Cornet. *What's surprising is that our material does both at the same time, acting as a cathode as well as an anode. So, one can imagine creating an artificial “sheet” with just one sample of our material, immerged in water in the sunlight, in order to simultaneously produce hydrogen and oxygen molecules, thus imitating plants when photosynthesis is initiated when the sun rises at dawn.* » There's also another surprise: The electric charges move vertically through the micron of III-V material applied to the silicon substrate. So, it would seem that the samples are insulators horizontally and conductors vertically. This is what we describe as being anisotropic, which means that their property changes depending on the direction.



Technical facilities for crystal growth at the FOTON Institute (Renatech + Nano-Rennes technology platform, building 10, INSA Rennes).

This new material probably hasn't finished revealing its secrets, which the researchers from Rennes are trying to uncover so that we will be able to convert solar energy into hydrogen on an industrial scale. « *We're on the right track,* concludes Charles Cornet. *We have carried out numerous tests on photo electrodes made using our material: They work efficiently under illumination, and they could very well be integrated into electro chemical cells to reproduce solar hydrogen on a larger scale. Our solution is very promising and interests scientific organisations, which have agreed to give us substantial funding to research the subject even more, and to improve the stability of our cells so that they can be used in industry.* »

Researchers are already looking further ahead still. Within the next five years, they hope to develop a fully integrated demonstrator consisting of a small cell equipped with photo electrodes composed of thin layers of III-V materials deposited onto silicon, placed under a trickle of water, and capable of producing hydrogen and oxygen under the effect of the sun's rays.

To be continued!

Will perovskite materials revolutionise the photovoltaics industry?

At Institut Foton, III-V semiconductors are not the only materials being put under the microscope. After a decade of research into perovskites, great new rays of hope for high performance, low cost photovoltaics are beginning to crystallise. Over the years, significant progress has been made in this field, and now, Jacky Even, physicist at INSA Rennes, is convinced that industrialisation is on the horizon.

Are perovskites exotic materials? On the contrary, this crystal structure is one of the most common on earth. As Jacky Even explains: « *We already knew that halide perovskites were sensitive to light, but the first perovskite solar cells were only invented in 2009, at the University of Tokyo. The results were rather disappointing, only 3.8% was converted into electricity, and degradation occurred with just a few seconds. So, the work carried out by the Japanese chemist, Tsutomu Miyasaka, never received the attention it deserved!* »

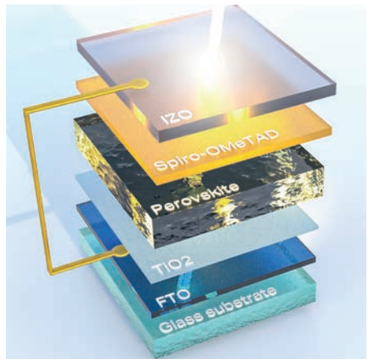
The intuition of a major breakthrough

Nevertheless, he mentioned his work to some European researchers. And bingo! Two articles were published in 2012, one from Oxford and one from Lausanne, demonstrating the benefits of perovskites for photovoltaics, and where the power conversion efficiency (PCE) exceeded 10%. Jacky Even points out that « *We were still far from the 26% observed with silicon in laboratories, but the fact of generating a strong electric current with a material which can still be perfected a great deal definitively convinced us to focus on this topic. It was already a major breakthrough!* »

In 2010, the physicist from Rennes had indeed already put together a simulation group to research this subject with Claudine Katan, Head of Research at ISCR (Rennes Institute of Chemical Sciences). For several years now, they have been working with three American laboratories: Los Alamos National Lab in New Mexico, Rice University in Houston, and Northwestern University in Chicago.

Efficiency close to that of silicon cells

When it comes to the importance of perovskites, Jacky Even and Claudine Katan were on the right track. Perovskites have created quite a buzz among the scientific



community, sparking thousands of publications per year. The power conversion efficiency of photovoltaic cells has really taken off. The current record is 25.6%, while only consuming small amounts of materials.

Perovskite layers measure 300 nm, which is 1,000 times less than the 300 µm of silicon based layers. The production costs are reduced because the production temperature of perovskite cells is only around 100°C (212°F), which means that perovskite cells are 20 times cheaper to make! In order to improve efficiency even more, some teams are exploring the use of “tandem” cells of different types. Through the combination of a layer of perovskites, which capture the high energy photons of the sun's spectrum, with silicon, which captures the infrared, low energy photons, an efficiency of 32.3% was achieved in 2022!

Obstacles overcome one after the other

There are a few hurdles, however, when it comes to perovskites. First, there's their instability, something Jacky Even and his team have been studying for several years: « *Working alongside our American colleagues, we have already proven that perovskites repair themselves when in the dark. In a study which will soon be published, the cells lasted 2,000 hours under controlled radiation and humidity conditions, thanks to the combination of two layers of perovskites, one of which is based on research published in the scientific journal,* Nature, *in 2016. Remember that in 2009, the cells which Tsutomu Miyasaka studied degraded in just a few seconds!* »

The second challenge to overcome is increasing the size of the solar cells. In laboratory conditions, they measure less than 1 cm2. However, as the size increases, the efficiency drops from 26% to 16%.

[1] Institut Foton : UMR CNRS 6082 - Université de Rennes 1, INSA Rennes, CNRS.
[2] ISCR : UMR 6226 - CNRS, Université de Rennes 1, ENSCR, INSA Rennes.

Laurent Pedesseau, Senior Lecturer at INSA Rennes, and Jacky Even, Professor at INSA Rennes and senior member of the Institut Universitaire de France.

« *We observed that the variety of perovskites used to extend photostability is compatible with the depositing methods for large surfaces, and it is promising to help prevent the reduction in efficiency.* »

The only problem remaining is the lead: An ingredient in the structure of perovskites offering as high as 26% efficiency. « *The quantities of lead are minimal, about per 0.5g/m2 of solar panel. The only issue is that European regulations forbid any new technologies which contain lead, whereas there are already a few grams of lead per square meter in silicon solar panels.* » The ban to use lead may not be unavoidable. The group headed by Jacky Even and Claudine Katan contributes to the European DROP-IT programme, which aims to replace lead with other compounds in the photovoltaic cells of the future. All we have to do now is wait until 2023 for the results!

Articles in prestigious magazines

The Franco-American partnership resulted in several articles being published in the prestigious journals, *Nature and Science*, and also enabled Jacky Even to be ranked amongst the most quoted researchers in the world on *Web of Science*.

Video streaming: How to reduce its environmental impact

More than 300 million tonnes of CO_2 per year: That's how much online videos emit, which is the equivalent of Spain, according to the think tank "The Shift Project". What's even worse is that online video traffic has quadrupled over the last five years. Faced with this unsustainable situation, the IETR (the Institute of Electronics and Digital Technology) is looking for ways to reduce the energy consumption of video streaming.

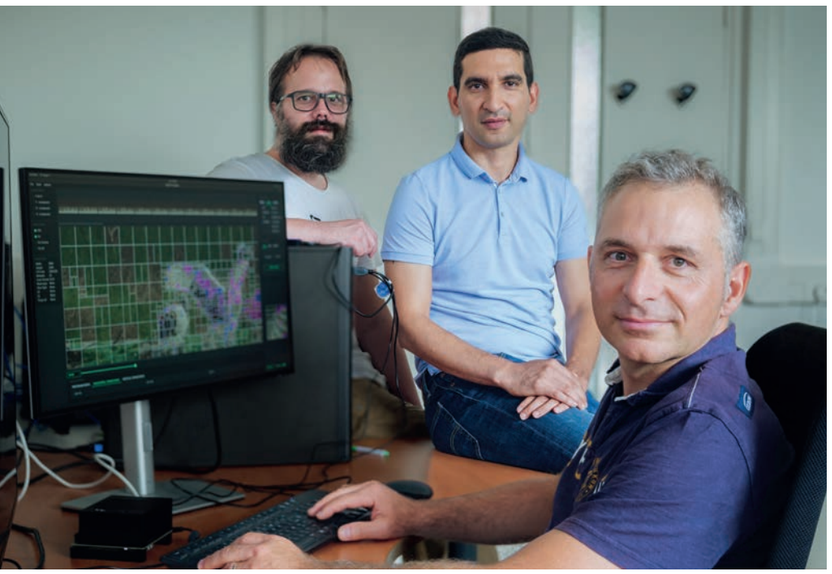
Do you spend more than one hour per day watching videos on your computer or smartphone? Be aware that this activity has a big impact on your carbon footprint. « *The use of videos is exploding,* explains Daniel Ménard, assistant director of the IETR in charge of the site at INSA Rennes, *with the rise of new services, such as video on demand (VOD), and video sharing websites (YouTube, TikTok...), in addition to new media formats which increase the data volume of videos: 4K, 8K, HDR[2], HFR[3]... And yet, these services use datacentres, networks and terminals, which consume a lot of energy and emit CO_2.* »

Each new standard brings a reduction in energy consumption

The IETR has been working on energy optimisation for video coding and video broadcasting systems, often in collaboration with companies based in Rennes. « *Particularly, Wassim Hamidouche, a current member of the international standardisation committee ITU/MPEG[4], who has developed a significant expertise in the standardisation of video coding* », points out Daniel Ménard.

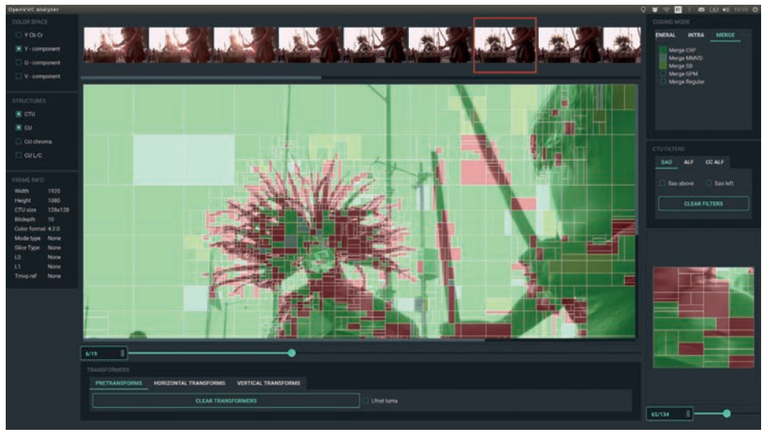
Each new standard enables us to half the amount of data compared to the previous standard, while maintaining the same video quality. Published in July 2020, the VVC standard (Versatile Video Coding) will enable us to reduce the energy consumption at the broadcasting end of the networks.

In order to help us decode this VVC standard, under the initiative of Wassim Hamidouche, the IETR's VAADER team (Video Analysis and Architecture Design for Embedded Resources) designed OpenVVC, a software decoder accessible to anyone who has a smartphone, without needing to wait for future processors with integrated decoders in order to watch a film. Nevertheless, optimising this decoder's energy consumption isn't an easy task, because the complexity of the decoding varies greatly over time.



[1] IETR : UMR 6164 - CNRS, CentraleSupélec, INSA Rennes, Nantes Université, Université de Rennes 1;
[2] High Dynamic Range, offering a wider range of colours and brightness.
[3] High Frame Rate, increased number of frames per second.
[4] International Telecommunications Union and Moving Picture Experts Group.

From left to right:
Pierre-Loup Cabarat, Research Engineer, and the leading developer of the open-source OpenVVC software;
Wassim Hamidouche, Senior Lecturer, HDR, Project Leader of the open-source OpenVVC project and Head of Video Coding within the VAADER research team of the IETR (Institute of Electronics and Digital Technologies);
Daniel Ménard, Deputy Director of the IETR – Head of the IETR's INSA site and in charge of the transversal research axis on Embedded Systems studied by the VAADER research team of the IETR.



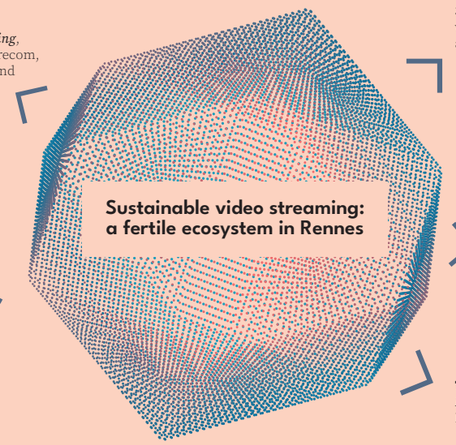
Reducing decoding and encoding complexity

In collaboration with Interdigital company, the IETR has been working on the encoder (used to compress the video stream) so that it sends metadata to estimate decoding complexity. This way, the decoder will use energy consumption reduction techniques better, such as controlling the processor frequency for example. « *Remember that back in the 90s, computers didn't get too hot because the processor frequencies were lower,* illustrates Daniel Ménard. *Obviously, they didn't perform as well. Nowadays, the goal is to find the lowest frequency capable of achieving the performance required to decode each image.* » The complexity shoots up for the encoder too: It's ten times higher than the with previous HEVC standard! So, the team has tried to reduce this by decreasing the search space of the video coding parameters using artificial intelligence technologies which are as little complex as possible. The IETR currently wants to define an energy model for the entire video broadcasting chain from the camera shooting to the viewer's smartphone, through the datacentre and the network. The idea is to estimate how much energy each part of the process consumes in order to reduce the overall environmental impact.

> ***Ten hours of viewing high-definition videos uses more data than all the articles in English on Wikipedia combined.***

« *Beyond technological progress, it would also be a good idea to change people's behaviour, so that everyone reduces their use of online videos,* concludes Daniel Ménard. *It is indeed surprising to see that the amount of video traffic on the internet is not slowing down, whereas the successive standards are reducing throughput. To prevent a boomerang effect, would the solution come down to raising social awareness or legislation? The debate is open!* »

Research at the IETR is generally carried out within the framework of close partnerships with players in the video industry, often from Rennes. Thus, the following projects have enabled works to be carried out focusing on the energy consumption of videos since 2017.



EFIGI, *Efficient Future & new Generation Video Coding*, with Thales SIX GTS, Vitec, ATEME, Ektacom, Eurecom, VideoLabs, LabStic, and financed by BPI France and Région Île-de-France.

3EMS et 3EMS2, *Energy Efficient Enhanced Media Streaming*, with Interdigital, ATEME, ENENSYS Technologies, and financed by Région Bretagne - FEDER (UE).

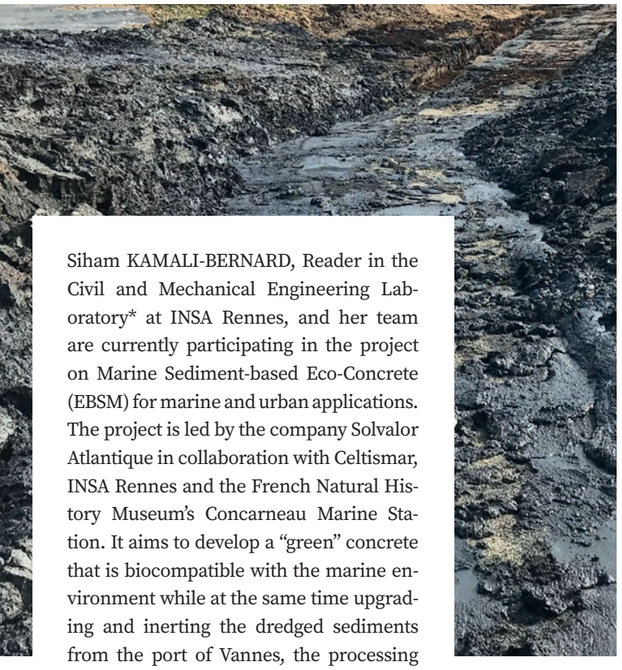
NESTED 5G, *New vidEo STandards for Enhanced Delivery*, with ATEME, Orange, Viaccess-Orca, ENENSYS Technologies, and financed by Région Bretagne – FEDER (UE).

DEEPTEC, *Delivery Over Energy-Efficient Processing and Transcoding in Edge Computing*, with TDF, Aviwest, and financed by Région Bretagne – FEDER (UE).

TRISTRAM, *TRansmission Intelligente et STreaming vidéo Robuste pour les Applications de la Mer*, with Ektacom, IMSolution, and financed by Région Bretagne – FEDER (UE).

Eco-friendly concrete made from marine sediments

photo story



Siham KAMALI-BERNARD, Reader in the Civil and Mechanical Engineering Laboratory* at INSA Rennes, and her team are currently participating in the project on Marine Sediment-based Eco-Concrete (EBSM) for marine and urban applications. The project is led by the company Solvalor Atlantique in collaboration with Celtismar, INSA Rennes and the French Natural History Museum's Concarneau Marine Station. It aims to develop a "green" concrete that is biocompatible with the marine environment while at the same time upgrading and inerting the dredged sediments from the port of Vannes, the processing of which is a major issue for the managers concerned. Solvalor Atlantique and its partners are hoping to use this marine sediment-based "green" concrete to design and produce artificial reefs, eco-friendly moorings and tetrapods as well as concrete urban benches to enhance the port of Vannes. The INSA team brings its expertise in the recovery of sediments in civil engineering as well as in the physico-chemical and mechanical characterisation of concrete. The success of the project will represent a major step forward, both in Brittany and at national level, in the field of sediment reuse and, more generally, in waste recovery.

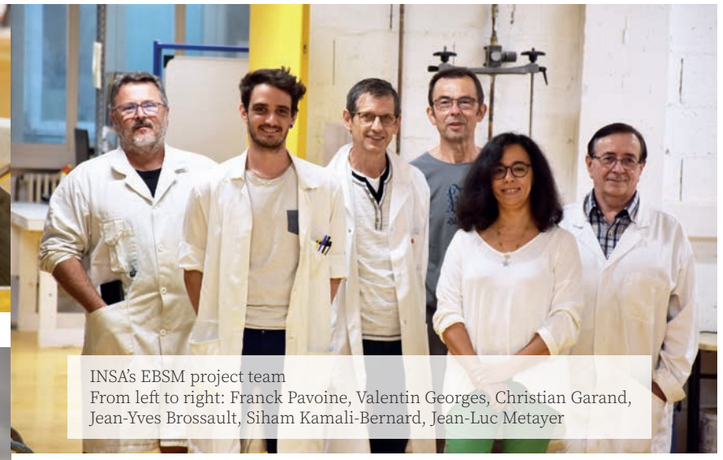
The project was accredited by the Brittany -Atlantic Maritime Cluster in 2021 and is supported by Brittany Region, the partner local authorities and the BPI (Public Investment Bank).

* LGCGM : Unité de recherche
INSA Rennes, Université de Rennes 1

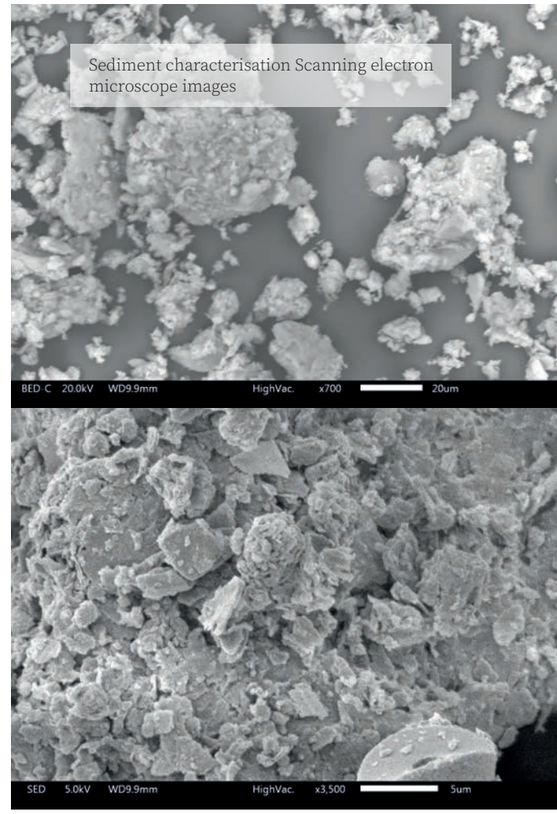
Storage basin for dredged sediments from the port of Vannes managed by the company Solvalor

Dredged sediments from the port of Vannes

Sediment samples in the laboratory



INSA's EBSM project team
From left to right: Franck Pavoine, Valentin Georges, Christian Garand, Jean-Yves Brossault, Siham Kamali-Bernard, Jean-Luc Metayer



Sediment characterisation Scanning electron microscope images

Specimens of EBSM concrete made of sediments from the port of Vannes and aggregates derived from treated land

Measurement of concrete workability

Did you know?

More than 30 million tonnes of marine and river sediments are dredged each year in France.

profile

Maud Marchal: Making virtual reality more « tactile »

Can we make people feel pressure, vibrations, temperatures or textures in virtual reality? This is exactly what Maud Marchal is focusing her research on. Full Professor in Computer Science at INSA Rennes and member of IRISA*, Maud is interested in the design of new haptic interfaces as well as their associated algorithms for interacting with virtual environments.

Native from Rennes, Maud Marchal left her home town for eight years; completing a PhD and then two post-doctoral fellowships. She returned to her homeland in 2008 to join IRISA (Research Institute of Computer Science and Random Systems) and INSA Rennes. « *INSA Rennes has the advantage of bringing together multiple disciplines, including mechanics and electronics, which are essential to my work. For me, it's a very rich ecosystem* ». Maud Marchal also collaborates with researchers in neurosciences, this time at the international level.

In recent years, there has been a significant resurgence of research into haptic interfaces and their algorithms. Up until now, she had been focusing on expensive sensor-based systems called force-feedback arms, which replicate what we call the "kinaesthetic" aspect of touch.

Simulating the sense of touch, a complex challenge

Then the arrival of virtual reality headsets, video game controllers and other interfaces accessible to the general public democratized this field, which also opened up to the entire professional world. This has encouraged new advances, particularly towards a more "tactile", virtual reality, as Maud Marchal explains: « *It is a question of stimulating the mechanoreceptors placed under the skin, to simulate pressure, vibration, temperature or texture for instance. But these sensations are very diverse, and the mechanoreceptors are present all over the body. So haptic interfaces are much more complex to design than those for sight or hearing.* »

* IRISA : UMR 6074 - CentraleSupélec, CNRS, ENS Rennes, IMT Atlantique, Inria, INSA Rennes, Université Bretagne Sud, Université de Rennes 1

An example of a new haptic interface attached to the hand of a user immersed in virtual reality in order to recreate the sensation of touch for virtual objects.

Depending on the objective, these interfaces can take the form of a ring, a jacket, or a device placed on the floor that will give the illusion of walking on sand or on a wet surface... Thanks to 3D printing, Maud Marchal and her colleagues can easily build prototypes to evaluate and improve them and then conduct user studies.

She also designs the algorithms associated with these new interfaces. « *They are very specific. In particular, if we want to simulate a « real » touch, they have to be four to twenty times faster than those used for visual rendering* ». The difficulty is even greater if we want to virtually grasp and manipulate deformable objects such as human tissue, fruit or clothing: the objects are not homogeneous and their properties change depending on the way they are held and used!

Use cases: medicine, industrial robotics...

Maud Marchal is specifically interested in the simulation of deformable objects, which opens up promising opportunities for tactile virtual reality. In surgery, for example, it could help the novice practitioner to train for an operation, or offer his experienced colleague the possibility of comparing several options before a risky operation. « *This field speaks to me,* says the researcher. *My thesis was dedicated to medical applications. And at one point, I was considering studying medicine before turning to computer science.* »

Another potential application is industrial robotics, with future robots endowed with a keen sense of touch. They could be able to delicately manipulate deformable objects such as fruit, cakes, cables or expensive costumes...

Research with international recognition

Her research is widely recognised by the international community. Indeed, since 2018, Maud Marchal has been a junior member of the prestigious Institut Universitaire de France, which distinguishes university professors for the excellence of their research. She co-leads the CNRS research group on Computer Graphics and Virtual Reality, which is 500 researchers strong. The researcher also contributes to the organization of major international conferences.

Her busy schedule also includes teaching computer science, computer graphics and virtual reality to students at INSA Rennes. « *I like to transmit and I like this teaching activity. I just regret that there are so few girls who choose to study computer science.* »

The six main dates of her academic career

- 2003: Double degree in Engineering from the School of Engineering in Applied Mathematics and Computer Science (ENSIMAG, Grenoble) and Master in Research from Joseph Fourier University, Grenoble
- 2006: Doctorate in Computer Science (Joseph Fourier University)
- 2008: Lecturer at INSA Rennes, researcher at IRISA (Institute for Research in Computer Science & Random Systems)
- 2014: Accreditation to direct research (HDR)
- 2018: Member of the IUF (Institut Universitaire de France)
- 2020: Professor at INSA Rennes

spotlight on

Tagging materials: an answer to the issue of recyclability?

In 2010, Olivier Guillou and Carole Daiguebonne, both teacher-researchers at INSA Rennes, together with Nicolas Kerbellec, founded the company Olnica whose activity centres around the properties of rare earth-based luminescent taggants. Within the space of a few years, the company has become a specialist in the fight against counterfeiting, forgery and theft in the industrial sector.

Collaboration between the research team and the company took a new turn in 2021 when they launched their joint laboratory ChemInTag (Chemical Inorganic Taggants). Two objectives were defined at that time: understanding the mechanisms governing the luminescence of rare earth-based coordination polymers and the search for new high-performance systems, along with technology transfer and the development of the most promising systems with a view to their commercialization. A few months ago Olnica joined the SOCOMORE Group, a leader in the field of specialty chemicals for industry, giving this long-standing collaboration new perspectives. Today, Olnica and its researchers are trying to find solutions to the shortage of materials and the issues surrounding recyclability by developing new applications.

Diverse perspectives on these new challenges.

**The Solid State Chemistry and Materials Team of the Rennes Institute of Chemical Sciences (ISCR – UMR 6226 - CNRS, University of Rennes 1, ENSCR, INSA Rennes)*

Carole Daiguebonne and Olivier Guillou work together on material identification

QUESTIONS *for*

Carole Daiguebonne, Senior Lecturer and Olivier Guillou, Professor at INSA Rennes

Your research work is now moving towards other applications. Can you tell us a little bit more about this?

Initially, our research focused on the fight against counterfeiting. Today, faced with the problem of recycling materials, another market is proving promising: material identification. Indeed, the same type of tag can be used since our tags are unique in that they can be integrated into the raw material, not just on labels or in paint. Identification tagging within raw materials, which few of us offer, takes on its full meaning here if we want to ensure the recyclability of the material.

Which materials does this cover?

Our tags burn and decompose at 500 C°, therefore they can only be used in industrial processes below that temperature. Plastics, rubber, fabric and paper all currently represent a huge challenge, however the niche we most believe in is unquestionably plastics. Mixing different plastics results in a recycled material that has lost some of its properties and which is used to make products with low added value such as bin bags, garden hoses, street furniture, etc. The idea is to refine the material recycling process in order to manufacture fewer products.

Do you already offer companies practical applications?

At the moment, we are only at the beginning of our prospection. We don't actually do the prospecting ourselves; in fact it is Olnica that approaches companies and then comes back to us with their problems and feedback. It is then up to us to transform this into a scientific problem which we try our best to address. That is the whole point of the joint laboratory.

Do you plan to establish a new Chair on this topic?

The societal aspect of our work is very important, which is why we are considering setting up a Chair that would in particular convince the general public of the importance of recycling. This transdisciplinary Chair could involve experts in the legal and societal aspects of this issue. It would also explain to students the relevance of our work for society. This is the training/research link that we are trying to develop via the joint laboratory.

QUESTIONS *for*

Nicolas Kerbellec,
Chief Operating Officer at Olnica

You are working with ChemInTag on the problem of the lack of raw materials and the recyclability of materials. What is your approach to this subject?

Recycling is a rich and extensive field. It will most certainly be one of the major topics at the World Plastics Trade Fair in Düsseldorf in October, in which we will be participating. Industrialists are short of raw materials and there is enormous pressure on industry because to sustain employment, we need to be able to produce, and to be able to produce, we need materials. However, it is essential to guarantee the quality of what we produce. In tomorrow's world, the objective is to replace the materials we use with other materials that have less impact on the environment and are more degradable. These materials will perhaps be reused by another industrialist who will, in turn, upgrade them.

How does Olnica fit into this recycling process?

A number of manufacturers are implementing private CSR recycling initiatives to reduce the environmental impact of their industries. The aim is to install a recycling process requiring the material to be marked from the outset, tracked and authenticated, with the guarantee at the end of the process that it is indeed this material that has been recycled. The concentrations of taggants are so low that the product itself is not affected by them.

Is plastics a growth sector?

There is so much plastic all around us that this material has become an important subject matter. Improving its recyclability in order to reduce its environmental impact and create new plastics is now a necessity. Whatever route plastics take (simple recycling, more eco-friendly innovative plastics recycling, or incorporating them into a secondary recycling process), they need to be differentiated and authenticated.

How can we convince industry of the need to reflect on this issue?

I am in contact with workers' trade unions who are ideally placed to disseminate information to their members, which is one of the key elements. But it sometimes takes time, because although the unions are easy to reach, it is sometimes more difficult to get industrialists to move forward on this issue. However, each of us can, in our own field of influence or professional domaine, create a system that allows us to recycle materials and reduce our impact on the environment. That is where traceability and the use of tracers comes into play. And it is necessary given the urgency of the situation.

About OLNICA

As an expert in consumer product traceability, Olnica enables brands to guarantee the authenticity of their products and the transparency of their origin. Olnica offers unique and innovative technology solutions capable of protecting corporate and government property, brands, products and supply chains in order to combat counterfeiting, fraud, embezzlement and theft. With its unique taggant, specific fluorophores, connected devices and cloud software, it provides every type of visible or invisible authentication system, ranging from a simple control system to taggants, all of which provide concrete evidence against counterfeiters. In April 2022, Olnica joined the SOCOMORE Group, a leader in the field of specialty chemicals.

OLNICA

in short

Metal 3D printer

The Chemistry-Metallurgy (C-Met) team of the ISCR laboratory (UMR CNRS 6226 - CNRS, University of Rennes 1, ENSCR, INSA Rennes) is going to be equipped with a machine for additive metal manufacturing using laser powder bed fusion. The objective behind this acquisition, which was financed through Rennes Metropole's Acquisition of Scientific Equipment grant scheme, is to enable the additive manufacturing of complex metal alloys.

The «Statistics and Health» Research Cluster Days

INSA Rennes is hosting the Statistics & Health 2022 Days on 17 and 18 November. This event, which is jointly organised by the "Statistics and Health" Research Cluster, the French Biometrics Society and the Biopharmacy group of the French Statistics Society, provides the numerous research teams working on these topics with the opportunity to exchange information and collaborate.

Three new emeritus professors

INSA Rennes congratulates its three new emeritus professors: Bruno Arnaldi (IRISA), Mireille Ducassé (IRISA) and Fabienne Nouvel (IETR).

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