MINA-NEWS
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MINATEC
NEWSLETTER
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TOP NEWS

Silicon can emit single photons at 1.28 microns

Irig was among the partners on a French national research agency *(ANR)* project that resulted in the on-demand emission of single photons in silicon at 1.28 µm, a wavelength used in telecommunications. They did it by introducing carefully-engineered defects into the material. The goal is to integrate this photon source into CEA-Leti chips for quantum communications.

There is certainly no lack of research on point defects in silicon and, specifically, light-emitting defects formed by carbon pairs interacting with interstitial silicon atoms called G-centers. However, it had never been posited that these defects could emit single photons. The Octopus project implanted G-centers into the silicon and demonstrated that they could emit single photons. The findings were published in *Nature Electronics*.

A POTENTIAL ENABLER OF QUANTUM COMMUNICATIONS

The G-center the researchers engineered turned out to be a very efficient source of photons that could potentially be embedded into chips. Using an external source to generate photons and then injecting them into the chip creates line losses. Single photons, however, are not affected by these reamplification issues.
The partners are now working with CEA-Leti to integrate the G-center into a chip to assess its potential for quantum communications. They are investigating the degree of spin freedom of isolated G-centers embedded in membranes of silicon 28, a spinless isotope.
The G-center could be a future single-spin quantum memory, capable of storing the state of a single photon.

jean-michel.gerard@cea.fr

INNOVATION

New ultra-low-power shape recognition

A new shape-recognition sensor developed by CEA-Leti and STMicroelectronics is making headlines for its extremely-low power consumption, which, at 10 microwatts, is 1,000 times lower than commercially-available solutions. Five years in the making, the innovation is protected by a handful of patents on its pixel reading mode, data formatting, machine learning algorithms, optimized architecture, and other distinguishing features.

The active standby system allows the sensor to wake up when it detects movement and recognize a class of previously-learned shapes, such as faces, without the need for an external controller. These capabilities are a perfect match for smartphone integration. The device could also be of use in home automation, building surveillance, and automotive applications.

camille.giroud@cea.fr

Pentagons magnetically frustrated, but still fairly well-organized

Magnetic frustration is a phenomenon resulting from competing constraints in a material, such as when an atom's magnetic moments want to organize themselves in antiparallel pairs, but can't due to their geometry. This causes matter to organize itself in complex fundamental states. Researchers have been studying magnetic frustration in triangles, for example, for decades.

In a world-first, researchers from Irig identified a pentagonal lattice of magnetic atoms, demonstrating that the magnetic moments in iron oxide atoms are organized at 90-degree angles to each other. In addition, this pentagonal lattice is organized around a pair of magnetic moments whose bond is stronger and, therefore, not as sensitive to variations in magnetic field or temperature. This pair controls the ordering of the magnetic moments, even in the presence of magnetic frustration.

eric.ressouche@cea.fr

Spin Hall effect observed in a ferromagnetic material

The spin Hall effect, where a charge current is transformed into a spin current, has been amply documented, but only in non-magnetic materials. Researchers at Spintec wanted to know if the effect could be observed in ferromagnetic materials. Specifically, they have been looking for the reverse spin Hall effect (spin current to charge current) in a copper-nickel alloy. Whether the ferromagnetic alloy was cold or heated, causing it to lose its permanent magnetization, the effect was present to the same degree.

The spin Hall effect can be used to reverse the magnetization of memory and will play a role in the design of beyond-CMOS devices. The idea now is to expand the range of materials that could produce the effect. The research is ongoing. Up next: electrical transport measurements.

jean-philippe.attane@cea.fr | laurent.vila@cea.fr

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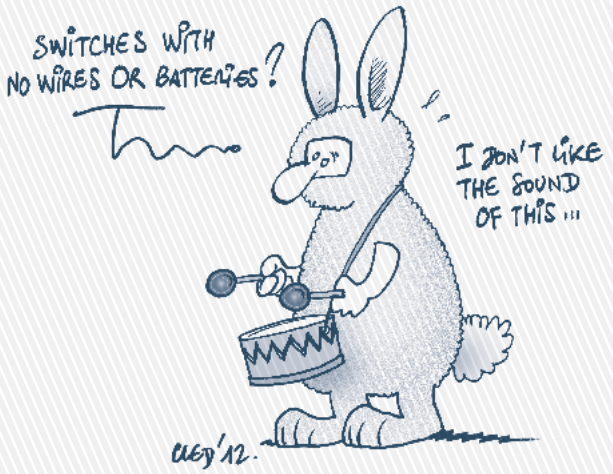
3 parvis Louis-Néel, 38054 Grenoble Cedex 9 France



Wireless, batteryless lighting and roller shutter control

Electrical equipment manufacturer Legrand, CEA-Leti, and CEA-Liten recently unveiled their new wireless, batteryless connected switch technology. This thrice-patented innovation took several years to develop and is different from competing solutions in several ways. First, it leverages an advanced electromagnetic energy harvesting system for a final product that is 17 dB less noisy and that requires half the force to activate. Second, it is 2 mm thinner than competing solutions, an important consideration when it comes to design and aesthetics.

Last, but not least, these new wireless, batteryless switches could save more than a ton of batteries each year. Legrand plans to release the products (which will be sold to consumers and professionals) by summer.

camille.giroud@cea.fr

Infrared holography could provide faster, more accurate cancer diagnosis

Diagnosing cancer from a biopsy currently takes between two days and two weeks. A PhD research project underway at CEA-Leti could help make analyzing biopsies faster and more accurate. The non-operator-dependent method would utilize infrared holography, taking advantage of the specific absorption wavelengths of the DNA, proteins, amides, and other biochemical molecules characteristic of biological tissue samples.

Instead of the current methods, which depend on electromagnetic absorption by water, the approach proposed here would enable *in vivo* testing. The research is ongoing, and should confirm the potential of this method to identify cancerous tissue in a variety of biopsy samples. One final advantage: It does not require sample preparation.

camille.giroud@cea.fr

Hydrogen could prevent Covid-19-related runaway inflammation

TIMC (a CNRS-Grenoble-Alpes University lab) recently kicked off its HydroCovid clinical trial. The goal is to evaluate the effects of hydrogen-saturated water* on Covid-positive patients over age 60 well enough not to require hospitalization. Several studies show that hydrogen could mitigate the runaway inflammatory response that sometimes occurs as a complication of Covid-19.

If HydroCovid is a success, it could lead to future trials involving the administration of hydrogen-enriched saline. Losses of hydrogen, a highly-diffusive gas, will be substantially reduced thanks to LEPMI's materials specialists, who helped select the material for the IV bag, catheter, and distribution method and create the protocol for injecting the hydrogen into the bag.

**Hydrogen is the common name for dihydrogen (H_2)*

Participate in the trial: http://hydrocovid.imag.fr/

marian.chatenet@grenoble-inp.fr

Microwire and quantum dot could connect two worlds

An 18 µm conical gallium arsenide microwire with a quantum dot at its base could one day help connect the traditional and quantum worlds. This novel device was developed by a research consortium* that included scientists from Irig. The advance could pave the way toward the development of ultra-sensitive sensors and quantum information technologies one day.

When the quantum dot is excited by a laser pulse, its volume expands slightly, causing the wire to bend. When the optically-induced excitation is repeated at the wire's resonant frequency, vibration can be induced and measured. Ultimately, they would like to "print" the dot's quantum state on the mechanical oscillator.

**Institut Néel, ENS Lyon, University of Campinas (Brazil), and University of Nottingham (Great Britain)*

julien.claudon@cea.fr | jean-philippe.poizat@neel.cnrs.fr

Germanium-laser-on-silicon contacts could become more stable

Optronics researchers love the idea of germanium lasers on silicon—but the devices' contacts are highly thermally unstable. In a world-first, a PhD research project being conducted at CEA-Leti has explained this unpredictable behavior. PhD candidate Andrea Quintero has published ten papers on the phenomenon over the past three years, even winning a Best Paper Award at ECS Prime 2020.

Germanium is an indirect gap material, so it must have tin content of 10% or 15% to deliver the desired optical performance. However, a heating process used to fabricate the contacts exposes them to temperatures that cause tin segregation. Andrea utilized several pieces of equipment at the Nanocharacterization Platform (PFNC) to observe and formally describe the diffusion of tin towards the surface of the material.

Go to the article: https://doi.org/10.1149/09805.0365ecst

camille.giroud@cea.fr

New mustard-gas assessment can be used up to fourteen days after exposure

Mustard gas has been banned by international treaties. However, it does remain a threat in certain armed conflicts and could potentially be used by terrorists. Scientists at Irig, who have been studying the effects of the gas for years, recently developed* a method for measuring the dose received. It can be used up to fourteen days after exposure. It is also simpler and provides more complete information than the techniques currently in use.

This method, which targets the metabolites produced when mustard gas interacts with an intracellular antioxidant, glutathione, has been tested with success on cells in culture, skin tissue, and animal blood plasma. It could make a real difference in providing

an accurate exposure assessment, crucial to prescribing effective treatment and limiting long-term negative health effects. It is used in addition to the non-quantitative assessment of eye and skin damage.

**With CEA-Joliot (Saclay) and France's military biomedical research institute*

thierry.douki@cea.fr

STT-MRAM memory cells under under the microscope

For the past four years, Spintec has been working on a STT-MRAM memory point geometry that eliminates an etching step that degrades the magnetic layer. Their research required in-depth knowledge of the magnetic behavior of the memory points, which are deposited on 230 nm pillars spaced 400 nm apart. So, they went to the Nanocharacterization Platform (PFNC) to use the Titan™ Ultimate transmission electron microscope.

The electron-holography images obtained showed that if memory points absorb the magnetic flux generated by adjacent points, they "talk" to each other. However, if they line up in the same direction when a magnetic field is applied, the memory works as intended. The magnetic layer is deposited on the substrate in between the pillars. The Titan™ images showed that the magnetic layer's large surface area allows it to absorb the magnetic flux radiated by memory points.

aurelien.masseboeuf@cea.fr | david.cooper@cea.fr

Smart window films boost indoor cellular service

Windows with insulating glass are good for your energy bills, but bad for cellular reception. This type of glazing can attenuate cellular signals by 30 dB to 45 dB. Fortunately, IMEP-LAHC spinoff Lichens has a solution! The company's smart plastic window films can mitigate signal attenuation by around 15 dB—enough to restore network service.

The innovation, which has been patented for Europe, the United States, and China, leverages clever patterns printed with a conductive metal ink that resonates with the glazing's conductive layer. The film simply peels off for cleaning and will be easy to replace with a future 5G-compatible version. The product's commercial release is slated for 2022 but Lichens is looking for test sites now. Interested?

tan-phu.vuong@grenoble-inp.fr | francois.vincent@lichens.io

DAY BY DAY

Phelma engages students through flipped classrooms

Grenoble INP-Phelma faculty members Fanny Poinsotte and Nicolas Ruty have been using flipped classrooms to teach their electronics classes for three years now. They are both contributing to a project called CHA(I)Se to encourage more active learning and group work. Four classrooms at MINATEC and two on the Grenoble-Alpes University campus have been equipped for this kind of learning through the project, which is financed through the French government's IDEX educational initiative.

The traditional classroom furniture was replaced with much more modular six-person tables and movable chairs. The classrooms also got new displays, touch screens, and moveable whiteboards. This type of classroom—in high demand from both faculty and students—is removing the physical barriers to more student-centered learning at Phelma.

fanny.poinsotte@grenoble-inp.fr

Eagerly-awaited ferroelectric tester arrives at G2Elab

G2Elab recently acquired a particularly buzz-worthy piece of characterization equipment. The eagerly-awaited TF3000, a state-of-the-art ferroelectric tester from aixACCT, will also be useful to scientists at TIMA, LTM, and LMGP. The tester will provide a host of new characterization capabilities that scientists will be able to use to test solid materials and thin films, evaluate polarization and electrical hysteresis cycles, and conduct endurance and aging testing over millions of cycles. The TF3000 is fully automated, offering precision, repeatable test conditions and archiving all results.

Located at CIME Nanotech, the equipment has been included in the open-access WFNT OPE)N(RA platform. It has been up and running since December.

skandar.basrour@univ-grenoble-alpes.fr
alain.sylvestre@g2elab.grenoble-inp.fr

Radiobiology: X-ray generator delivered to Irig

Irig recently received a 250 kV X-ray irradiator with a maximum dose rate of 10 Gy/min. The new equipment is dedicated to the CEA's radiobiology program, where it is being used by the four Irig labs that provided the funds for the purchase. The labs are investigating the effects of low doses on cells and DNA. They are also studying the behavior of radioresistant bacteria that repair their DNA after exposure to radiation.

Before the new X-ray generator was purchased, the labs had been using the cobalt 60 sources at Arc Nucléart and, much more occasionally, the beamlines at ESRF. This X-ray generator only emits radiation during operation, making it an excellent solution for the work Irig is doing. Outside scientists will also be eligible to use the equipment.

jravanat@cea.fr

LIVE FROM MINATEC

Four renovation projects will improve building energy performance at CEA-Grenoble

Four CEA-Grenoble buildings (40, D5, C4, and D4) will be rehabilitated to improve their energy performance. The work, financed to the tune of €12 million through the French government's economic recovery package, will kick off this year and be completed in 2022 and 2023.

Building D5, home to Irig lab facility, will get an all-new insulated roof. The roofs and façades of all four wings of Building 40, home to a clean room and CEA-Leti office space, will be renovated and insulated. The other projects will take place at CEA-Liten. The C4 building project will focus on the north-facing façade and the replacement of certain HVAC* equipment. The D4 building will get roof repairs and improvements to boost the thermal performance of the building envelope.

**Heating, Ventilation, and Air Conditioning*

thierry.vignon@cea.fr

THIERRY BARON,
director of LTM,
the lead on the Need for IoT* project:

"More economical use of materials now a priority for the microelectronics industry."

MINA-NEWS: What is the rationale behind Need for IoT, a joint project between Grenoble-Alpes University, Grenoble INP, CNRS, and the CEA?
Thierry Baron: The idea for project, which launched in 2018, came from scientists at LTM and CEA-Leti. They wanted to head off the problem of dwindling cobalt, gallium, indium, germanium, and platinum supplies to mitigate the impact on the microelectronics industry and, especially, on IoT devices. The average smartphone contains dozens of these and other critical materials, most of which come from China, South Africa, and Latin America.

MINA-NEWS: This is nothing new. What makes your approach to the problem different?
TB: There have been supply chain concerns in the energy industry for a long time. However, the microelectronics industry started looking at the supply chain much later. In 2018, when we initiated this project, the industry's main focus was still performance. We have eight PhD dissertations underway, with research taking place in ten labs. Our main innovation lies in our approach, which combines the physical sciences, the focus of five of the dissertations, and the humanities, the focus of the three other dissertations.

MINA-NEWS: Two years in, do you have any results to report?
TB: A photodetector demonstrator which contains at least 1,000 times less critical materials (GaSe, InSe), albeit with lower performance, was built as part of one of the PhD projects. Solutions that are ready to scale up are still five to ten years away, so we will have to be patient. The Need for IoT project also produced a webinar for the general public and a serious game for college students and businesses. This is a topic that concerns everyone. ■

**Learn more about Need for IoT: bit.ly/MINATEC_NeedforIoT*

thierry.baron@cea.fr

Clinatec Endowment Fund kicks off R&D programs

The Clinatec Endowment Fund is now running its own R&D programs at Clinatec leveraging CEA know-how and technologies. The change comes after Clinatec began offering contract R&D services to companies. Donations to the Clinatec Endowment Fund must be used separately from these contract R&D budgets and be allocated solely to public-interest projects.

The Endowment Fund has already kicked off research to identify the top needs of tetraplegic patients to guide future technology R&D, a project on the mechanisms triggered by neuro-illumination and DBS*, and, finally, the COVEA Neurotec project. This last project applies the photobiomodulation techniques used to treat Parkinson's disease to Alzheimer's.

**Deep Brain Stimulation*

thierry.bosc@clinatec.fr

HORIZONS

Quantum: New silicon qubit tester will save years

A silicon qubit tester recently acquired by CEA-Leti will substantially speed up quantum computer research. The tester can measure the electrical performance of several hundred qubits processed on a 300 mm wafer at 1.7 K (–271.3°C). The qubits that make it through these tests will then be tested individually on a cryostat at Institut Néel at temperatures below 100 mK, a requirement for integration into quantum processors.

It takes several months to fabricate a wafer of qubits at CEA-Leti, and several more months to unit-test them at Institut Néel and Irig. Therefore, the time this batch testing step will save the CEA-CNRS silicon quantum program will be measured in years. There are only two testers of this kind in the world. The other one is at Intel in the United States.

camille.giroud@cea.fr

Grapheal raises €1.9 million for its digital biosensors

Startup Grapheal, founded in 2019 by scientists at Institut Néel, recently raised €1.9 million in capital. The influx of funds will go to R&D and clinical trials of the company's flagship smart dressing for chronic wound monitoring and fast Covid-19 saliva test.

Both products are built on the same sensing device engineered from an atomic layer of graphene on a flexible circuit connected to a RFID chip. The smart dressing monitors wound healing and detects infection without having to remove the dressing. The fast Covid-19 saliva test turns results around in just five minutes. Competing tests take 15 to 30 minutes. Tech-transfer service provider Linksium licensed three patents to Grapheal. This IP forms the company's core technology. Improvements to the technology are ongoing, including through a partnership with CEA-Leti.

vbouchiat@grapheal.fr

CEA Grenoble Director Bruno Feignier rolls out his roadmap

Management of the CEA's Grenoble campus is now part of the CEA's national organization. Bruno Feignier was appointed as Director of CEA Grenoble in January. Bruno will represent the CEA-Grenoble employer brand and oversee implementation of a roadmap that encompasses occupational health and safety, asset management, strategy, social and environmental responsibility, workforce planning, and budgeting.

Health and safety, important in normal times, have taken on a new urgency. Recent Covid testing and vaccination campaigns have highlighted just how crucial the CEA-Grenoble occupational health department is. Another priority will be to rehabilitate CEA-Grenoble buildings and common areas. This year, four building rehabilitation projects to improve thermal performance have been financed through the French government's economic recovery plan.

bruno.feignier@cea.fr

Becton Dickinson now a Grenoble INP-Phelma partner

The French subsidiary of Becton Dickinson (BD), a leading global manufacturer of medical and diagnostic equipment, became a Grenoble INP-Phelma partner in late 2020. BD develops and commercializes innovative solutions for medical research and improved patient care. Over the next three years, the company will play an active role in campus life and support student career placement.

BD is the first Grenoble INP-Phelma partner from the biotechnology industry. It will be especially beneficial to undergrad and graduate students in the materials science and engineering, biomedical engineering, nanomedicine, and structural biology programs.

Grenoble INP-Phelma also recently extended its partnerships with LYNRED and CS Group, bringing the total number of corporate partners to fourteen.

aurelie.dinola@grenoble-inp.fr

Internet of Things: Making security better, together

The European DigiFed project, coordinated by CEA-Leti under the IRT Nanoelec* technology research organization, brings together sixteen European SMBs around cybersecurity for IoT applications. Specifically, the project partners are investigating the use of STMicroelectronics' STM32MP1 microprocessor to enhance the security of embedded software.

Each SMB partner brings a unique use case with its own communication protocols and secure software. Over the next year, CEA-Leti will delve into these use cases to develop a solution effective at keeping hackers out. Several of the participating companies are from the Auvergne-Rhône-Alpes region and specialize in sensors for healthcare and smart cities applications.

**Financed in part by the Auvergne-Rhône-Alpes regional government*

camille.giroud@cea.fr

Maxime Leprince's mouth-watering Three Minute Thesis

Maxime Leprince, who is doing his PhD at CEA-Leti's DTBS and CNRS lab CERMAV, earned great reviews for his Three Minute Thesis. After coming through the regional finals with flying colors, he went to the French national semifinals on April 1, where, unfortunately, his adventure came to an end.

Maxime, who is developing conductive and resorbable inks and hydrogels for biological tissue stimulation and monitoring, very creatively laid out his research like a recipe. He will defend his dissertation in polymer sciences at the end of September and is currently designing intracranial electrodes with one major unique feature: They can be absorbed by the body. Ultimately, the innovative biomedical solutions Maxime is helping develop could be used to treat Parkinson's disease or epilepsy.

https://urlr.me/z1kfC

camille.giroud@cea.fr

Covid and equal opportunity: Phelma remains vigilant

Grenoble INP-Phelma has been working hard to ensure that all students and, especially the most vulnerable, have been getting the help they need since September.

Financially-needy students benefited from fifteen laptop computers on loan from the school so that they could keep up with their online classes. And, to keep people connected, the school did everything it could to get students and faculty back on campus as soon as possible. Very strict safety measures were implemented to bring around 30 students whose financial, social, and technological circumstances make them particularly vulnerable back to campus starting in mid-November. In particular, lab classes were held at school and, to make sure the playing field was level for all students, almost all exams were held in person.

christine.morales@phelma.grenoble-inp.fr

CONTACTS

MINATEC

MINA-NEWS is published by MINATEC 3, parvis Louis-Néel – 38054 Grenoble cedex 9, France
Head of Publication: Jean-Charles Guibert - **Editor-in-Chief:** Julie Spinelli
Contributors: Camille Giroud, CEA-Leti, *camille.giroud@cea.fr*
Nathalie Mathieu, Phelma, FMNT, *nathalie.mathieu@phelma.grenoble-inp.fr*
Patrick Warin, IRIG *patrick.warin@cea.fr,* Julie Spinelli, MINATEC, *julie.spinelli@cea.fr*
Alexis Sableaux, Phelma, *alexis.sableaux@phelma.grenoble-inp.fr*
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