MINA-NEWS
#60
MINATEC
NEWSLETTER
JULY'20

TOP NEWS

Compact tunable antennas for IoT devices

What if IoT antennas could be made even smaller without compromising efficiency simply by tuning their frequency? A PhD candidate at CEA-Leti did just that! She also developed an analytical model that is as reliable as today's simulators.

CEA-Leti fabricated an antenna whose size is no more than 1/15th of the wavelength, compared to the usual size of around 1/4 of the wavelength. The antenna maintains high radiation efficiency by instantly covering only the band of the signal emitted, around 500 kHz.

To cover the rest of the band used in the target application, the antenna's frequency is tuned by a fast digital management module for RF components designed at CEA-Leti and integrated into the antenna.

MANUFACTURERS HAVE ALREADY EXPRESSED INTEREST

Rana Berro, the PhD candidate who did the research also bumped up against another hurdle: The available electromagnetic simulators were not well-suited to investigating the impact of ohmic losses in miniature antennas. So, she solved that problem, too, by developing a faster analytical model to study impedance and radiation efficiency. She used the model to run even more tests and improve the dimensioning and position of the components on the radiating element.

A patent was filed to protect the antenna miniaturization technology, which has already garnered interest from several manufacturers. Berro will spend the last year of her program fabricating and testing prototypes. She won a special award for her research at IWAT2020 in Bucharest in February.

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LIVE FROM MINATEC

Life is gradually returning to normal on campus

France began easing its Covid-19 restrictions almost two months ago. As we move into summer, life on the MINATEC campus is gradually returning to normal. Grenoble Institute of Technology-Phelma students will not return to campus until at least September. The school's faculty and staff are back, however, but with a maximum of 40% of a given department's personnel allowed at work the same day. The rationale behind this very gradual return is to give everyone an opportunity to get accustomed to taking the necessary precautions so that the school can be up and running 100% safely in September.

FMNT is also using the 40% rule, with staff coming in on a rotation. PhD candidates, interns, and, more generally, anyone who needs to do lab work, is given priority.

The CEA brought staff back in waves: first, employees tasked with restarting equipment, then scientists, then other categories of staff. As of July 6, work-on site will be considered standard practice (unless it is not possible).

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INNOVATION

Covid-19 vaccine: CEA-Leti and its Lipidots® drug delivery system out in front

CEA-Leti and IAB* started work on a Covid-19 vaccine. Their strategy is to attach SARS-CoV-2 messenger RNA to Lipidots®, the oil microdroplets designed at CEA-Leti. Lipidots® are the same size as the virus and have a strong affinity for the dendritic cells that trigger an immune response. And, because Lipidots® are very stable, they should reach their final destination intact.

The mRNA strategy is already getting results in preclinical trials run by other organizations, like Moderna Therapeutics in the US. Now the researchers just have to find the ideal vector, and that could be where Lipidots® will make a real difference. The goal for the Grenoble-based LipiVAC COVID19 vaccine development project is to successfully complete preclinical testing within a year.

**Inserm/CNRS/Grenoble-Alpes University*

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Tomorrow's spintronics could use 1,000 times less energy

Researchers from Irig-CNRS and Thales published a breakthrough advance in spintronics in *Nature*. Rather than manipulating spin with a nanomagnet, they selected a ferroelectric material to do the job. Their novel approach uses 1,000 times less energy to write information.

Like for ferromagnetic materials, the information stored is non-volatile (it is stored without the need for additional energy). The polarization state of the ferroelectric element can be read without depolarizing, eliminating one of the habitual problems with ferroelectric RAM.

The researchers will now turn their attention to reproducing these effects, which they observed at 45 K, at ambient temperature.

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Haptic interfaces: Wafer-level manufacturing just around the corner

Touch interfaces can now effectively simulate the feel of sand, fabric, or a control panel button, an advance made possible by placing ceramic piezoelectric switches on a screen and making them vibrate at several dozen kHz. However, the switches must be bonded to the screen manually, which increases production costs. CEA-Leti has found a solution in the form of a 200 mm wafer-level fabrication technique.

The 300-micron-thick ceramics were eliminated. Instead, a thin layer (under 3 microns) was used, making integration much simpler. This step also enables several subsequent steps to augment the performance of the materials, deposit a transparent piezoelectric layer, and apply the layer to the entire screen. A demonstrator of the technology can be seen at the Y.Spot showroom.

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Their work lays the foundations for ferroelectric spintronics, which could enable innovative new low-power memory, neuromorphic components, and more.

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Irig's electronic nose is now even more discerning

Irig's electronic nose, which was transferred to startup Aryballe Technologies, now has an even broader range of uses. But first it will have to be usable in the field and at wider temperature ranges. Researchers at Irig redid some of the basic science on the device, comparing theory with lab testing results.

They looked at the influence of the emission source wavelength on the system's sensitivity. They also probed the impact of the thickness and roughness of the metal layers where the biosensors that capture odor molecules are housed. Finally, they came up with a method for characterizing the optical performance of the prism at the heart of the electronic nose. Their results will be used in a PhD research project to design a temperature calibration method suitable for measurements in the field.

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LEDs could soon promise mercury-free UV

What if LEDs could be used instead of mercury*-vapor lamps in a wide range of bacteria-killing UV devices? Researchers from Irig and Institut Néel recently made a major step toward mercury-free UV lamps. They successfully and significantly augmented a UV LED's p-type doping level of aluminum nitride (ALN) by adding a small fraction of indium to the magnesium, the doping material. They also structured the ALN into nanowires, rather than thin layers, facilitating the relaxation of strain generated by the dopant. An ALN nanowire p-n junction was fabricated and two patents were filed.

This advance could lead to a solution to the main issue with today's LED UVs: their low efficiency (the ratio of photons emitted to charge carriers injected). A PhD dissertation on research demonstrating the approach on an entire LED is forthcoming.

**These will ultimately be phased out under the Minimata Convention on Mercury (2017)*

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Photovoltaics: Looking at the instabilities that affect hybrid perovskites

Hybrid perovskite photovoltaic cells can deliver yields of more than 20%. However, they do not age well. Researchers from Irig and INES joined forces to investigate the mechanisms that underpin the formation of the best-known hybrid perovskite, $MAPbI_3$*, which is synthesized in thin layers.

The research revealed two things that explain the behavior of cells made from these thin-layer materials: First, the intrinsic instability of $MAPbI_3$, which breaks down under mechanical strain (here, it is linked to the spontaneous appearance of $MAPbCl_3$, a chlorinated perovskite phase); and, second, the substantial variability in the material's lattice structure.

New and more complex materials derived from $MAPbI_3$ but with the promise of greater stability will benefit from this novel approach.

**methylammonium lead iodide*

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Power electronics: GaN module sets new records

CEA-Leti developed a packaging for its new GaN (gallium nitride) power components that could unlock the components' full potential. The two-sided cooled module stands out for its extremely low parasite inductance. The risk of overvoltage is reduced, allowing switching at 350 V and 10 A, and a switching speed of 15 ns. The researchers think that their chances of obtaining even better performance in an upcoming round of tests are good.

The module was fabricated with CEA Tech Toulouse and Aspi3D, which contributed two technology bricks. The architecture can still be improved and fine-tuned for even more powerful components. Ultimately, the module could be used in electric-vehicle inverters which require power of 100 kW to 150 kW.

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Detecting SARS-CoV-2 in the air in just 30 minutes

The Flash Arise project, funded by France's national research agency (ANR), was set up to develop a solution for detecting SARS-Cov-2 droplets or aerosol in the air within a maximum of 30 minutes. CEA-Leti and the Institut Pasteur are engaged in the project, which kicked off in March. The partners' hope to be able to bring a portable automated analyzer to hospitals and retirement homes by July 2021.

The target solution will be built on an electrostatic air sample collector and a microfluidics module. CEA-Leti, which has already fine-tuned both technology bricks, will now tweak them to meet

the needs of this project. The major challenge at this point is that samples will have to move from the collector to the microfluidics module automatically.

While CEA-Leti tackles the device, Institut Pasteur is working on biological reagents for *in situ* viral RNA detection. Institut Pasteur will also test the system when it is completed.

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A new and sustainable photoelectrode for hydrogen production

Researchers from Irig, Institut Néel, and EPFL in Lausanne developed a sustainable electrode for the production of hydrogen by photoelectrolysis, a CO_2-free process. This photosynthesis-inspired innovation uses non-toxic and abundantly-available materials, and features a p-type semiconductor interface that absorbs light with a molecular catalyst.

The semiconductor material, a copper iron oxide, is covered with a nanometers-thick layer of titanium oxide deposited using ALD. The cobalt-based catalyst is placed on top of this layer. The system can produce hydrogen from aqueous solutions.

This hybrid architecture is a breakthrough innovation that is still at the basic research stage. One aspect that must be substantially improved is current density.

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CEA-Leti engaged in EU project to develop neuromorphic processor

CEA-Leti is developing a ferroelectric tunnel junction for the EU Beferrosynaptic project, which kicked off in early 2020. The junction could become the core component of tomorrow's neuromorphic processors. Neuromorphic processors or chips differ from conventional chips in that memory and computing resources are very tightly integrated, just like in the human brain. Plus, they could use 1,000 times less energy than conventional chips.

The researchers chose a material called hafnium oxide, which is already used in CMOS devices. But using the material in tunnel junctions does raise some new challenges, like understanding crystal formation, controlling the thin-layer deposition process to within 1 nm, and selecting the operating voltages. To overcome these hurdles, CEA-Leti will leverage the advances of another EU project on hafnium oxide it has been working on since 2018.

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Tiny FlexAmes for flexible energy storage and harvesting

Integrating energy storage and harvesting into a single system is not all that common. Doing it in a system that measures just a few square centimeters is even rarer. Now make the 1-millimeter-thick system flexible so that it can hug any shape, and you get something truly exceptional. Tiny Flex-Ames, developed by the EU EnSO project consortium, which includes CEA-Leti, does just that. The demonstrator includes a 10 mAh lithium-ion battery (up to 500 cycles), a printed antenna for wireless NFC charging, and an integrated power management circuit.

With ten patents behind it, Tiny Flex-Ames is ripe for the connected device market, where self-powering solutions are becoming increasingly sought-after. CEA-Leti and its partners are allowing manufacturers to customize the device to meet their needs.

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DAY BY DAY

FMNT: Catherine Lo Cicero wins CNRS Crystal Medal

Catherine Lo Cicero, who has been FMNT's Chief Financial Officer since 2018, will receive one of 23 Crystal Medals to be handed out in 2020 at a ceremony in the fall. The Crystal Medals are awarded to research support staff members whose creativity, technical expertise, and sense of innovation contribute to the excellence of research in France.

Lo Cicero earned kudos for the key role she played implementing management tools to allow 120 pieces of equipment to be made available on an open-access basis at the FMNT OPE)N(RA functional characterization platform. Her mission is to ensure that OPE)N(RA's financial accounts can be certified. However, she had a much broader impact. The tools she set up will allow academic and industrial partners to allocate the costs of using the platform to research budgets funded through French national and EU financing instruments.

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Masters in nanotechnology students go deep inside ESRF and ILL online

The Covid-19 lockdown in France took some of the spice out of the Grenoble Institute of Technology-Phelma Masters in Nanotech program this year. Students usually get to do lab classes at ESRF, ILL, and CIME Nanotech. The program heads came up with an ingenious workaround. First, they teamed up with ESRF and ILL to develop a day-long online workshop that was well-received by students. The morning was dedicated to three lectures on using X-ray and neutron beams. In the afternoon, students rolled up their sleeves to work on four case studies inspired by the lectures. The traditional tours of the facilities were postponed until September.

An online seminar was also set up with Melexis, a company that regularly hires interns and recent grads from the program. Several students applied for positions as a result of the seminar.

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Leti Innovation Days 2020: the fall's top innovation event

Leti Innovation Days, traditionally held in June in Grenoble, was postponed to October 12 to 16 this year. This year's event will showcase technologies that connect humans to their physical environment. Attendees will discover the building blocks of the next generations of sensors, haptic interfaces, audio and image/video systems, and, of course, artificial intelligence embedded in the objects we use every day.

The program includes a total of thirteen workshops on Leti's flagship technologies, two plenary sessions with high-level speakers from companies like Sanofi, Legrand, and STMicroelectronics, and a 1,000 sq. m exhibition featuring 30 demonstrators and a full slate of startups.

Leti Innovation Days brings in experts from academic research, professionals from the world of industry, and market analysts. More than 1,000 people attended last year.

Learn more at: http://www.leti-innovation-days.com/

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ANNE VILCOT
Dean, Grenoble Institute of Technology's Phelma Engineering School:

"We are preparing for all possible scenarios in the fall."

MINA-NEWS: How well did Phelma navigate the shift to 100% online learning?
Anne Vilcot: It was hard to get things going. Our faculty had to reorganize their entire course loads on very short notice. The videoconferencing tools we had couldn't handle the capacity: We only had ten Zoom licenses at the time. But everyone rolled up their sleeves and the solutions were there. A group of students recommended we use Discord, a free online chat platform for gamers. Zoom granted free educational licenses. And the Chamilo online document repository was upgraded to handle more traffic.

MINA-NEWS: Were you able to keep the students on board?
AV: Some students were at a clear disadvantage in terms of technology, with problems ranging from slow internet connections to outdated computers and basic cell phone plans. Here again, we rapidly turned problems into solutions. A student club collected and reconditioned second-hand computers. In terms of the school, we made sure we stayed in touch with these students by phone and provided financial assistance to some of them. Our dropout rate was between 1% and 2%, the same as in a "normal" academic year.

MINA-NEWS: What are you doing to get ready for the fall?
AV: The French government has asked us to prepare for all possible scenarios, including a hybrid scenario with some classes online and others in person. Our top priority will be to make sure that the school year gets off to a good start for our incoming first-year students. We want to at least be able to offer them in-person lab classes, study hall, and project sessions. The idea is to give these incoming students the foundations they need to stay enrolled. ■

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CEA drives development of OCOV mask

The Y.Spot building, which closed on March 16, partially reopened the very next day for a project to develop reusable masks, initially for the Grenoble University Medical Center. The partners, who came from across the Auvergne-Rhône-Alpes region, began by tackling the design aspects of the project. Y.Spot staffers and Liten filtering media specialists also helped. They then 3D printed prototypes and went through four testing cycles with the medical center before scaling up the mask and processes and launching manufacturing in early April.

The OCOV mask has five washable filters and can be reused up to 100 times. It is five times less prone to leakage than a FFP2 mask. The CEA's Grenoble campus ordered 5,000 units for its employees.

**Learn more: https://www.voc-cov.org*

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From PhD student to entrepreneur with Enhanced IoT

Mohammamahdi Asgharzadeh, who was at IMEP-LAHC doing his PhD until late 2019, was one of the winners of the i-PhD innovation competition in early 2020. In April he moved to business incubator Linksium, where he has been busy getting his startup, Enhanced IoT, off the ground. His idea is to adapt a technology called "synchronized averaging," which has been used for decades in the medical industry, to the IoT.

The technology could extend communication ranges and eliminate crippling signal-to-noise ratios. It also offers the added benefit of being compatible with all IoT radio communications protocols. Asgharzadeh continues to receive support from his lab as he develops his prototypes and works on his business model. Two patents have been filed to protect the innovation.

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AGENDA

August 24 to Sept. 4 [online event]
ESSON: EUROPEAN SCHOOL ON NANOSCIENCES & NANOTECHNOLOGIES
https://www.esonn.fr/

September 14 [online event]
ESSDERC: EUROPEAN SOLID-STATE DEVICE RESEARCH CONFERENCE
ESSCIRC: EUROPEAN SOLID-STATE CIRCUITS CONFERENCE
https://www.esscirc-essderc2020.org

October 12 to 16 [Maison MINATEC]
LETI INNOVATION DAYS 2020
http://www.leti-innovation-days.com/

October 15 [online event]
PHELMA PARTNERS DAY
https://phelma.grenoble-inp.fr/

October 19 to October 22 [Maison MINATEC and World Trade Center]
GRAPHENE 2020 CONFERENCE
THREE NOBEL LAUREATES IN PHYSICS WILL SPEAK AT THE PLENARY SESSIONS
http://www.grapheneconf.com/2020/

November 16 to 20 [online event]
THE FIRST NANOSAFE DIGITAL CONFERENCE
Contact: nanosafe2020@cea.fr

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