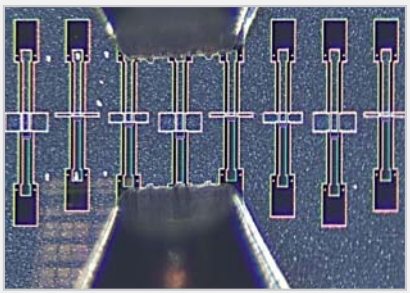
Successful energy conservation at Institut für Mikroelektronik Stuttgart

Institut für Mikroelektronik Stuttgart has made significant progress in saving energy. Through a series of measures, the annual demand for electricity, district heating and district cooling has been massively reduced.

Energy conservation at the IMS page 2

Further development of patented GaN nanohole technology in the ALL2GaN project

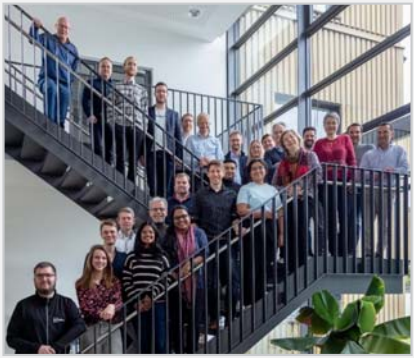


The GaN nanohole technology patented by the IMS for the production of normally-off GaN high electron mobility transistors (HEMTs) with positive turn-on voltage is being further developed in the ALL2GaN project. For this purpose, monolithic integrated circuits are produced using application demonstrators, which enable the simultaneous production of power, high-frequency and MEMS components on one wafer in a common GaN technology.

GaN nanohole technologie page 3

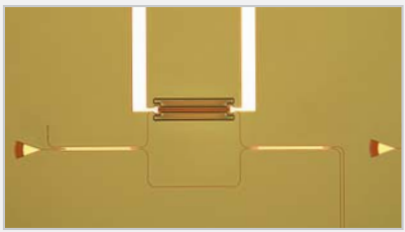
HyPerStripes - New packaging and connection technology for reliable bendable electronics

The second kick-off meeting that took place at IMS CHIPS in April marks the start of the European joint project HyPerStripes - "New packaging technology for reliable bendable electronics" entering its final year. 16 partners from three countries are collaborating to develop solutions for flexible connections and two-dimensional hybrid film systems.



HyPerStripes page 3

PhotonQ project



In the PhotonQ project, funded by the BMBF, a measurement-based and scalable processor for a photonic quantum computer will be developed with our university partners. At the heart of the quantum processor is an integrated photonic chip, which is being researched and developed at the IMS. For this purpose, new types of phase shifters, integrated optical circuits and optical interconnect technology will be investigated.

PhotonQ project page 4

Successful energy conservation

Institut für Mikroelektronik Stuttgart has made significant progress in energy conservation over the past year

Operating a clean room requires a lot of energy. Just cleaning the air, which must be virtually free of particles, and treating tap water to produce ultrapure water is very costly and accounts for a large proportion of the total energy requirement. In addition, there are the actual machines and systems to structure and manufacture complex components for microelectronics. As well as electricity for operation, these devices also require energy for cooling or air conditioning. For example, the temperature of the room in which the 11-ton SB4050 e-beam writer is located must be maintained with an accuracy of 1/10 of a degree Celsius - around the clock, 365 days a year.

Many of the devices produce waste heat that has to be dissipated or cooled using cooling systems. To date, district cooling has been used on a large scale for this purpose, which is distributed from two cooling centers at the University of Stuttgart via a network of pipes on the Vaihingen campus.

Through a variety of measures, we were able to reduce our annual electricity consumption by 554,600 kWh, while district heating consumption was reduced by 467,000 kWh. Since 2018, we have also reduced district cooling consumption by an impressive 2,000,000 kWh.

Our success is based on adjustments we made in various places that have enabled us to reduce our energy consumption. In particular, the renewal of our central clean room control system and the optimization of our cooling water circulation have played an important role in this. In addition, a photo voltaic system was installed on our roof to generate clean energy and further reduce our environmental footprint.

In addition to these extensive measures, many smaller ones were also implemented. Further savings were achieved by replacing light bulbs and pumps. These continuous efforts have led to a significant decrease in our energy consumption.

As a further measure, a new heat pump was installed a few weeks ago, which utilizes the heat absorbed by the cooling water and uses it as a heat source to supply heat to the building. Exhaust fans are currently being replaced with new models that have an adjustable, more efficient drive and promise further savings.

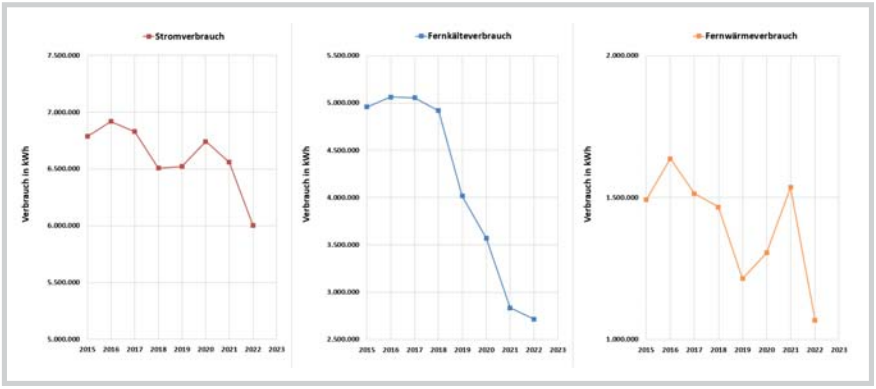


Figure: Significant savings in electricity, heating and cooling visible.

Additional measures are planned for the future to further reduce our energy consumption. One focus will be the expansion of the photo voltaic system on the roof to produce even more renewable energy.

The fluorine-containing process gases used in our clean room are rendered harmless by so-called combustion scrubbers with a thermal plasma and the combustion products are washed out and filtered.

We are proud of the progress we have already made in energy conservation at the IMS. With commitment and a focus on sustainable solutions, we will continue to expand our contribution to environmental protection.

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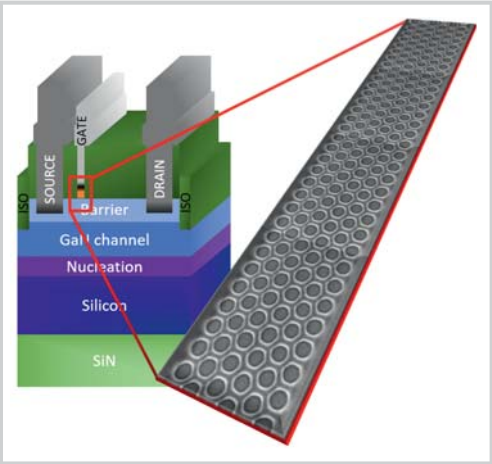
Patented IMS nanohole technology in the ALL2GaN project

Threshold-Voltage-Engineered GaN HEMTs for high frequency, power and MEMS integrated circuits



Last year, the European ALL2GaN project was launched in response to the European Chip Act and the challenges of climate change. The aim is to bring together European players in the field of power and high-frequency electronics to create a common ecosystem in which energy-efficient GaN ICs can be manufactured on an industrial scale.

Among the 45 partners from all over Europe is the IMS, which will be working on the further development of the patented nanohole technology on GaN-on-Si wafers as part of the project. This technology is a method to structure the gate areas in GaN HEMTs by means of which the switch-on voltage of the transistors can be changed in a targeted manner. This enables the simultaneous production of GaN transistors with specifically adjusted switch-on voltage within the same IC.

The idea is to produce transistors for a wide range of applications on a single wafer using the same technology, which can include high-frequency, power and MEMS components.

Following the successful demonstration of the technology, the work within the ALL2GaN project represents the next development step towards Threshold-Voltage-Engineered HEMT ICs.

In cooperation with SweGaN (Linköping, Sweden), the portfolio of the IMS GaN process is also being expanded to include the processing of GaN-on-SiC wafers, which are manufactured using QuanFINE technology. The circuits produced in this work package are primarily used for process development and material characterization on this new type of material system and complement the existing component production on GaN-on-Si wafers.

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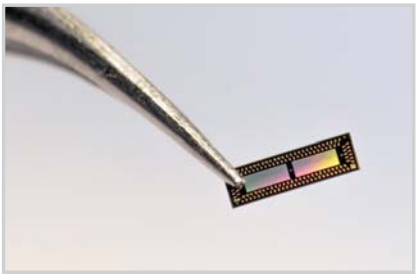
HyPerStripes

New packaging and connection technology for reliable bendable electronics



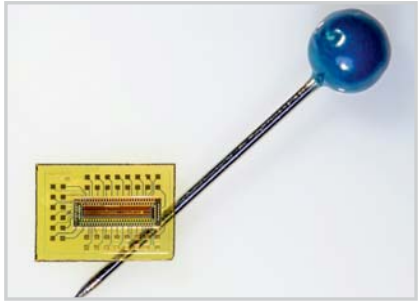
1.4 mm x 4.35 mm selection ASIC, thinned to 30 µm

The HyPerStripes project, which was launched in spring 2022 targeting the development of new packaging and connection technologies for bendable electronics, quite impressed the European reviewers with its interim results in April of this year.

The work on the six application demonstrators, which are mainly designed and developed for the medical sector, was presented. These range from the use of large-area sensor mats for the continuous recording of vital parameters to the replacement of rigid cabling systems with flexible polymer films. The latter is of crucial importance, as breaks and interruptions can occur during the installation of the connection cables and therefore the reliable functioning of the entire sensor unit or system cannot be guaranteed.

In the German consortium of the nationally funded project (funding code: 16ME0469), IMS CHIPS is responsible for chip chip integration and contacting on flexible polymer substrates for the application demonstrator of the cardiac catheter specialist Osypka.

The application demonstrator consists of two individual components. One is a sensor patch to record electrical signals in the tissue, which is equipped with an integrated readout ASIC. This is used to evaluate and digitize the small, sensitive signals directly on site. The second main component is a long and thin polymer strip, which is intended to replace the rigid connecting cables. Both components are made of a polymer, thermoplastic polyurethane, which not only offers flexibility but also stretchability as a material property. Fraunhofer EMFT is developing the roll-to-roll technology for the bendable cable systems, and the sensor patch is being produced at Würth Elektronik using the sheet-2-sheet process. The electrical connection of the two components is made possible by galvanically grown nanowires on the contact surfaces and subsequent joining processes, which are provided by the NanoWired GmbH. This metallic lawn of hair-thin metal rods ensures the electrical and mechanical stability of the entire application demonstrator, similar to a Velcro fastener.



Selection asic integrated in polymer foil

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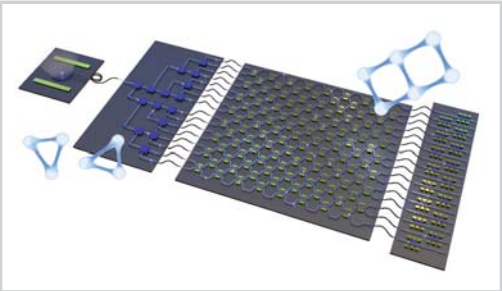
PhotonQ project

Exploring a measurement-based and scalable quantum processor



Principle of the measurable quantum processor. Image: University of Stuttgart / Stefanie Barz

The idea behind quantum computers is that they are expected to one day solve problems that are unaccessible to classic computer systems. However, before such computers can be used in practice, they will have to process considerably more qubits and exhibit lower error rates. A joint research group around Professor Stefanie Barz of the University of Stuttgart is currently developing a photonic quantum processor, which will allow the realization of quantum algorithms with a small number of qubits and, in the long run, enable rapid scaling to qubit numbers relevant to practical applications.

Last year, integrated optical components made of aluminum nitride (AlN) and thermal phase shifters with heating elements made of titanium nitride (TiN) were developed for PhotonQ. AlN waveguides enable low-loss and fast phase modulation through piezo-induced material strain (see picture on front page). TiN heaters, on the other hand, allow very low-loss phase modulation in silicon waveguides due to their short design.

At the same time, e-beam lithography is being optimized for integrated photonics with the Vistec company. To this end, the influence of layout definition, data preparation and exposure on optical performance is being investigated and optimized.

The project also aims to build up expertise in optical assembly and connection technology. To this end, the first fiber-to-chip connections were produced using 3D-printed polymer waveguides (photonic wire bonds). The Vanguard Automation machines required for this are located at ZAQuant at the University of Stuttgart and are also accessible to the IMS. The aim is electronic and optical co-packaging of integrated photonic circuits.

Further information can be found on the following website: www.quantentechnologien.de/forschung/foerderung/quantenprozessoren-und-technologien-fuer-quantencomputer/photonq.html

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News Flash

EBL prize for young scientists – The GMM/DVS conference "Elektronische Baugruppen und Leiterplatten" EBL is the most important German-speaking platform in the field of electronic assembly production. Ulrike Passlack from IMS CHIPS presented research results from her doctoral thesis and impressed both in the written paper and in the presentation and was awarded the EBL Young Researcher Prize 2024. https://www.ebl-fellbach.de/de

MedtecLIVE 2024 – is the leading trade fair in Europe for the development and manufacture of medical technology. IMS was represented with a stand and showed innovative microsystems for sensor technology in biomedical engineering.

„Beams & More" - This title defines the 21st lithography workshop to be held at the IMS. This workshop will be held at the IMS on November 28th, 2024. For further information and registration, please go to https://beams-and-more.ims-chips.de.

Research Association
of the Institut für Mikroelektronik Stuttgart e.V.

The non-profit Research Association of the Institut für Mikroelektronik Stuttgart was established in 1983 and supports the contacts between industry and research. It is a contact point for talents from Germany as well as from abroad that will be supported by the IMS with a scholarship. It opens doors to member companies that sponsor them.

An annual member meeting takes place every year. Members receive a discount on trainings and events.

For further information, please refer to www.ims-forschungsverein.de.

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