HUMAN++

Pioneering efficient healthcare

imec

Imec leverages its expertise in nanoelectronics to develop solutions for a more efficient and better healthcare. An example is imec's generic technology for wireless ECG systems, such as the ECG necklace prototype, which can be used for permanent screening of people at risk of cardiovascular disorders, heart beat and beat analysis information for fit & healthy people, and therapy compliance and follow-up for people under cardiovascular treatment.

ENHANCING LIFESTYLE AND HEALTHCARE THROUGH NANOELECTRONICS

Our healthcare system is under immense pressure. It is estimated that by 2025 healthcare costs will exceed 15% of GDP in OECD countries, fueled by growing elderly populations, the ubiquity of unhealthy lifestyles and the increased incidence of chronic diseases. Paired with an increasingly personalized standard of care, these factors necessitate the allocation of more resources than are currently available. More effective and sustainable healthcare models are therefore needed. Nanoelectronics technologies are in a unique position to address this need by driving and supporting innovation for biomedical tools used across the healthcare continuum of care, from prediction to detection and treatment.

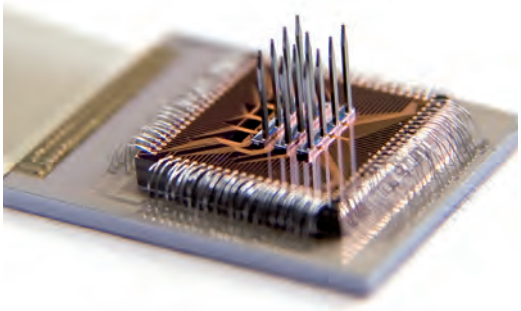
Remote health monitoring is one way to reduce the cost of treatment of chronic diseases while improving the patients' health and comfort. Telehealth technologies can reduce visits to hospitals and doctor's offices and improve patient health with lifestyle coaching. Highly sensitive sensors attached to and implanted in the body will communicate over body-area networks not only providing lifestyle modification but also delivering just-in-time, life-saving information to physicians or even closed-loop therapy.

Also, diagnostics can be significantly improved thanks to the evolution in science and technology. They will achieve greater sensitivity, specificity and reliability at more affordable cost. Biosensors can measure extremely low concentrations of clinically relevant molecules, allowing earlier and more precise detection of disease markers. Incorporated into lab-on-chip systems, biosensors allow seamless integration of all processes from sample collection to detection and quantification. Such lab-on-chip systems will play an important role in reducing the cost and eliminating the factor of human error while increasing the accessibility and efficiency of diagnostics.

At the other end of the healthcare spectrum, the efficiency of treatments can be improved and the cost reduced by developing evidence-based and targeted therapies. Side effects will be reduced to a minimum by specific therapies. Again here, sensors will play a prominent role, closely following the relevant molecular profiles of the patient allowing adjustment of the therapy accordingly.

These advances in diagnostics, medicine and therapy can only become reality by bringing life sciences research to the next level. Life sciences can benefit from progress in nanoelectronics which is now working at dimensions and with a precision equaling those of biology. Research at imec focuses on fulfilling the promise of micro- and nanotechnology by improving the sensitivity and resolution of biologically relevant measurements while accounting for the complexity of biological systems. Imec offers application-specific platforms that can be tailored to interrogate biological processes at the molecular, cellular, or system level by optimizing biological interfaces, surface topology, sensor modality and read-out circuitry.

01 Wireless sensors give more freedom to patients during long measurements and tests, for example sleep-staging tests or EEG monitoring for diagnosis of epilepsy. Moreover, the diagnosis is more reliable because no cable-motion related artefacts are present.



02 An implantable slim-base three-dimensional (3D) probe array can be used to record and/or stimulate neural activity, especially for in vivo brain studies. The platform is only several hundred microns thick which is highly relevant for chronic experiments in which the probe array should be able to float on top of the brain instead of being pressed against the skull.

01

Wearable health and comfort monitoring

Autonomous sensor nodes can be used to create a body-area network that is worn on the body and monitors vital body parameters in an unobtrusive way during daily life. When alarming values are reached, a care giver can be contacted. This is especially promising for elderly people wishing to stay in their own homes longer independently and for diagnosis and follow-up of chronic diseases.

Sensor networks are also beneficial for sports applications allowing coaches to assess the data of their athletes in real time. In gaming or e-learning a feedback loop can be generated between body parameters and the system making the application much more attractive to the user.

02

Integration technologies for wearable and implantable devices

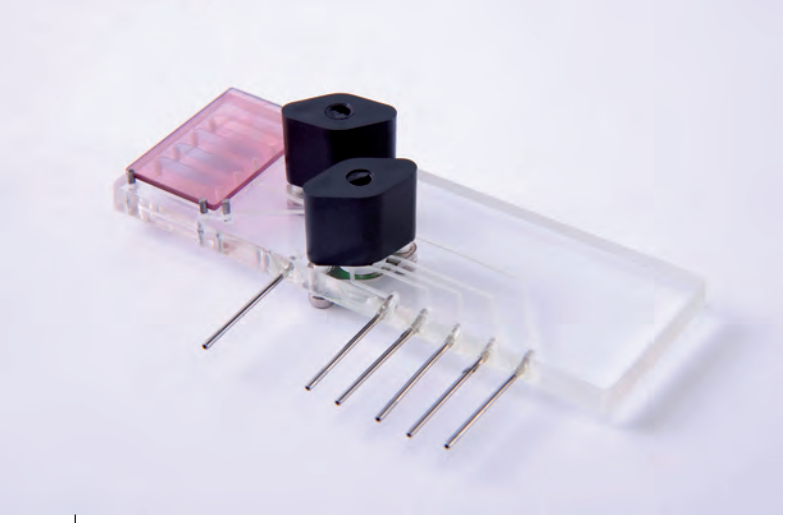
Further miniaturization of implantable and wearable medical technologies and adding more on-board intelligence, will strongly contribute to the patient's comfort and facilitate more personalized proactive healthcare. For example, the life quality of an epilepsy patient would drastically increase with an implanted brain-wave monitoring system that alerts the patient to danger and then automatically administers medicinal drugs to ward off an epileptic attack.
Advanced packaging solutions and integration technology developed in the microelectronics industry can enable a strong miniaturization of today's medical devices. In the future, they can bring completely new devices with additional features and on-board intelligence at cost-effective production.

To increase the autonomy and unobtrusiveness of tomorrow's medical devices and ambient sensor networks, imec focuses its research on:

- Creating wearable or implantable patient-friendly systems using innovative packaging and integration technologies: for example, ultra-thin-chip embedding in flexible and/or stretchable packages, chip-in-wire technology, and 3D out-of-plane integration.
- Improve the biocompatibility of implants to guarantee long-term operation and to reduce adverse reactions.
- Making the devices autonomous by reducing power consumption of the active components and using energy harvesting so that no batteries need to be replaced.
- Wireless communication of measured data to the outside world.

This research is carried out in the framework of Holst Centre, an open innovation initiative set up by imec and the Dutch research institute TNO.

Holst Centre
Open Innovation by IMEC and TNO



03A Imec is involved in a lab-on-chip project developing a microsystem that can diagnose breast cancer by isolating tumor cells from blood samples, counting them, and analyzing them genetically. The system consists of three modules: a cell separation module, an RNA amplification module and a detection module.

03B Suspended noble metal and metal oxide nanoparticles of various sizes and morphologies.

03

Molecular detection platforms

03A A medical lab of only 1x1 cm² for fast, easy-to-use, cost-effective tests

Our growing understanding of the molecular underpinnings of diseases requires equally sophisticated technologies to take advantage of this knowledge. Disease-indicating molecules are often found at such low concentrations that their detection requires controllable and reliable sample preparation and increasingly sensitive detectors.

Miniaturizing and integrating laboratory operations onto a single compact lab-on-chip device paves the way towards fast, easy-to-use and cost-effective diagnostic systems that can be used at the point of need, in the hospital, at the doctor's office.

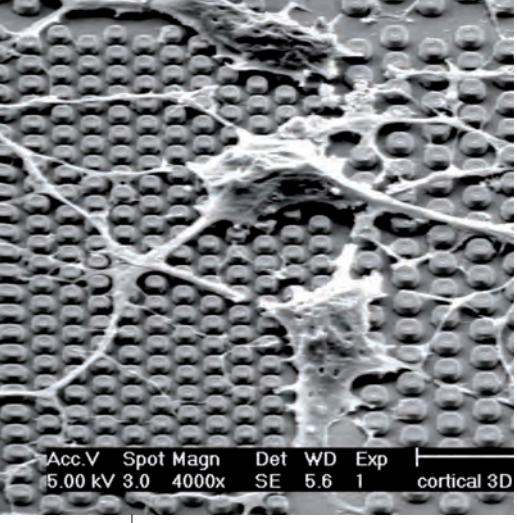
Imec develops technologies for sensitive and true multifunctional lab-on-chip systems:

- Surface chemistry
- Bioplasmonics- and biomagnetism-based nanobiosensors
- Nanofluidics
- Lab-on-chip systems

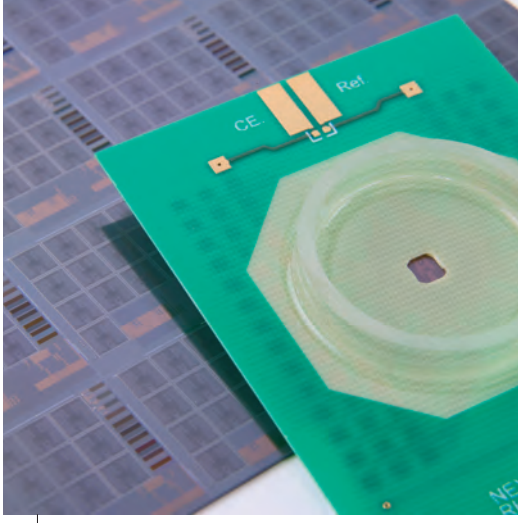
03B Nanoparticles: the holy grail for diagnostics and therapy

The size of nanoparticles approaches those of biological entities such as viruses, proteins or DNA thereby facilitating interaction while improving their individual interrogation and manipulation. Nanometer-sized particles present unique and tunable biochemical and physical properties inherent to their size. By altering materials, size, shape and by surface functionalization it is possible to devise tailor-made tools to specifically probe cellular and sub-cellular processes in vivo and in vitro. For example, nanoparticles can be used to enhance the contrast of MRI scans and for targeted therapy such as tumor ablation.

Imec develops synthesis and biofunctionalization protocols for nanoparticles. Together with partners, we deliver proof of concept of biomedical applications of nanoparticles for in-vitro and in-vivo diagnostics and for therapy.



04A Cortical neurons engulf microscopic nail structures on the surface of imec's micronail chip (3-day in-vitro culture).



04B Packaged chip for electrical recording and stimulation of electrogenic cells.

04C At imec, cross-disciplinary research is brought to reality through the daily interaction between experts from different disciplines. This is key to achieve breakthroughs in the field of neuroelectronics and nanomedicine.

04

In-vitro and in-vivo cell-interface platforms

The development of novel medical therapies and pharmaceutical treatments in areas such as neurology, cardiology or oncology demands new technologies that cannot only interact at the level of the individual cell but can also capture the complexity of cellular networks, tissues or organs.

Integration of multi-modal (electrical, chemical, micro-fluidic, optical) sensors and actuator arrays based on micro- and nanoelectronics with biocompatible packaging and signal processing electronics leads to novel devices for use in fundamental R&D, pharmaceutical, biotech, and clinical environments.

Imec develops technologies for in-vitro and in-vivo cell-IC interfaces:

- High-resolution sensor-/actuator arrays (cell-on-chip)
- Miniaturized implants (in-vivo pharmacology)
- Active brain implants (medical therapy)
- In-situ bio-signal processing

Nanobio-convergence laboratory

Imec's nanobio-convergence lab, set up in cooperation with the Flemish Institute of Biotechnologies (VIB) and the Leuven University (K.U.Leuven), facilitates daily interaction between researchers from the fields of molecular biology, medicine, nanoelectronics engineering and physical sciences in order to increase the impact of nanotechnologies in life sciences. With this laboratory, cell culturing, molecular biology and electrophysiology facilities have been added to the semiconductor processing, nanotechnologies and biosensor infrastructure already present at imec.

LET US TAKE ON THE HEALTHCARE CHALLENGE TOGETHER

What we offer?

Benefit from innovation to enhance diagnostics, therapy, drug discovery and development. Imec provides you innovation and breakthrough solutions tuned to your specific needs. Imec aims to reduce your cost of research and speed-up-time to market.

At the start of a joint project, a suitable ruling for the intellectual property is agreed. This protects your IP and allows you to benefit from the IP results of the project.

You can work with imec on different levels:

- Research programs
- Development projects leading to a proof of concept
- Long-term research

Potential partners

- Medical diagnostics and instrument makers
- Molecular diagnostics
- Diagnostics companies
- Microfluidics companies
- Material suppliers
- Micro-structured component suppliers
- OEM suppliers
- Bioscience and pre-analytic equipment manufacturers
- Design houses
- Medical device manufacturers
- Pharmaceutical companies
- Biotechnology companies
- E-health service companies
- Sport equipment manufacturers
- Integrated device manufacturers

Why imec?

- More than 25 years of knowledge in micro- and nanoelectronics which can advance product innovation in preventive, predictive, more personalized diagnostic, therapy or medicine.
- Expertise in several healthcare-relevant domains: body-area networks for monitoring and diagnostics, packaging technology for wearable and implantable healthcare systems, cell-electronic research, biosensing technologies and surface coatings.
- A state-of-the-art research infrastructure including biolabs that house expertise in molecular biology, cell biology, neuroscience, medicine, microelectronic engineering and physical sciences; ultra-modern nanoelectronics cleanroom.

Contact us

imec Belgium
E-mail: Maarten.Willems@imec.be
Phone: +32 16 28 83 78

imec the Netherlands
E-mail: Philippe.Mattelaer@imec-nl.nl
Phone: +31 40 277 4005

www.imec.be
www.humanplusplus.com