Fraunhofer IZM is an independent research facility with more than 250 scientists. It develops advanced assembly and packaging technologies, which maximize the functional density and reliability of mesa-, micro- and nanosystems. Medical applications, in particular, benefit from advances in microsystem technologies, since the latter often facilitate progressive miniaturization. Such technologies have so far been successfully applied to products like pacemakers, hearing aids, bio-microfluidic devices or retinal implants.

Indeed, the many assembly and packaging technologies, ranging from flip-chip soldering to adhesive bonding, from flexible circuit substrates to microfluidic channels, can be used in a wide range of bio- and biomedical applications. The most advanced of these processes are being used in permanent implants, like pacemakers or auditory prostheses. Developments like eye pressure implants are also nearing approval. Future concepts include disappearing sensor and actuator devices, for example, sensor band aids, sensor-shirts or integrated hybrid electro-microfluidic devices.

By using tele medicine infrastructure combined with advanced sensor technology and non-obtrusive system integration for constant monitoring at the point-of-care (POC), overall medical costs are reduced while quality of care is improved.

MEDICAL PROGRESS THROUGH MICROSYSYTEM TECHNOLOGY
Today’s hearing aids are so small that they can be completely hidden in the ear canal. Pacemakers offer more functionality and last longer. Neural stimulators help patients get urinary incontinence under control. Many of such innovations, which have improved the lives of patients immeasurably, are the result of advances in microintegration technology. Diagnostics is another area that benefits greatly from such progress. Modern X-ray sensors in dentist practices, microcameras used in endoscopy, high-performance CT sensors or so-called pill cameras, which can simply be swallowed, would not have been possible without miniaturization.

Fraunhofer IZM has been front and center in this development process for over fifteen years. Our know-how in microtechnology and innovative integration processes helps manufacturers bring innovative new medical engineering products onto the market. In recent years, the demand for the institute’s services has shifted from technology development support to help at every stage of the development chain (“from concept to prototype”), and the institute has responded by establishing the new research area Medical Engineering.

Now manufacturers and research partners have a one-stop contact for all of Fraunhofer IZM’s services in Medical Engineering, which allows them to select a technology that is precisely tailored to their individual requirements. Of course, Fraunhofer IZM also continues to perform customized reliability analyses, evaluate biocompatibility and assess risk according to ISO standards and based on an understanding of the relevant processes, materials and application-specific failures. Simulation models that utilize the results of the above analyses are also often drawn on to ensure the development process is as precise as possible.

The new research area Medical Engineering covers the following specialized research and development foci:
- Implants
- Therapeutic Systems
- Diagnostic Systems
- Ambient Assisted Living
- Veterinary and Alimentation
Organ failure or damage is caused by a wide variety of factors – disease, accidents, lifestyle or simply the ageing process itself. However, thanks to implants, medicine has been able to return quality of life to patients, prolong life span and alleviate the symptoms that prevent patients from fully participating in everyday life. The heart pacemaker is possibly the most familiar example of an implant. These days, though, cochlea implants, retinal stimulators, bladder control implants, brain-computer interfaces all rival pacemakers in usage, as the functionality and safety of many different implants has reached a point that the devices can remain in the body over decades.

Fraunhofer IZM has a long history of advancing the adoption of implanted medical devices as standard healthcare, with developments including pioneering chip-scale packages for pacemakers, implantable chemotherapy pump control systems, assemblies for retinal implants and wireless brain computer interfaces attached directly to the cortex. Fraunhofer IZM’s expertise spans from material selection and miniaturization technology, to reliability testing and risk assessment on technical and biological levels according to ISO 13485, ISO 14971 and ISO 10993.

Fraunhofer IZM collaborates with leading companies and research institutes in Europe and internationally on such research. One prominent example is its participation in NIH and DARPA projects, which developed brain-computer interfaces capable of wirelessly relaying neural signals through the skull to a powerful computer, thus allowing even tetraplegic patients to control wheelchairs or robotic arms.
THERAPEUTIC SYSTEMS

Medical technology has an exponentially growing role in healthcare. Not least among the new possibilities is the move away from stationary assistive systems towards mobile solutions. Using technology to bring healthcare to the patient anywhere and at any time will be a key factor in improving healthcare systems while simultaneously reducing costs.

Fraunhofer IZM is putting all its know-how to work to accelerate this process even more. As part of this, we have developed electronic monitoring devices that help patients and orthopedists monitor the quality and improve the longevity of prosthetic feet and lower limb prostheses. The institute has designed light therapy systems that alleviate chronic pain in the form of lightweight and comfortable patches that can be applied by the patient himself.

IZM scientists have introduced advanced hearing aids that set new standards in miniaturization, weight and comfort. Smart bandages not only help treat wounds, but simultaneously also monitor the treatment process itself. Last, but not least, Fraunhofer IZM pioneered the integration of electronics into textile systems that use electrostimulation as a treatment for convulsions and cramps.
Correct diagnosis is the vital first step in medical treatment and comprises a number of processes, which are continually being advanced in terms of both technique and technology. An important new tool here is the microfluidic point-of-care system, which delivers fast, accurate diagnostic results from blood, urine, sputum and even tears.

Another key area of focus is long-term monitoring, necessary to both ensure convalescence is progressing or to adapt individual treatment plans where necessary. Moreover, some health issues, such as so-called ‘hidden episodes’ in COPD and miniscule cardiac events, are only detectable by monitoring vital signs over prolonged periods.

Fraunhofer IZM provides cutting-edge expertise in integrated microfluidics (i.e. capillaries with integrated sensors) to point-of-care diagnostics (PoCD) and has established innovative concepts that combine capillary and digital microfluidics into powerful, single systems. Fraunhofer IZM’s know-how is also demonstrated by its wide range of contributions to diagnostic technology – from highly miniaturized pulse oximetry devices integrated into hearing aids, to hand-held systems for monitoring wound healing, through to a capacitive sensor integrated directly into a textile shirt that captures minute EMG signals.

The institute is also always looking to the future. Works-in-progress include devices based on non-traditional substrates that can obtain meaningful data from new sites of the body. One example of such a device is our forthcoming contact lens monitoring system.
**AMBIENT ASSISTED LIVING**

Medical care typically starts with the patient experiencing symptoms and visiting the doctor’s office. However, many events in the daily routine already offer pro-active means of addressing health issues, both in a preventive manner, as well as in the form of an early indication.

Bringing the diagnosis into the ambient of the daily life is expected to support our ways of living a long healthy life. This Ambient Assisted Living (AAL) has demonstrated not only to support the elderly, but also to be endorsed heavily by the active generation with the wearable health devices. Ubiquitous wireless data capture and transmission is key to this paradigm shift. Fraunhofer IZM as a founding member of the Fraunhofer AAL alliance has since supported the development of the AAL vision by offering technologies for distributed sensor communication, energy scavenging, multi protocol wireless transmission and the implementation of systems suitable for the deployment in housing and everyday apparel.

**VETERINARY AND ALIMENTATION**

Our daily life is significantly affected by our diet. As of this, crop and livestock are very important assets of our daily routine. Ensuring quality of our food as well as respecting our environment has become an important factor of our understanding of life. Electronics can provide improved insight on our food quality, on eco-sustainable even on the appropriateness of the livestock species routines.

Fraunhofer IZM therefore is commissioning its capabilities to these challenges. Offering highly robust, miniature sensors, the quality of life of livestock can be monitored and optimized. Ensuring that the harvesting of crop results in highest quality food by employing wireless sensors into the harvesting process allows to keep quality high and costs low. Sensing the level bio- and pesticides, artificial fertilizer usage in conjunction with crop health and irrigation requirements ensures that both the crop output and resource usage is optimized to ensure a sustainable agricultural industry.

Fraunhofer IZM has worked on many projects to monitor the stock agility, fish health, meat quality, crop harvesting quality, irrigation needs and more in the past decades and offers a long standing history of supporting the veterinary doctors and the farmers on their fields.
SUMMARY OF SERVICES
AT FRAUNHOFER IZM

Fraunhofer IZM develops and provides the following services for bio- and biomedical devices:

- Packaging technology and reliability analysis for miniaturized medical devices and implants
- Lab-on-substrate technologies for patient-friendly laboratory diagnostics
- Improved functionality of neural interfaces and intelligent prostheses
- Flip chip assembly processes for small to large volume fabrication processes
- Thin chip assembly on ultrathin flexible and stretchable materials
- Integration of electronic modules and sensors in/on textiles
- Opto-electro-mechanical systems integration targeting medical devices
- Sensor integrated microfluidics for point-of-care diagnostic devices
- Biohermetic encapsulation for ISO 10993 compatibility
- Technology support from your medical device idea to the product implementation, reliability evaluation and prediction for medical risk assessment
- Wireless transmission concepts for secure medical data
- Energy scavenging technology for prolonged autonomous operation
- RoHS, WEEE, EuP/ErP and REACh consultancy

COMPREHENSIVE DEVELOPMENT SUPPORT FOR ALL PROJECTS, NO MATTER THEIR SIZE OR CHALLENGE

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