Fraunhofer
IPMS

FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

Application Area

Quality of Life

Overlay image of visible spectral range (VIS) and thermal infrared range (LWIR).

Quality of Life

With extensive experience in the development of photonic microsystems and related technologies including nano-electronics and wireless microsystems, Fraunhofer IPMS has released a variety of applications benefiting both industrial customers as well as society as a whole. Innovative products developed at the institute can be found in all markets relevant to the information and communication technology, consumer electronics, automotive, semiconductor and medical industries. We are proud to present some selected examples here.

Recent advances in microelectronics have brought many benefits to the private spheres of individuals around the globe. Affordable and easy to use portable devices have uniquely improved the quality of life and have been particularly profitable. MEMS technology developed at Fraunhofer IPMS makes it possible to configure more products to fulfill societal calls for improved safety, greater comfort in mobility or targeted support when selecting food, goods and medication. Technologies that were previously reserved for experts, can now be used by the general public.

Multispectral Imaging

Whether in security systems monitoring airports, tunnels or train stations, automotive driver assistance systems, remote sensing and environmental analysis, industrial metrology, quality control or medical technologies, wideband spectrum imaging is applied in many areas of everyday life. In addition to the visible spectral range, the infrared spectral range with wavelengths above a few microns is of particular interest. It offers extremely useful image information which is not provided in the visible range.

Fraunhofer IPMS has developed a camera system, which can simultaneously record images in different spectral regions without a parallax error. This is achieved by using just one lens. The system approach is based on a special mirror lens designed specifically for multispectral imaging. In contrast to transmissive lenses, mirrors are not limited by the transparent areas in VIS and IR and can therefore be implemented in several spectral ranges. Moreover, such systems eliminate chromatic aberrations that otherwise reduce image quality.

Key Topics

- Multispectral Imaging
- Wearable Electronics
- Laser Projection
- Food Analysis
- Security

Shoe-embedded polymer energy harvester optimized for powering a transmitter module. (Photo: iStock)

Wearable Electronics

In recent years, converting kinetic energy from human motion into electrical energy has become an attractive approach to powering wearable electronic devices. The combination of energy production and portable electronic devices worn on the body build a self-sustaining system which can be found, for example, in fitness gadgets for tracking temperature, speed and position data.

Fraunhofer IPMS has developed an innovative energy harvesting system based on emergent electro-active polymers, which is small enough to be embedded in wearables. The mechanical-to-electrical converter device is based on thin polymer films with large relative permittivity. As compared with traditional piezoelectric concepts, this device works non-resonantly and can be optimized for harvesting energy from mechanical power sources also in the low frequency range.

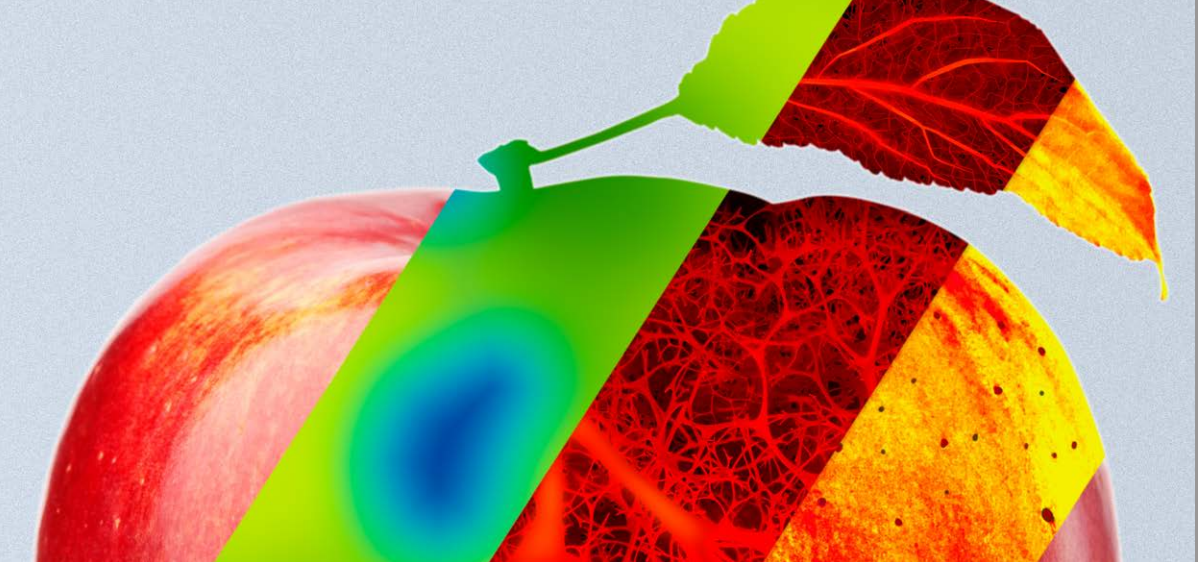
The harvester system (device and circuit) can be adapted for other applications such as for powering wireless sensors and portable electronic devices.

Laser Projection

High-quality data visualization is extremely important and plays a central role in both private and business environments in the modern information society. Today, large, high-resolution screens are used to accurately display photo and video content. However, mobile presentation remains problematic for partly different reasons.

Laser projection is, in many respects, a suitable solution for overcoming problems in the mobile presentation of information. Therefore, Fraunhofer IPMS has developed a scanning mirror for light deflection in one and two dimensions. The "Laser Beam Steering" principle for imaging in which a laser beam is quickly guided across the screen is used. With a typical diameter of approximately one millimeter and made of mono-crystalline silicon wafers, scanning mirrors are manufactured in the Fraunhofer IPMS microsystems technology cleanroom according to established microelectronics methods. To facilitate necessary scanning mirror movement, Fraunhofer IPMS implements an electrostatic drive via comb-shaped electrodes.

Many fields of application use laser-projected image and video display. By not using an imaging optic, it is possible to generate clear and sharp images on sloping as well as curved surfaces. Head-Up-Displays as well as other driver-support applications in automobiles benefit from these advantages. Laser projection methods can also be used in LIDAR systems which will make partial or fully-autonomous driving possible in the future.



Hyper spectral imaging using the example of an apple.

Food Analysis

Often, it is not easy for consumers to accurately evaluate the quality of food products. To ultimately determine whether the already-paid-for apple is actually fresh, one must take the first bite. In the future, a spectrometer will inform customers as to the quality of their food choices prior to purchase.

Fraunhofer IPMS has developed a micro-spectrometer able to be integrated into common smartphones. The application is based on a near-infrared spectrometer which illuminates a sample with broadband light to determine its proportions of water, sugar, starch, fat and protein. The light reflects various wavelengths in the near infrared area at different degrees of strength depending upon composition levels.

An essential component of the system is a micro scanner with optical diffraction grating developed at Fraunhofer IPMS. The mechanical movement of the mirror provides a simple and cost-effective detector, resulting in significant cost advantages for the measurement of wavelength ranges (such as NIR above 1100 nm), in which more expensive III-V semiconductor elements rather than cheaper silicon detectors must be used.

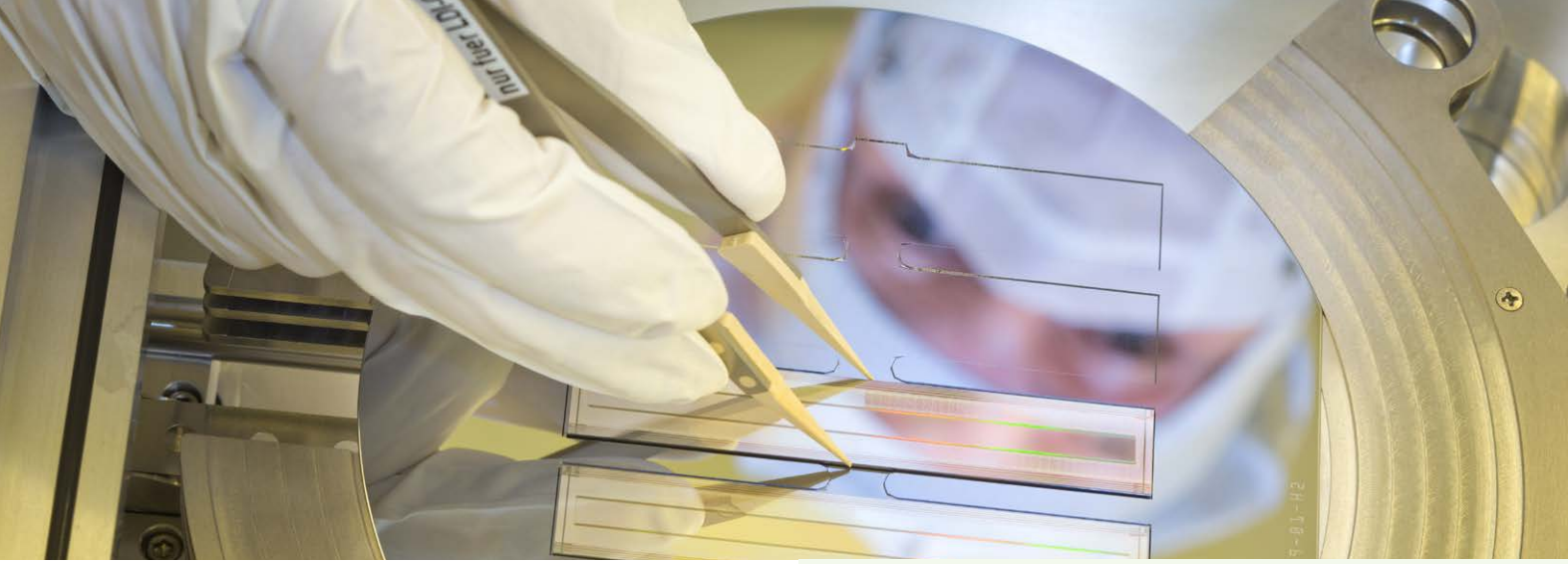
Applications of the spectrometer are not limited to the food sector. Materials of diverse goods can be examined to confirm high-quality originals or identify low-quality copies. Used cars can be scanned to expose areas which have been painted over and the contents of medications and creams can also be verified.

Security

With the increasing use of technology, unauthorized access to user accounts and sensitive infrastructures presents a worrisome challenge. Secure passwords, secret PIN codes and personal identification cards are often not enough to ensure complete protection.

Similar to a fingerprint, the blood vessel pattern of the retina is unique to each individual. Therefore, retina scanning can provide the accurate identification of any and every person. To improve personal as well as data security, Fraunhofer IPMS has developed a system for mobile authentication using retina scanning. This micro scanner is meant to be integrated into personal devices such as smartphones and can direct an eye-safe laser beam to systematically scan the retina. The newly developed optic then generates an image of the retinal surface from the reflected laser beams.

Through the secured identity of the user, mobile devices can provide key support to numerous everyday actions in which a high level of security is needed. Applications range from conducting mobile banking via electronic mail and entering personal housing, to controlling access to sensitive areas and critical infrastructure. Devices can also be used as mobile virtual displays, projecting information onto the retina to transmit personal data that cannot be seen by others.



Services

The Fraunhofer IPMS offers various cooperation possibilities along the entire value chain to its customers. Feasibility studies are the first step if it is unclear at the beginning of a cooperation whether – and if so by what means – a customer request can be realized. For the basic proof of the functionality of a device or system demonstrators are realized within a development project. Especially in wafer-based processes, new technologies might be required which could be then developed in parallel. In the second step, the demonstrator turns into a prototype that fulfills all customer specifications. Fraunhofer IPMS offers qualified pilot fabrication in its clean room for MEMS and other microsystem devices.

Fraunhofer IPMS participates in the high-performance center "Functional Integration for Micro-/ Nanoelectronics". Together with multiple other Saxon Fraunhofer institutes, Dresden University of Technology, Chemnitz University of Technology and the University of Applied Sciences Dresden, Fraunhofer IPMS is working on developing application-oriented products based on the results of basic research to strengthen the economy. The whole project is coordinated by the Fraunhofer IPMS. On the basis of roadmaps we jointly identify possible opportunities for cooperation in talks with industrial customers. If the need arises, the center of excellence's topics can be extended accordingly.

Research Topics

The applications realized in close cooperation with our customers make use of the following results of our R&D activities:

- SPATIAL LIGHT MODULATORS
  Arrays of micromirrors on semiconductor chips
- MEMS SCANNERS
  Resonant and quasi-static MEMS mirrors for light deflection
- WIRELESS MICROSYSTEMS
  Devices and systems for RFID and optical communication
- ENVIRONMENTAL SENSING
  Sensor devices and systems for photonic and chemical sensing
- NANOELECTRONIC TECHNOLOGIES
  Semiconductor device development and screening of processes and materials on 300 mm wafers
- MESOSCOPIC ACTUATORS AND SYSTEMS
  Electrostatic bending actuators with very large stroke
- CAPACITIVE MICROMACHINED ULTRASOUND TRANSDUCERS
  Ultrasonic devices manufactured with microelectronic technologies
- SMART MICRO-OPTICS
  Liquid crystal wave guides, tunable micro lenses and energy harvesting solutions
- MEMS SENSORS
  Product oriented development and pilot fabrication of diverse physical and chemical sensors

Short profile

Based in Dresden, Fraunhofer IPMS is your research and service partner in the fields of optical sensors and actuators, integrated circuits, microsystems (MEMS/MOEMS) and nanoelectronics. As one of the currently 67 independent institutes making up the Fraunhofer-Gesellschaft for the Promotion of Applied Research, the leading European organization for near-industrial research, our approximately 280 scientists work together with both private industrial and service companies as well as the public sector in projects to directly benefit business and society. To meet the high standards of our customers, Fraunhofer IPMS is certified by DEKRA in accordance with DIN EN 9001:2008 for the research, development and manufacturing of microsystems, respective semi-conductor and microsystems processes as well as integrated actuators/sensors.

Regarding micromechanical and photonic microsystems we offer complete solutions: From conception to component right up to complete systems. This includes sample and pilot production in our 1500 m² (15,000 ft²) clean room (ISO 14644-1 class 4) with qualified processes. Additionally, our business unit Center Nanoelectronic Technologies CNT provides services in the field of nano and microelectronics with functional electronic materials, processes and systems, device and integration, maskless lithography and analytics. Another 800 m² of clean room space (ISO 14644-1 class 6) is available for this purpose, along with analysis and metrology processes with atomic resolution and high sensitivity.

Smart Industrial Solutions

Quality of Life

Medical and Health

Fraunhofer IPMS

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