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IPMS

FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

MEMS REPORT

JUL – SEP 2012

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◄ Cover picture: Fraunhofer IPMS clean room for microsystems..

Prof. Dr. Hubert Lakner
Director of Institute

Dear Customers, Partners, and Friends of Fraunhofer IPMS,

Already for the third time we inform you about recent news and developments at Fraunhofer IPMS by means of the "MEMS Report" We are delighted about the positive reactions we received so far. In the first two issues you have read about manifold scientific and technical successes of the institute. For commercialization and especially transfer of the results into small and medium sized enterprises we have chosen new methods recently. The intensive use of the EU funding scheme „Research for the Benefit of SMEs“ opened up new customers throughout Europe, with mutual benefits. We will present this programme in much detail in this edition of the »MEMS Report« and will showcase results we have achieved in the past together with our partners. Fraunhofer IPMS will be happy to become your partner if you choose to apply for this scheme.

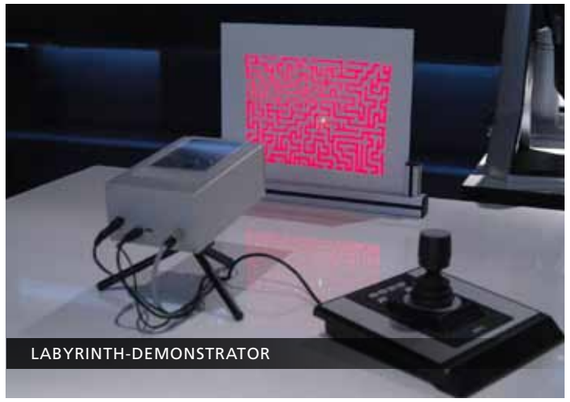
And now I wish you another interesting read of the Fraunhofer IPMS MEMS Report.

Prof. Dr. Hubert Lakner

QUICK NOTES

New Demonstrators at the MEMS Micromachine

Two new demonstrators were presented by Fraunhofer IPMS in July, 2012 at the MEMS Micromachine in Tokyo. The first was a three-dimensional electric-powered model of a tip-tilt mirror as a component within a mirror array matrix scaled at 15 000:1. The purpose of the exhibit was to demonstrate the function and construction of the actuators, which are only a few millimeters in size. The second demonstrator was a laser projector which combines micromechanically produced resonate and quasi-static scanner technology. Here, a red labyrinth pattern is produced by two resonant oscillating one-dimensional scanning mirrors which can be passed through by a green laser spot. The green laser spot



LABYRINTH-DEMONSTRATOR

is deflected by two quasi-static microscanners and is controlled with a joystick. Both demonstrators, which generated a lot of interest at the trade show, are the result of an internal idea competition for show exhibits which was held by the Institute in the first half of 2012.

New Image Video Online

In the first quarter of 2012, significant parts of Fraunhofer IPMS' new image video were filmed in our microsystems clean room. The film can be viewed on both YouTube and our website at www.ipms.fraunhofer.de. The four-minute video is to provide interested parties with an initial impression of how micro-mechanical components are developed, produced and implemented at Fraunhofer IPMS.

RESEARCH FOR THE BENEFIT OF SMES: SUCCESSFUL COOPERATION WITH ENTERPRISES FROM ALL OVER EUROPE

LASER PROJECTION MODULE FROM THE PROJECT "PICODICON" COMPARED TO A MOBILE PHONE

The European economy depends significantly upon the success of small and medium sized enterprises (SMEs). In order to strengthen the innovative abilities of these businesses in particular, the European Union has introduced the support program "Research for the Benefit of SMEs", in short R4S, in its 7th research support program. Fraunhofer IPMS has been making use of this instrument successfully for years, cooperating with enterprises from all over Europe.

Small and medium sized enterprises shape the economy in Europe. In many fields they can exist as "hidden champions" on the world market. They are, however, also forced into constant innovation in order to retain that status. For long-term strategic development in a time frame of two to three years, it is often the case that the resources needed for short-term project development are scarce or lacking. Necessary access to innovative technologies available at research centers is also often not possible for such enterprises – due in part simply to unawareness of their existence.

The European Commission has recognized this dilemma and called the support instrument "Research for the Benefit of SMEs" into being as a solution to the problem. It differs from traditional joint funding in a few aspects. A minimum of three SMEs from three separate countries have to cooperate in a project together with at least two research service providers. The latter carries out the fundamental development work, orientated on the concrete needs of the businesses. These businesses, in turn, receive relatively little direct financial funding from the EU, which reimburses the costs of the developers to 100%. In effect, the businesses subcontract the development at the expense of the EU. The advantage for the SMEs is that all of the rights to the project results are handed over to them upon completion of the project and can then be put to commercial use.

Fraunhofer IPMS has implemented a number of different R4S projects in past years and has substantial experience in both the configuration of the consortium and in application for grants. A further round of R4S applications will be completed on 11/15/2012. The resolution to continue SME funding in the

new research program Horizon2020 has already been passed. Fraunhofer IPMS will again be heavily involved in the program. A few of the R4S project highlights from Fraunhofer IPMS are listed in the following:

PICODICON: Mobile Projector for the Paperless Construction Site

The goal of the successfully completed project PICODICON was the development of a robust pico-projector for the construction industry. It was to make the on-location display of drawings and other documents possible, and thus also make the provision of bulky paper archives at the construction site largely redundant. In order to achieve the goal, nine participating partners from six EU countries concentrated on a laser projection module built upon two micro-mechanical scanner mirrors which were developed at Fraunhofer IPMS and manufactured with microsystems technology methods. It deflects a laser beam so fast that a stable image is produced with simultaneous modulation of the light intensity. Due to the compact design of the scanner mirrors, the projection module could be integrated into a PDA or a similarly sized device. The Institute was also responsible for both the mechanical integration of the mirrors into one module and the necessary control electronics. Other research partners took over the development of the laser sources or the system optics. The solution that was achieved can also be utilized for similar applications outside of the construction industry.

EUROTHENTIC: Development of Banknote Testing Technology

Since their introduction in 2002 the Euro has become one of the most significant currencies in the world. As a result there is a need not just to guarantee the authenticity but also the quality of the circulating money in a large geographic area. The European Central Bank has set up stringent rules for the issue of banknotes. Nevertheless, there are about 15 000 locations in northern Europe alone where consumers can withdraw cash other than from banks or well controlled automatic tellers – in supermarkets, for example. Automatic, compact and cost-effective solutions to ensure the authenticity and validity of the bills present an unfilled need here. In the project EUROTHENTIC, seven partners from six countries have come together to develop a module that will close this gap. It is supposed to pull in banknotes, at a supermarket till for example, and then test them automatically. Conversely, the banknotes could then also be used to make change. For that reason, the device has to first test a banknote for authenticity, and then subsequently decide whether that same banknote is fit to go back into circulation or is too worn out. This can be evaluated largely based on the optical characteristics of the banknote by scanning it with a suitable imaging device and then performing a software analysis. Fraunhofer IPMS is responsible for the collection of the banknote image data in this project. The Institute is making use of its expertise in image acquisition with suitable sensors and modern signal processing methods.

ELECTRONIC BANKNOTE TESTING

RUNSAFER: Development of a Running Shoe with Integrated Electronics for Real-Time Transmission of Bio-Mechanical Data

The goal of the RUNSAFER project, which began in September of 2012 with six partners from four countries, is an innovative technical support solution for athletes. The developmental focus is a running shoe with an integrated micro-electronic system. It measures the bio-mechanical parameters of the athlete during a run and transmits these to a mobile phone carried by the athlete, which stores the data on a memory card. An app on the mobile device gives information about the attained training targets in real-time and suggests alternatives to the motion pattern in order to, e.g. prevent injuries. After training the recorded data can be transmitted to a web portal for further analysis or to devise individual training schedules. The linking of athletes in a social network is also possible.

The system integrated in the shoe has to fulfill sophisticated requirements: high-precision measurements, shock resistance to shoe deformation or dampness, while still being lightweight and comfortable. Price is also a considerable factor if the innovation is to become widely accepted. Fraunhofer IPMS is responsible for the development of the microsystem, the wireless charging of the accumulator integrated into the shoe and for the wireless transmission of the measurement data.

FIVE QUESTIONS FOR UWE SCHELINSKI

Dr. Uwe Schelinski has been a member of the research staff since the foundation of the Fraunhofer IPMS. He is leading the group "systems integration" and is the project manager of the R4S-project "Eurothentic".

Fraunhofer IPMS: "Financial institutions are focusing more and more on cashless transactions, and EC and credit cards are both widely accepted and used by shoppers. Will banknotes still play a large role in the future?"

Uwe Schelinski: "Yes, certainly! Hardly anyone is out and about without cash, and snacks, newspapers or bus tickets are still usually paid for in cash. Every cashless transaction generates costs that are of consequence. That is why cash will not disappear. Even today supermarkets and gas stations offer cash withdrawals. The handling of cash will end up being transferred to shops and service providers. It is exactly for this reason that low-priced and reliable test devices are in demand."

Fraunhofer IPMS: "In the R4S project 'Eurothentic', you are working together with six partners. How did you manage to find these partners and convince them to work together toward a mutual research goal?"

Uwe Schelinski: "An increasing market for compact and low-priced cash handling devices has been developing. The devices can't do quite as much as the larger systems at banks, but certainly more than a till. That is why there are companies that want to develop and sell these types of devices. So the search for partners with suitable know-how wasn't really that difficult. And the R4S program in which research organizations develop know-how for small and medium sized businesses is very attractive for both sides because the rights remain property of the SMEs."

Fraunhofer IPMS: "How are you satisfied with the cooperation so far? What have been your greatest challenges as project leader along the way?"

Uwe Schelinski: "All of the partners have shown great commitment to the project goal, but they naturally also have their own interests. That is why it was important to include all of the partners in such a way that a convincing result was achieved in the end. The project review done recently in Brussels has confirmed that co-operational conditions are good. One technical challenge is that payment with the Eurothentic solution is not supposed to take any longer than it does now!"

Fraunhofer IPMS: "The project runs until September, 2013. What contributions do Fraunhofer IPMS and its team want to make by then?"

Uwe Schelinski: "It is our task to develop a suitable sensor technology for testing banknotes along with the accompanying electronics and mechatronics to handle the bills. That means that our technology will not only test the money for authenticity, it will also recognize worn out or damaged bills and pull them out of circulation."

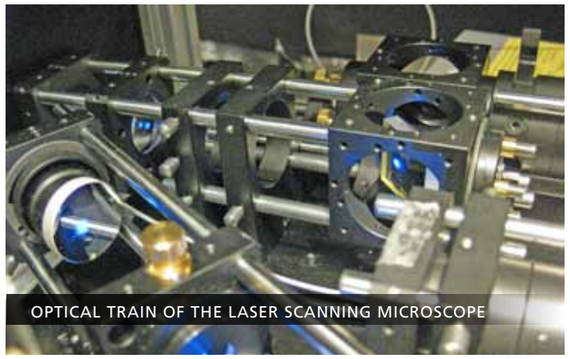
Fraunhofer IPMS: "That doesn't sound exactly trivial. If you are successful: How long will it then take for the technology to be installed in the first units?"

Uwe Schelinski: "The Eurothentic project develops the technical requirements necessary for cash to be automatically tested and then re-issued as change. At the end of the project, the actual development of a technical and attractively calculated product can start. I think that it will be available in about 2015. The R4S support model will have positive results here: Future suppliers are already involved in the project after all, and the results will then be at their disposal."

MEMS SCANNER MAKE COMPACT CONFOCAL-MICROSCOPES POSSIBLE

Engineers at the Fraunhofer Institute for Photonic Microsystems IPMS have made use of a special two-dimensional micro mirror design to construct a compact confocal fluorescence microscope that will be presented to the public at Vision 2012. Confocal microscopy could therefore become both more affordable and attractive for mobile applications.

In contrast to conventional light microscopes, where the sample is given planar illumination, the confocal fluorescence microscope scans the sample point by point, measures the stimulated reflected or emitted fluorescent radiation and subsequently reconstructs the image. Along with the imaging of horizontal cross sections in high resolution, this also makes the production of 3D models with structured surfaces and fluorescent samples possible. Characteristics that are in demand in biological and medical research as well as in industrial quality control in equal measure. Conventional instruments, however, are stationary, complex, and expensive.



OPTICAL TRAIN OF THE LASER SCANNING MICROSCOPE

As the demonstration instrument at Vision 2012 - which works in the same manners as a conventional confocal fluorescence microscope - will show, the utilization of a micro scanner mirror is a real alternative. The MEMS mirror responsible for the deflection of the laser beam and the scanning of the sample, which was developed at Fraunhofer IPMS and is manufactured with silicon micromechanics, makes both compact construction and a cost-efficient mass production possible. The electrostatic driven actor with a mirror diameter of only two millimeters resonates in two orthogonal directions of 190 and 1290 Hz respectively. In this manner, the preparation is scanned point for point by a focused laser spot in the form of a Lissajous figure. A special algorithm allows the image of the object under examination to be reconstructed with a resolution in both axial and lateral directions of two millimeters each.

NEW WAFER SEPARATION PROCESS OPTIMIZES PROCESS TIME, YIELD AND QUALITY IN THE MEMS BACKEND AREA

In the manufacturing of micro-mechanic systems from bonded silicon wafer stacks, the final separation of the chips from the wafer composite poses a particular challenge. On the one hand, traditional separation processes such as wafer sawing endanger the sensitive components due to saw particles, slurry or mechanical stress. Lacquers used for protection lower the yield on the other hand, as they have to be removed again after processing. Fraunhofer IPMS has successfully tested an alternative process, so-called stealth dicing, with the support of Fraunhofer IZM/ASSID on unstructured, structured and bonded wafer stacks. In this process, an infrared laser is focused on the center of the wafer thickness. The energy input makes polycrystalline silicon from the original monocrystalline silicon so that the mechanical cohesion of the wafer is dissolved at the interface, and defined, predetermined breaking points, so-called 'paths' result. Several such paths placed over each other make it possible to break, or rather tear, through sections of the wafer adhered to the film. Experiments have shown that very straight breaklines are produced, with excellent spalling-free edge characteristics, and with no or veritably no particles. With targeted omission, different sizes of chips were able to be separated.

BREAKLINE OF AN UNSTRUCTURED BSOI-WAFER WITHOUT CHIPPING, SAWING PATH ENLARGED TO 120 MICROMETER

IMPRESSED NIGHT OWLS

Knowledge is night! This was the motto for July 6th by which four Dresden universities and 38 scientific facilities opened their lecture halls and labs. At 129 different locations in Dresden, over 113 individual hosts presented a sophisticated program with 605 experimental shows, tours, exhibitions, lectures, films and music – more than ever before in its 10 year history. Among them was also the Fraunhofer Institute for Photonic Microsystems IPMS, which invited visitors onto the Institute premises in Dresden-Klotzsche for the first time ever.

GUESTS WERE IMPRESSED AND OFTEN STAYED FOR HOURS

Along with Fraunhofer IPMS, three further Fraunhofer Institutes (COMEDD, IZFP, and CNT) met together in Klotzsche with industry partners X-FAB, VON ARDENNE Anlagentechnik and GLOBALFOUNDRIES to make up Campus MikroNanoNord. Amidst exhibits spread out over several floors, children's programs, lectures and even guided clean room tours, the visitors were able to get an impression of how a bare silicon wafer goes through over 100 single process steps to be transformed into microchips; for example for oscillating mirrors that selectively split light and can be utilized in pico-projectors or spectrometers that are hardly larger than a sugar cube.

Fraunhofer IPMS had over 600 visitors alone. Had the weather played along a bit better, there would have been even more. But even so, the crowd of visitors was overwhelming at all of the stations, and the guests were visibly impressed by what was offered and often stayed for hours, late into the night.

The 11th Dresdner Lange Nacht der Wissenschaften (Dresden Long Night of Science) will take place on July 5th, 2013 from 6 pm to 1 am.

UPCOMING EVENTS

Vision
Stuttgart,
Hall 1, Booth A 22 — 6.-8. November 2012

Electronica
Munich,
Hall A 5, Booth 121 — 13.-16. November 2012

Medica
Düsseldorf,
Hall 3, Booth E 74 — 14.-17. November 2012

Arab Health
Dubai,
Zabeel Hall, Booth ZE 58 — 28.-31. January 2013

Photonics West
San Franscisco,
Hall D, Booth 4323 — 05.-07. February 2013

www.ipms.fraunhofer.de/en/events.html

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Editor: Moritz Fleischer, info@ipms.fraunhofer.de