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## ICU News Flash

### Infrared Imaging Components for Use in Automotive Safety Applications (ICU)



Co-financed by the EC

## Dear Reader



Editor: Dr. Frank Niklaus  
ICU Project Coordinator

Easter is just away and ICU runs for almost two years. We can look back with satisfaction on the results and achievements coming from the international collaborative work done by KTH, Autoliv, Acreo, SensoNor, VUB and Umicore. Excellent progress has been made towards the project goals of demonstrating the key components for next generation of far infrared cameras, including the infrared lens system, the infrared bolometer array, the wafer-level vacuum package and the camera assembly.

The second evaluation with the European Commission is well on the way and we are all looking forward to the review meeting. From a personal point of view we would like to thank the European Commission for funding the ICU project through the Seventh Framework Programme and all participants for the extraordinary work enabling such constructive and positive work.

The newsletter you are reading now is the second newslaunch from ICU. The plan is to publish newsletters on a yearly basis. We hope that you enjoy the information and if you have any questions you are more than welcome to contact us.

## ICU consortium



SensoNor Technologies AS, Norway

Autoliv, Sweden

Acreo AB, Sweden

KTH - Royal Institute of Technology, Sweden

Vrije Universiteit Brussel, Belgium

Umicore NV, Belgium

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## Infrared Imaging Components for Use in Automotive Safety Applications (ICU)



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# V i s i o n   a n d   m i s s i o n

An EU-sponsored consortium of industry and academia under the acronym of "I CEE YOU" (ICU- Infrared Imaging Components for Use in Automotive Safety Applications) works on a low-cost sensor that will pick up images of pedestrians or animals crossing roads at night and transfer them to the drivers. The sensor will project the image onto the car's front screen, so that it is immediately visible to the driver. The breakthrough is based on infrared imaging technology and captures the energy emitted by warm (living) objects which is independent of ambient light and temperature conditions. This solution will considerably reduce the death tolls and the numbers of injuries caused by motorised transport. It is therefore a first step towards a considerable reduction of the more than 50.000 traffic fatalities and the almost 2 million



Source: BMW AG

injuries in Europe yearly. In addition, this infrared imaging system will also enhance operations security of heavy duty vehicles, by surveying load carrying units of lorries and/or railcars, and also warehouses and other storage facilities. Although construction of the prototype will be quite challenging in terms of integration of several complex components, the multiple

applications may lower the costs of production through mass fabrication.

"The most important challenge of all, however, is to achieve an optimum performance at the lowest possible cost, such that the infrared imaging module is affordable for everyone and can be integrated in high volume applications", said Frank Niklaus from The Royal Institute of Technology from Stockholm who is the project coordinator. However, he is also very optimistic saying that the proof-of-concept of the night vision camera will be demonstrated by end 2010'.

The European consortium developing this new optical system involves three industrial companies and three research institutes, all key-role players in infrared photonics. The industrial partners are the market leaders in automotive safety systems (Autoliv Development AB from Sweden), in automotive component manufacturing (SensoNor from Norway), and high-volume infrared optics (Umicore NV from Belgium). The universities or research institutes that will participate in the project (Acreo AB, Sweden; KTH Royal Institute of Technology from Sweden; and Vrije Universiteit Brussel from Belgium) all have a strong track record in research and development of photonic components and technologies.



# Latest Breakthroughs



Academic partners

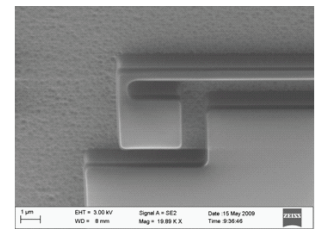
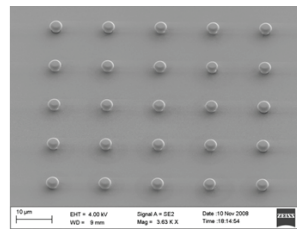


KTH (Royal Institute of Technology, Sweden) is one of the foremost technical universities in Europe and devoted to world highclass research. The Microsystem Technology Group at KTH has a very strong trackrecord in MEMS and photonic research.



Heterogeneous 3D integration has been a hot topic in the MEMS community for some time. The ICU project implements heterogeneous 3D MEMS integration for a commercially viable infrared imaging chip based on uncooled bolometer arrays, leveraging on the advantages of heterogeneous MEMS integration. A generic technique called SOIC (Silicon-On-Integrated-Circuit) integration that was developed by researchers at KTH-Royal Institute of Technology is being implemented to combine high performance bolometers with state-of-the-art electronic read-out circuit from a CMOS foundry supplier.

In the ICU project, KTH has implemented a version of the SOIC integration process containing exclusively dry etch processes, allowing for the extremely small (sub-micron) feature sizes that are required for state-of-the-art infrared bolometers. In ICU KTH also has developed plating processes to implement the very small high-density vias between the IC wafer and the bolometer structures with via dimensions of 1-3  $\mu\text{m}$  in diameter and 3  $\mu\text{m}$  in lengths. Each imaging chip contains close to 100 000 of these vias. All process steps for the SOIC platform are readily available in MEMS foundries and the technique allows easily migration between IC wafers from different suppliers or technology nodes. Thus, a foundry-less business model is viable. Beyond the ICU project, the generic SOIC platform opens new opportunities for IC integrated mono-Si MEMS such as inertia sensors, pressure sensors, resonators and microphones with increased functionality.



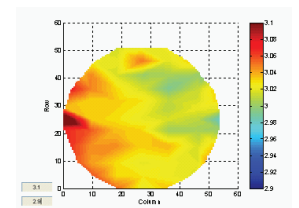
SOIC technology from KTH for MEMS and IC integration



Acreo AB (Sweden) is a research institute working in the fields of electronics, optics and communication technology. Acreo has a long history of developing and manufacturing infrared detector systems and contributes to the project with its expertise in sensor materials, microsystem manufacturing technology and ASIC design.



A theoretical investigation of the electrical properties of the SiGe quantum well material has been performed at Acreo by numerically solving the Schrödinger equation for holes in the quantum wells. The results were used to tune the model parameters of the Medici simulation packager where circuit simulations were performed. Good agreement between measured electrical response and simulated current-voltage response was obtained. The temperature sensitivity was also investigated and model predictions and measurements were in good agreement. SiGe quantum wells with a Ge fraction of 34% gives a temperature coefficient of resistance of approximately 3.2% at room temperature.



Wafer uniformity plot of TCR for 32% Ge fraction



Vrije Universiteit Brussel

The Department of Applied Physics and Photonics (TONA) is a research group within the Faculty of Engineering of the Vrije Universiteit Brussel (VUB, Belgium). The group is internationally recognized for its basic, strategic, and applied research in the field of "micro-optics" and "micro-photonics", and is also uniquely involved in industrially oriented research projects.



During the first project year of ICU, VUB came up with an optical design of a single lens (singlet) that fulfils the optical requirements and specifications which were set by the automotive industry. Going from a two lens design towards a singlet can be seen as a first step towards low-cost mass manufacturability. In the latter design the cost of the system is mainly influenced by the thickness of the lens and thus by the cost of the GASIR material out of which the lens will be fabricated. In a next step VUB investigated if the lens functionality can be achieved by a fully diffractive, a hybrid or a free form approach taking manufacturability, mouldability and coatability into account.

# Latest Breakthroughs



## Autoliv

Autoliv (Sweden) develops and manufactures automotive safety systems for all major auto makers in the world. Autoliv has developed an infrared vision enhancement which is used by BMW.



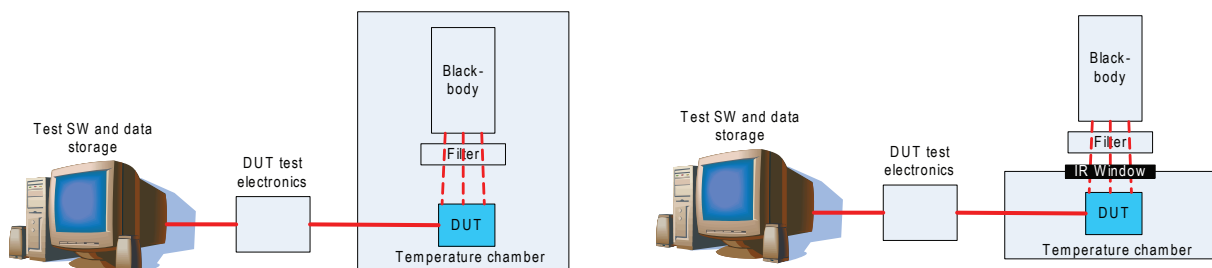
During this first year of the project Autoliv has concentrated its efforts on doing design studies for shutter, heater, power and temp sensors to find a cost effective solution. The main part in the electronic design, the FPGA is waiting final input from the work on the infrared bolometer focal plan array to define the needed computing power of the FPGA and memory size needed for calibration and real time thermal compensation. At the end of this first year Autoliv started to put together a group for the mechanical design work it consists of people skilled in mechanics, electronics, industrial engineering and testing.



Sensoror (Norway) has leading expertise in development, design and manufacturing of Micro Electro Mechanical Systems (MEMS), including key competence in wafer level bonding in controlled environments.



Within the ICU project, Sensoror is responsible for wafer-level hermetic packaging of the bolometer pixel array as well as assembly of wafer-level optics. Encapsulation of the bolometers is performed using a Cu-Sn Solid-Liquid Inter-Diffusion process in vacuum. Metal deposition and bonding technologies have been developed, and properly sealed vacuum cavities have been demonstrated on wafer level. The processes have been improved in order to be compatible with respect to thin film getters and miniature vacuum sensors for pressure level verification. The pressure sensor is of pirani-type and designed similar to the active bolometers. Its signal is compared with the corresponding bias current from thermally shorted reference pixels.



Integration of wafer-level optics has a huge potential to reduce the overall cost of the FIR system. Together with Umicore, Sensoror has considered optics design trade-offs, materials and process technologies. A strategy for lens assembly in front of the focal plane array based on entirely low-temperature processes has been proposed. The concept is planned to be tested in middle of 2010.



Umicore (Belgium) is a materials company active in applications, such as solar cells, car catalysts, batteries and infrared optics. Umicore provides moulded infrared optics for automotive, thermography and other applications.



As a benchmark for the fully diffractive lens design, and as a classical demonstrator route, Umicore has designed a conventional optic using its mouldable glass GASIR. This lens design can be realized using conventional manufacturing techniques available at Umicore. However, to reduce cost of the lens and to maximize the benefit of using the mouldable GASIR, Umicore has developed a wafer level moulding route, that in this project will be used for the first time in a wafer level system integration approach. Moreover Umicore is designing a square lens to optimize materials utilization as well as lens integration cost.

Current efforts are focusing on integrating the lens bonding features into a mouldable design, and on the development of a moulding geometry that is able to offer the desired features and accuracies.

# Industrial User Club

ICU's Industrial User Club (IUC) is the interface between the academic and industrial partners in ICU and third party industry. Registration for the IUC is at no cost and its prime role is to facilitate the access of key-user companies to the competences of the partners in infrared imaging components and to ICU's know-how in enhancing products for infrared sensing. As a member of the IUC, companies find experts in infrared lens systems and bolometer arrays, wafer-level vacuum packages and camera assemblies who are prepared to help with problem solving and support in infrared imaging systems and cameras.

If you want to be informed about the IUC or to become a member, please contact  
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www.icu-eu.com

## ICU Benefits for Industry Workshop

ICU organizes a workshop to highlight the enabling forum of infrared components and sensors to industrial partners. This happening will take place on Thursday April 15th from 13.00 to 14.30 at Photonics Europe 2010 (Square Conference Centre), Brussels. This workshop provides the participants with first hand information on infrared imaging systems. Participants will have time to discuss specific questions with experts from the ICU consortium.

If you or your colleagues want future issues of this newsletter, you can register at [www.icu-eu.com](http://www.icu-eu.com)



## ICU consortium

