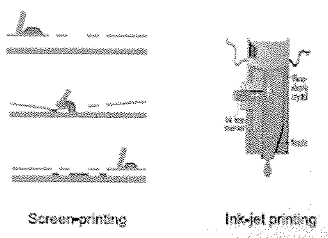
Steered by sense

Automotive safety systems will contain many more MEMS chips in the coming years, and a considerable number could be embedded in fabrics

AUTOMOTIVE safety systems are to be found in a growing number of vehicles, and shipments of MEMS – micro-electro-mechanical systems – that are crucial to their operation, are increasing even faster.

Presently, a European Union FP7 project is exploring the fabrication of miniature sensors and actuators (transducers) based on MEMS for the production of flexible smart fabrics, based on screen and inkjet printing, which could open up a range of new applications in automotive interior fabrics.

Screen printing and ink-jet printing in the MicroFlex Project



- The screen printing process is relatively simple and can be used to deposit active materials on a wide variety of substrates such as ceramics, steels, silicon and flexible substrates such as fabrics and textiles.
- Ink-jet printing is a simple non-contact technique that deposits the material in the desired pattern via a nozzle avoiding the use of screens or printing plates and is potentially compatible with many rigid and flexible substrates such as fabrics and textiles.

Rocketing

Nearly 100 million airbag, tyre pressure monitoring, and electronic stability (ESP) safety systems containing more than 300 million MEMS chips were sold worldwide during 2010.

By 2016, about 150 million systems are expected to be installed in vehicles, but the number of MEMS they contain will have rocketed to over 830 million.

"Safety systems are becoming more advanced and more complex, and each new system tends to contain more sensors than previous generations," explains ABI Research practice director Peter Cooney.

MEMS generally fall into three main categories – accelerometers, pressure sensors, and gyroscopes.

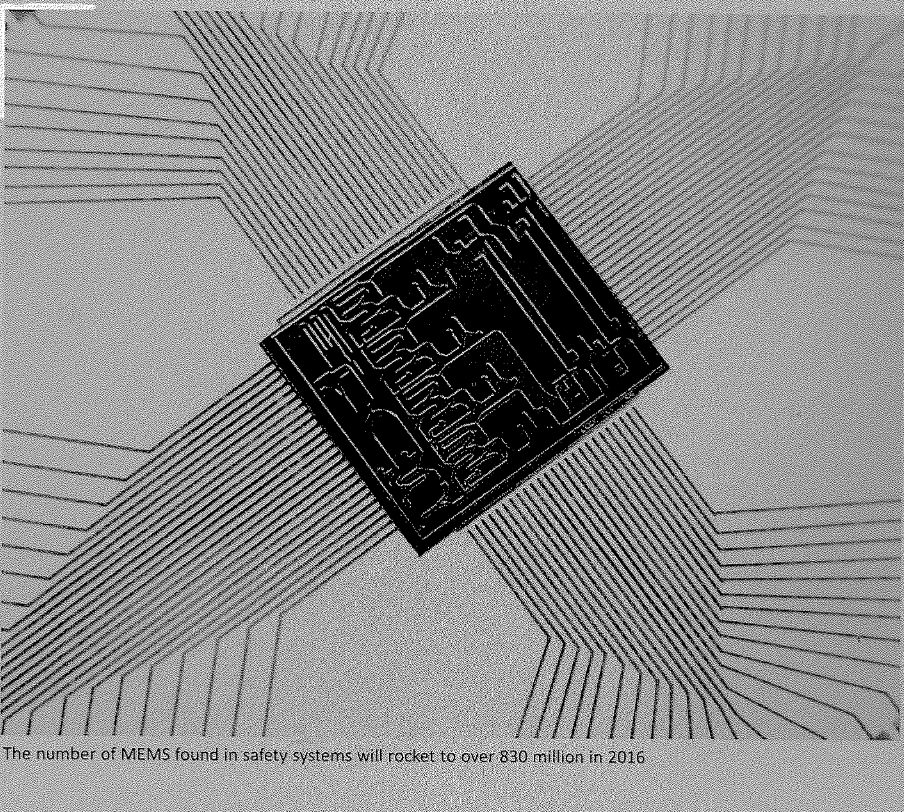
One technical trend is to integrate several sensors, or types of sensor, on a single chip and a related trend is to make a single MEMS do double or triple duty in the service of several safety systems.

"Sensor integration will have a negative effect on MEMS sensor market growth, which will also come under pressure from increasing market competition," says Cooney, who is the author of a new ABI report 'Automotive MEMS Sensors'.

More important than any of these changes, however, is the single largest driver of the automotive MEMS and safety systems market – government mandates.

When governments make safety systems mandatory, MEMS suppliers see a big benefit.

MEMS suppliers to the automotive market are currently few and it's certainly no market for start-ups being both difficult to get into and requiring substantial financing. But profits can be significant for those who succeed.


The number of MEMS found in safety systems will rocket to over 830 million in 2016

Printing MEMS on fabrics

MEMS processing capability for the production of flexible smart fabrics based on screen and inkjet printing – with new functional inks compatible with fabrics – is the goal of the €7.7 million EU FP 7 MicroFlex project.

The four-year project involves 14 partners from nine countries – including textile companies Klopman International, Bonfort, Paul Boyé – and will announce its final results in October 2012.

The MicroFlex project is concentrating on fabricating miniature sensors and actuators (transducers) based on MEMS which have mechanical and electrical functionality.

"At present MEMS technology is dominated by silicon microfabrication technology, although polymer materials and processes are increasingly being used," explains Dr Steve

Beeby, of the School of Electronics and Computer Science at University of Southampton, the project co-ordinator. "MEMS fabrication on fabrics is a challenge since a fabric is a very different substrate compared with a silicon wafer. A fabric has a rough, uneven and hairy surface and is flexible and elastic. While suitable for low temperature processing, fabrics have limited compatibility with solvents and chemicals.

"MicroFlex aims to use standard printing techniques to deposit a range of custom inks in order to realise freestanding mechanical structures coupled with active films for sensing and actuating."

The printing techniques being employed are:

- Thick-film printing, normally used in the fabrication of hybridised circuits and in the manufacture of semiconductor packages.
- Inkjet printing involving non-contact direct printing onto a substrate which is used for both fabrics and electronics applications.
- Sacrificial etching for the MEMS.

"These printing processes have many benefits, including low-cost, repeatability, flexibility, suitability for high throughput production, relatively inexpensive equipment, short development time and the capability of depositing a wide range of materials," says Dr Beeby. "All the novel printed inks will be electrically activated sensors and actuators and will use standard electronic devices for power supply and storage, signal processing and communications offering low price and mass production."

The printed MEMS process being developed consists of:

- A piezoresistive layer.
- An interface layer.
- A sacrificial layer.
- A structural layer.
- The fabric.
- An electrode.

The sacrificial layer must be printable, solid, compatible and easily removed without damaging the fabric or other layers, while the structural layer must be suitable for imparting mechanical/functional properties.

The MicroFlex project will first demonstrate the functional inks, and then use these in the sacrificial layer process. Among notable development steps so far:

- A printed strain gauge has been demonstrated by the Jožef Stefan Institute, with ink developed by ITCF Denkendorf on fabric from Italian technical textiles specialist Saati. This exploits the piezoresistive effect – piezoelectric materials expand when subject to an electrical field, and similarly produce an electrical charge when strained, making them ideal for sensing and actuating.
- The global engineering group Meggitt has developed a screen printable piezoelectric paste, based on graphite, that can be printed onto fabrics.
- The printed sensor was created with silver electrodes printed using a low temperature polymer silver paste.
- Conductors have been screen and inkjet printed on fabric.
- A heater has been screen printed on fabric.
- An electro-luminescent lamp has been screen-printed on fabric.

All of these developments are currently being evaluated.

www.abiresearch.com/research/1006492
www.microflex.ecs.soton.ac.uk

Avoiding hot spots

CoTexx knitted heating fabric developed by the company of the same name based in Gachenbach, Germany, is a semi-finished fabric made of litz wire.

It is being used for the simple and cost-effective construction of electric panel heaters which can be effectively employed in automotive interiors.

It also has the potential for use in composite parts manufacturing. Embedded in heated female moulds or heated silicon hoods the product helps not only to drastically reduce cycle times, but also to reduce the viscosity of the resin during injection, by preheating the mould.

"Studies conducted recently have confirmed that due to the reasonably large specific surface of the litz wire used, the thermal transfer to the surrounding matrix is extremely effective and therefore without unwanted thermal peaks," explained CoTexx managing director Hans-Thilo Langer.

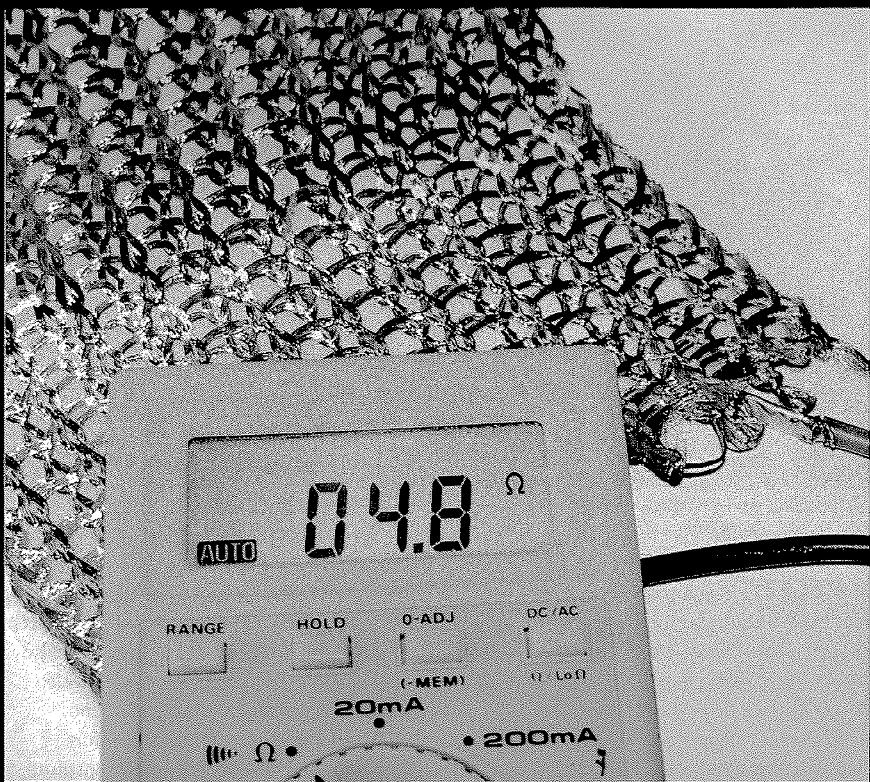
CoTexx consists of a knitted fabric made of multiple strands of litz wires. The individual wires of the litz wires are enamelled and insulated against each other, so in the case of breakage of individual wires, 'hot spots' are impossible.

Up to now, a maximum heating power of up to 1,500 watts per square metre has been demonstrated with a maximum temperature of 140°C. In specially designed models, temperatures of more than 240°C and much higher heating capacity can be achieved, the company says.

In addition to automotive and moulds for the manufacturing of fibre-reinforced plastics, other end-uses include use in electric airfoil ice protection systems for wings, rotor blades and propellers and the electric heating of tubing and lines for aircraft. It can also be used as a de-icer in a range of household and construction applications.

CoTexx is distinguished by a homogeneous heat distribution and a technically reliable design, making it simple and easy to process,

Contacting is rapid and reliable and it can operate with extra low voltage as well as rotating current.



CoTexx knitted heating fabrics