IMEC embeds **active optical links in flexible substrates**

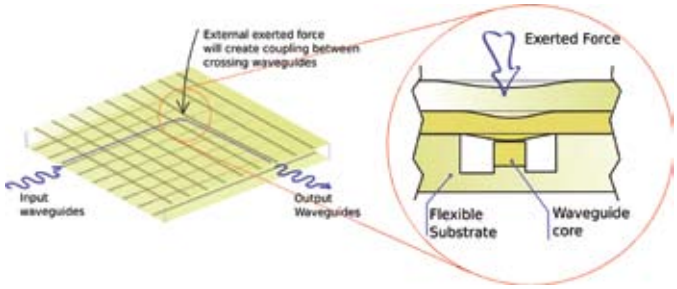
INTEC, IMEC's associated laboratory at the Ghent University has made the first functional optical links embedded in a flexible substrate. The links include optical waveguides, light sources, and detectors. With this technique, it becomes possible to make foils that sense changes in pressure. Such sensing, skin-like foils could be used for monitoring irregular or moving surfaces, e.g. in robots, pliable machinery, or as an artificial skin.

Integrated optical interconnections have the advantage that they are insensitive to electromagnetic interference, applicable in harsh environments, and highly sensitive. Last year, IMEC already reported embedded optical links on rigid surfaces. The current research takes optoelectronics one step further. Standard commercially available GaAs photodetectors and GaAs vertical-cavity surface-emitting lasers (VCSELs) are thinned down to 30µm. Next, they are embedded into a flexible foil of optical transparent material and optically coupled with embedded waveguides and out-of-plane micromirrors. The resulting structure shows good adhesion and flexible behavior.

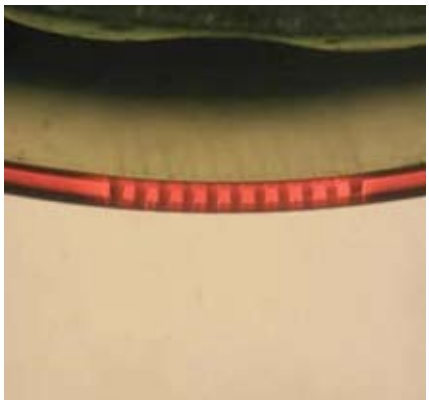
With this technology, IMEC is working on two types of sensors: array waveguide sensors and optical fiber sensors. Both can be used for sensor foils. Array waveguide sensors rely on the change in coupling between arrays of crossing waveguides. Two layers of polymer waveguides are separated by a thin layer of soft silicone. When no pressure is applied, no crosstalk is detected. But when pressure is applied to the foil, the distance between the waveguides in the separated layers decreases, and light is transmitted from one layer to the other. This low-cost sensor is ideally suited for high-density pressure sensors on small areas.

Optical sensing foils combine two technologies that have lately seen a growing interest: integrated optical interconnections, and flexible, stretchable electronics. The ambition of researchers is to create a flexible and stretchable skin-like foil sensitive to touch, pressure, or deformation. Such artificial skin could be used in medical and industrial environments. To this aim, a group of European research institutes, including IMEC, are collaborating in the 7th Framework project PHOSFOS (Photonic Skins For Optical Sensing).

PHOSFOS will develop photonic foils based on optical fiber sensors. These foils are targeted at applications in civil engineering and medicine. They will, for example, continuously monitor the integrity and the behavior of buildings, dams, bridges, roads, or tunnels. Other uses are monitoring aircraft wings, helicopter blades, or windmill blades. They will enable early warning of failure or anomaly. Skin-like PHOSFOS membranes will also be used in long-term monitoring of respiration and cardiac activity, as well as the detection of pressure points under bed-ridden patients.



Principle of the array waveguide sensor.



Optical foil, bended with radius of curvature of 1cm.

Patents

Europe

- *Optical system with a dielectric subwavelength structure having a high reflectivity and polarisation selectivity. (EP 0 798 574)*
- *Floating body cell memory device and a method for the manufacturing thereof. (EP 1 693 898)*
- *Dielectric constant (k-value) enhancement of Hf comprising compositions. (EP 1 372 160)*
- *CMOS semiconductor devices with selectable gate thickness and methods for manufacturing such devices. (EP 1 315 200)*
- *Organic light-emitting device with field-effect enhanced mobility. (EP 1 808 911)*
- *Molecules suitable for binding to a metal layer for covalently immobilizing biomolecules. (EP 1 798 250)*

Japan

- *Megasonic cleaner and dryer system. (JP 4114188)*
- *A method for producing micromachined devices and devices obtained thereof. (JP 4128764)*

USA

- *A method for producing micromachined devices and devices obtained thereof. (US 7,347,557)*
- *Method for selective deposition of a thin self-assembled mono-layer. (US 7,368,377)*
- *Design method for RF MEMS devices and devices resulting therefrom. (US 7,372,346)*
- *Methods for bonding and devices according to such methods. (US 7,378,297)*
- *Method for extracting the distribution of charge stored in a semiconductor device. (US 7,388,785)*
- *Dry etching of poly Si gates doped with Yb. (US 7,390,708)*
- *Etching of structures with high topography. (US 7,393,768)*
- *Formation of deep airgap trenches and related applications. (US 7,396,732)*
- *Impurity measuring method for Ge substrates. (US 7,399,635)*
- *Formation of deep airgap trenches and related applications. (US 7,400,024)*
- *Electrostatic discharge protection device. (US 7,405,914)*
- *Megasonic cleaner and dryer system. (US 6,928,751)*
- *Megasonic cleaner and dryer. (US 7,100,304)*
- *Composition and method for treating a semiconductor substrate. (US 7,422,019)*