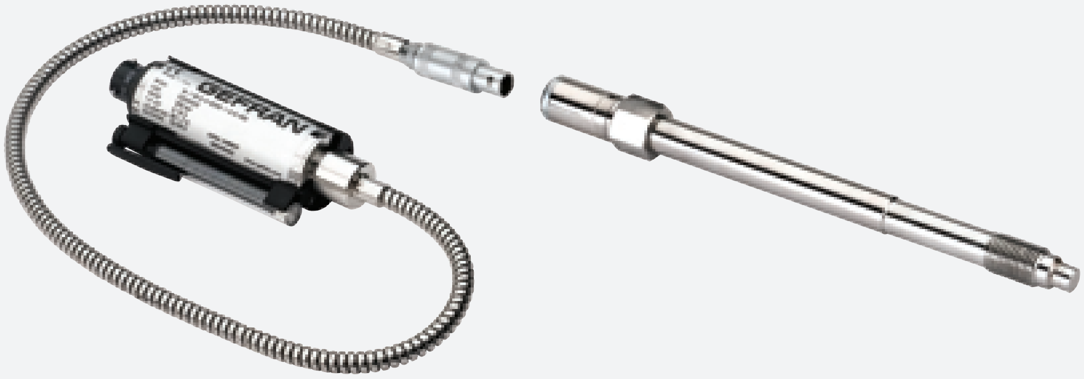
IMPACT
The Melt fluid free sensor

Gefran confirms its intense vocation for research, offering the market a **high temperature pressure sensor with innovative construction technology**.

Series I (Impact), realised using solid state technology, is a true novelty in terms of the products present on today's Melt sensors market.
For final users this new technology means **greater sensor sturdiness**, providing longer average life and a product that can withstand ruptures caused by the collapse and wear and tear of the contact membrane as a result of abrasion due to charged polymers.



IMPACT
Innovative Melt Pressure Accurate Transducer

IMPACT

IMPACT, a Gefran exclusive, comprises a series of high temperature sensors based on the piezoresistive principle and they do not contain any transmission fluid. They are not only mercury-free, but completely fluid-free.

These devices, realised with solid state technology, are widely used in sensor applications and silicon microprocessing is an already consolidated reality.
Gefran is itself a confirmation of the same, with its catalogue offering two pressure sensor series, realised with silicon technology: the TSA series and the PMH series.
Interesting development areas, on the other hand, can still be observed in the high temperature sensor equipment area, and here Gefran, which has always been actively commited to creating new technology, has interpreted the very latest needs by producing - the first in the world to do so - a 1000 bar pressure range sensor, for working temperatures of up to 350°C.

The project, which generated 4 new patents, originating and fully completed within Gefran, was the result of combining all the company's many competences.
Starting with the technological know-how involved in the primary element, developed in the centre dedicated to the study and production of primary technologies, right through to the design of the electro-mechanical elements, realised by the Gefran Sensori R&D group.

Sensor design

The sensitive element (fig. 3), directly positioned behind the contact membrane, is realised in silicon through microprocessing techniques. The micro structure includes the measurement membrane and piezoresistors.
The minimum deflection required by the sensitive element makes it possible to use very robust mechanics. The process contact membrane can be up to 15 times thicker than the membrane used in traditional Melt sensors.

Transfer of the pressure from the membrane to the sensitive element is entrusted to a push-rod, while behind the chip there is a system that functions as a holder for the entire packet (fig. 4).
All this could already be described as absolutely new. However, the developments achieved have also taken on board further difficulties arising as a result of the environment in which the entire structure operates. It is specifically in the push-rod area, where mechanical-thermal stresses are greater, that the sensitive element and all transduction mechanics are located.

The sensor not only has to withstand this environment, without compromising its functioning, but at the same time it also has to guarantee accurate and repeatable pressure readouts.
All this has enormously complicated the design work relative to which the commitment required has been intense, from a know-how point of view, as regards design creation, materials and the different technologies used in the assembly of all the various elements.

Extensive use of lasers and special alloys was therefore made to allow, for example, the coupling of different materials such as steel and ceramics and even more the creation of completely innovative transduction mechanics relative to which Gefran has filed, as mentioned above, 4 patents.
Though on the one hand use of solid state technology required a major design commitment, on the other, it had, as a positive effect, the total construction flexibility of many of the mechanical details included in the transducer.

It has therefore been possible to realise completely floating push-rod coupling mechanics.
Thanks to the fact that, starting with the push-rod itself, the transducer contains solely electrical wires, in the I series it has been possible to separate the rod from the conditioning electronics, since the two parts are connected to each other solely via a connector.

fig. 3

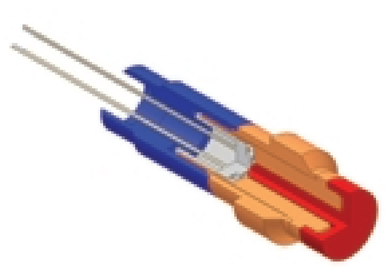


fig. 4

The Chip

The chip, (fig. 5), Gefran patent pending, is realised in a single microprocessed structure in silicon (MEMS), containing membrane and sensitive element.
One starts with a silicon membrane, with geometries appropriately designed, on which a layer of oxide has been deposited. The deposit of silicon oxide creates a dielectric insulation state. The advantage provided by use of SOI construction technology is that it permits higher working temperatures with respect to those observable with SI sensors, where P-N transition is used.
Subsequently, piezoresistors are inserted on this structure. The operation occurs via a ionic implantation process, which consists in introducing loaded particles (ions) with high energy within a substrate such as, for example, Si.
A further phase in chip construction is that required for deposit of the "Metals". The latter realise the electrical connections; as regards Impact, the piezoresistors are connected to each other in accordance with the classic Wheatstone bridge layout.

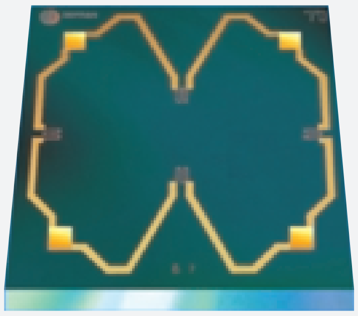


fig. 5

Technical features

Constructed mainly for reading Melt pressure on extruders, the I series offers features that can fully satisfy the application's requirements, guaranteeing operating temperatures of up to 350°C for pressure ranges starting from 100 through to 1000bar with a degree of accuracy equal to 0.25%FS.
Zero and full scale signal readout errors due to temperature variations around the transducer are contained within a value lower than 1%FSO for the entire 20-350°C temperature range.
This degree of error takes into account, at the same time, thermal variations that occur in the area of the push-rod and the electronics housing.
Attachments to the 1/2-20UNF, M18x1.5 process, and 4-20mA, 0-10V electric outputs represent the consolidated interface towards the process, guaranteeing interchangeability with existing products on the market.
As in all the Melt Gefran transmitters series, the I series too is provided with an Autozero function, able to guarantee easy resets of zero offsets, an essential function during the initial phase when coupling the sensor to the machine.
The novelty with respect to past models concerns the ability of the sensor to work in static and dynamic applications with readout times of 1 ms; this limit is provided by the conditioning electronics, since the sensitive element is individually able to refer signals by work frequencies in the order of tens of KHz.

Advantages

Each Impact element has been designed and produced to support pressure measurement requirements in the plastic material transformer machine.

Starting from the contact area with Melt, the first aspect to be noted is the **considerable thickness of the membrane**. A figure that immediately provides us with an idea of the enormous improvement which has taken place relative to this component is that obtained when comparing the thickness of the membrane of the Impact sensor with that of a "traditional" Melt sensor, realised with filled technology.

The ratio between the two involves a **thickness 10/15 times greater** in favour of Impact. It is clear that being able to count on a diaphragm of greater dimensions is in turn translated into greater sturdiness and as a result longer life for the sensor.
In terms of statistics, more than 90% of Melt probe breakdowns are due to contact membrane collapse.

More specifically, as regards use in the field, **there are no longer any concerns as regards wear and tear of the membrane caused by abrasion due to charged polymers**.

The improvement achieved in the membrane structure is such that in the design phase the decision was taken not to add any coating.
No protection therefore, precisely where, in traditional Melt probes, the choice of coating is fundamental in order to guarantee compatibility of the sensor with the process.
Again with respect to toughness, laboratory tests and field tests confirm **the sensor is completely free of any problems linked to the adhesiveness of some materials** e.g. PA and PC to cite just two.

This feature is extremely important when one considers the problem relative to what are commonly defined as **cold starts**: in all those process phases where, for unwanted reasons, the material is not in a Melt condition.
Advantages in a critical phase of the sensor's life can also be observed during **installation and substitution**, phases in which the risk of rupture is always present.

During the design phase, valid solutions were also discovered and realised in order to **facilitate installation: Impact mechanics are in point of fact floating** i.e. it is possible to have a rod entirely detached from the sensitive membrane-element. The sensor is modular where the rod is fixed to the flex and the signal conditioner through a connector.
In this way the two items can be kept separate during the installation phases on the machine.
In terms of application, and more specifically as regards stress under pressure, the ability to withstand static/dynamic pressures guarantees **compatibility with each plastic transformation process**.

Lastly, and certainly a fundamental feature of this sensor, is the fact that it **does not contain any transmission fluid**. Impact is therefore the "Mercury free" product, with no compromises, and hence the best solution for use with materials involved in the **food sector (e.g. film foodstuffs packaging, drinks containers), and in the pharmaceutical/cosmetic sector (e.g. medicines, soaps containers), in total compliance with the RohS European directive**.

Within the work team which Gefran set up to develop the project, there is a keen awareness that the I series constitutes an enormous leap forward in the way sensors for HT are constructed, de facto shifting the technological reference frame. Expectations concerning Impact are therefore very high given that we are still only in the initial stages of this new technology's considerable future potential.

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