New Technology

Low Cost Low Power Micro Force Sensor

FEATURES

- Precision force sensing
- Signal Conditioning Available
- Low linearity error (±1%)
- Very low power consumption
- Fully integrable with the stressed surface (no glue required)
- Very small dimensions of sensing area (300 x 300 µm)
- Intrinsic Wheatstone bridge configuration

TYPICAL APPLICATION

- Stress analysis
- Load and compression sensing
- Contact sensing
- Torque/Force separation
- Wireless Micro Force sensor
- Robotic finger sensor
- Sensorized surface
- Low cost Pressure sensor

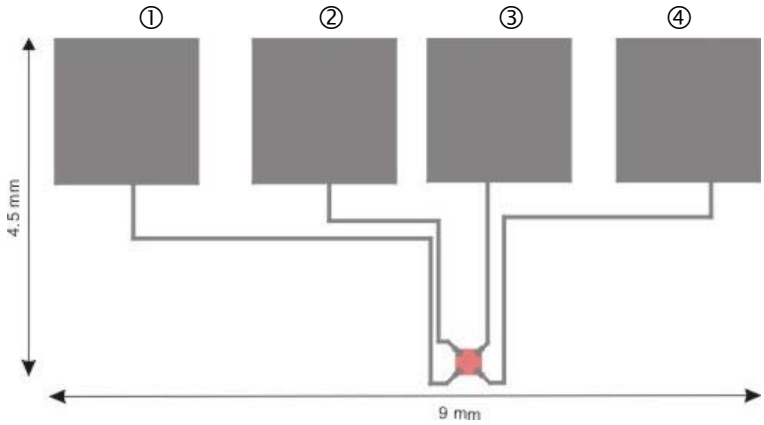

Figure 1: Layout of the sensing structure

This Force Sensor provide precise force sensing performance and it has unique features of very low power consumption and very small dimensions fully integrable by deposition on the stressed surface which is monitored. The low power, unamplified, non compensated Wheatstone bridge circuit design provide variable sensitivity up to 3 of gauge factor consuming 60 mW. This low power operation ensures realisation of Force/Pressure wireless measurement with good linearity on wide set of materials like glass, ceramic, stainless steel, plastic and flexible materials (Kapton).
Furthermore, the manufacturing processes based on deposition (CVD) avoiding the use of glue for the sensor installation permits to realise complex array of sensing elements in only production step also on non-planar surfaces (curvilinear profile).

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PERFORMANCE CHARACTERISTICS @ 25 °C
Unamplified and uncompensated sensor on Corning Glass 7059
Preliminary, based on limited data

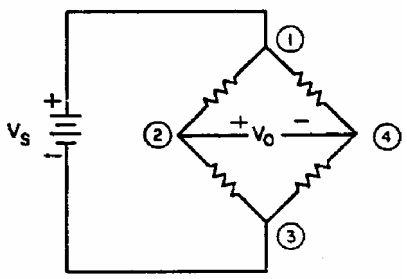
Parameter	Min	Typ	Max.	Units
Current Excitation	500		1500	µA
Null offset		80	190	mV
Linearity (BFSL)		± 1		% Span
Operating Force[3)]			± 100	gram
Strain Sensitivity[5)]	1,0		2,8	µV/µε
Force Sensitivity	2,0		6,0	µV/gramcm
Force Sensitivity	190		564	µV/Ncm
Input resistance		27K[4)]		ohms
Offset sensitivity in current mode[1)]		0,189		mV/µA
Offset sensitivity in voltage mode[2)]		7,163		mV/V
Resistance shift 20 to 50 °C		0,027		%/°C
Null shift 20 to 50 °C	90		270	µV/°C
Sensitivity shift 20 to 50 °C		TBD		% Span
Repeatability		TBD		% Span
Power Consumption	6,75		60,7	mW

[1)] Non-compensated force sensors, excited by constant current
[2)] Non-compensated force sensors, excited by constant voltage
[3)] Force sensors on Corning Glass Substrate (limited value to avoid glass break)
[4)] To be verify
[5)] Calculated for cantilever beam fixture

PERFORMANCE CHARACTERISTICS @ 25 °C
Compensated and amplified sensor

Parameter	Min	Typ	Max.	Units
Sensitivity	5		14	mV/µε
Null offset			50	mV
Null shift 20 to 50 °C		1,13		% Span

EXCITATION SCHEMATIC



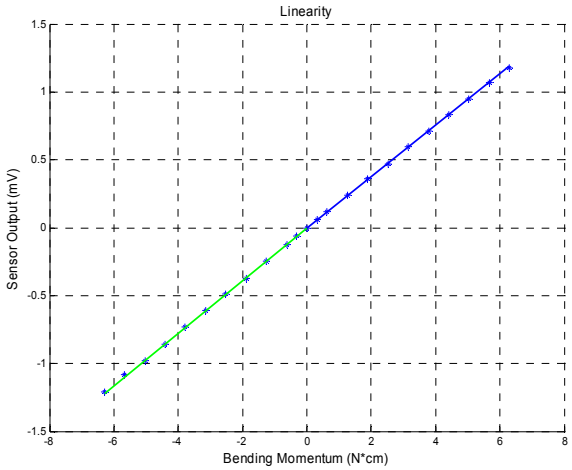
1. Circled number refer to sensor terminal (pins), see also figure 1.

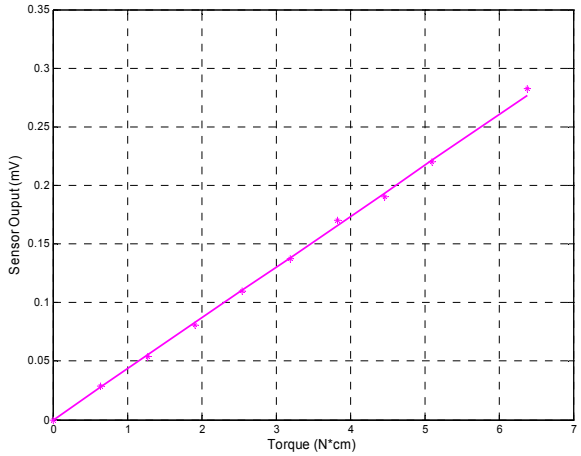
Pin 1 = Supply Vs (+)
Pin 2 = Output (+)
Pin 3 = Ground (-)
Pin 4 = Output (-)

2. The force sensor may be power by voltage or current. Maximum supply current is not to exceed 1,5 mA. Power is applied across Pin 1 and Pin 3.
3. The sensor output should be measured as a differential voltage across Pin 2 and Pin 4 (V_o=V_2-V_4). The output is ratiometric to the supply voltage. Shifts in supply voltage will cause shifts in output. Pin 1, Pin3 are interchangeable with Pin 2 and Pin 4.

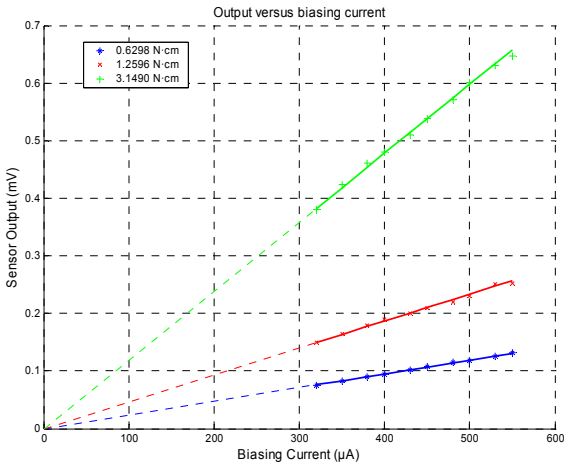
PERFORMANCE DIAGRAMS @ 500 µA

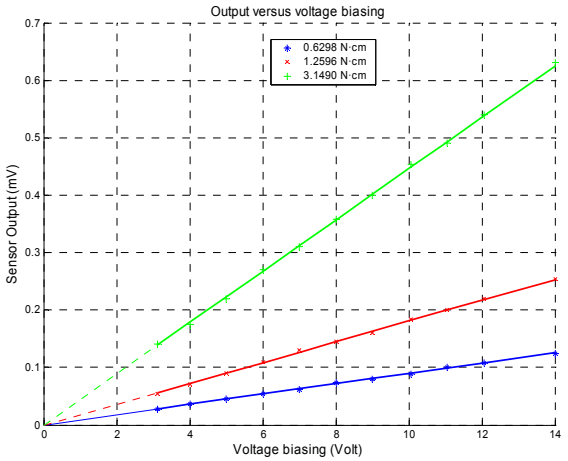
Linearity for bending and torque force



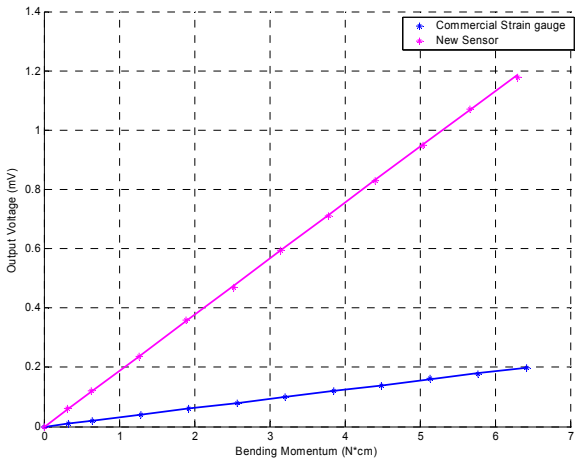


Sensitivity versus excitation value

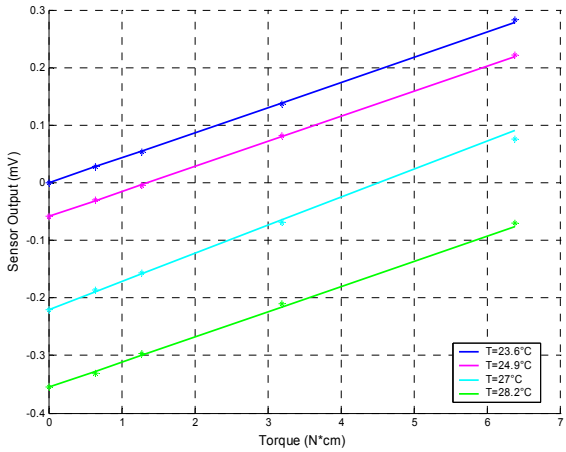




Sensitivity comparison with metal foil strain gauge @ 500 µA



Sensitivity shift



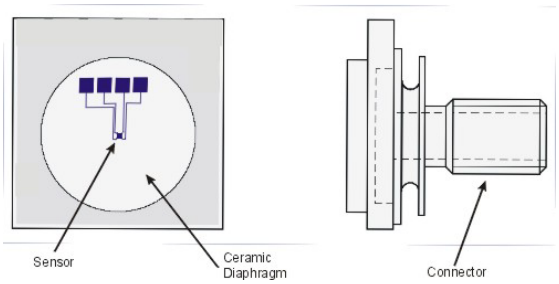
APPLICATIONS

General

Miniature pressure sensor

Background
In many application field we need to measure pressure with precision, reliability and very compact size. Today integration is a key factor in industrial, medical, electronics devices.

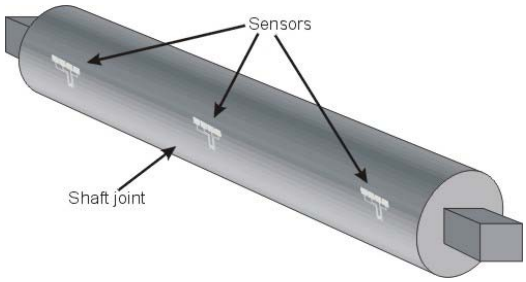
Solution
The sensing structure can be deposited on diaphragm of different material to realise a low power low cost pressure transducer. A low cost substrate like plastic (Kapton or PET) can be used. Al_2O_3 Ceramic material can be excellent diaphragm material to ensure sensor reliability in presence of aggressive fluids or gases. Different sensitivity and pressure can be measured depending on the diaphragm size and thickness.



Stress analysis

Background
Stress analysis means multi-axis stress fatigue testing, proof testing, residual stress, torque measurement, bending and deflection measurement, compression and tension measurement and strain measurement. Stress analysis is required in many field: force measurement in machine tools, in aerospace applications, in impact sensor, in hydraulic system, and so on.

Solution
New sensor technology realise a new way in the field of stress analysis. Array of these devices can be deposited on the stressed material to measure force/torque without using glue (epoxy resin). Planar and curvilinear surfaces can be monitored with this technology with the minimum installation cost. For example, pipe stress analysis or shaft torsion measurement are interesting application for this technology.

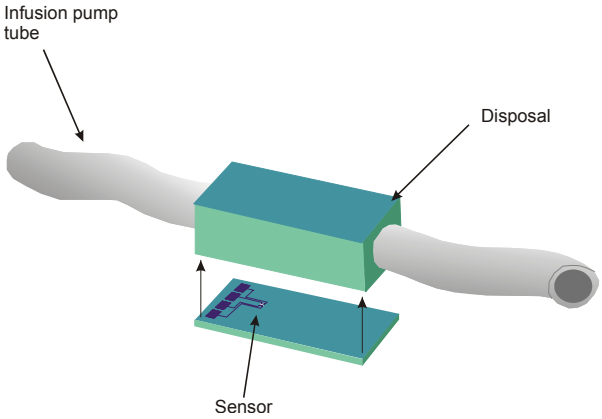


Medical

Infusion Pumps and drug delivery system

Background
The potential uses of the devices grow as they become more compact. The original infusion pumps were bulky mechanisms, but today, infusion pumps have evolved into easy-to-use models, including portable, ambulatory, and implantable devices.
Infusion pumps and drug delivery systems meter medication through a disposable plastic set or tube inserted into the patient. When a blockage prevents fluid from moving down the tube, the sensing element detects a pressure spike and indicates an alarm condition.

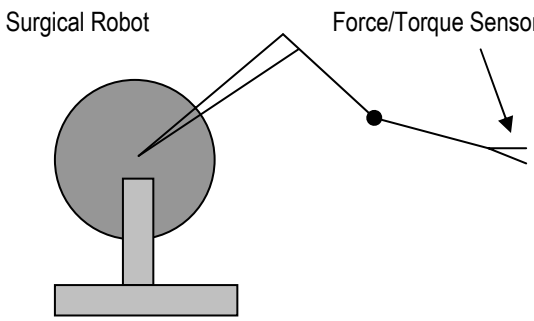
Solution
The sensor can be deposited directly on a disposable to monitor the pressure inside tube with the minimum size.



Force Feedback in Surgery

Background
In Robotic surgery the importance of force feedback is mandatory. The absence of force feedback increase the magnitude of applied force causing unwanted mechanical stresses. The force feedback is widely assumed to enhance performance in Laparoscopic surgery.

Solution
New sensor technology can be integrated in the robotic hand head for precise and local force/torque measurement without using glue which is not bio-compatible material.

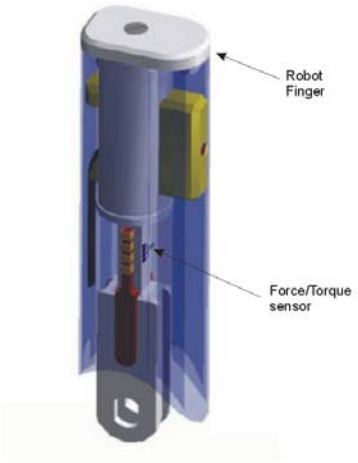


Industrial

Robotic finger sensor

Background
In advanced robotic applications where a physical interaction of the robot with the environment takes place, the measurement of interaction forces is of basic importance for a safe execution of the desired tasks.

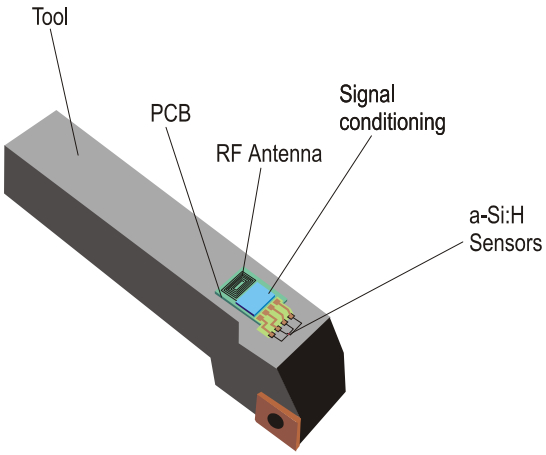
Solution
The compactness of the sensor can be useful to integrate and embed on robot parts to measure Force/Torque.



Wireless Tool Monitoring of an Automated Lathe

Background
In industrial application like CNC-machine tools is very important to monitor continuously the stressed mechanical parts as the lathe tool to detect the overload force and to avoid the unwanted torsion force on the cutting edge.

Solution
The sensor can be deposited on the tool without using of epoxy resin and the near signal conditioning system can be wireless transmit the measurement to the lathe control.

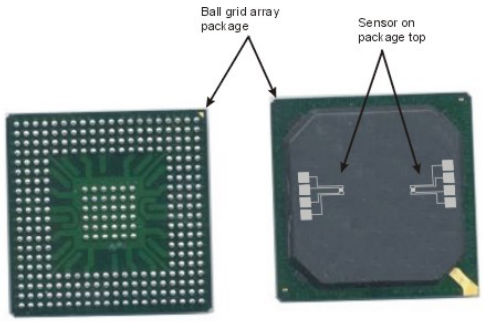


Microelectronics

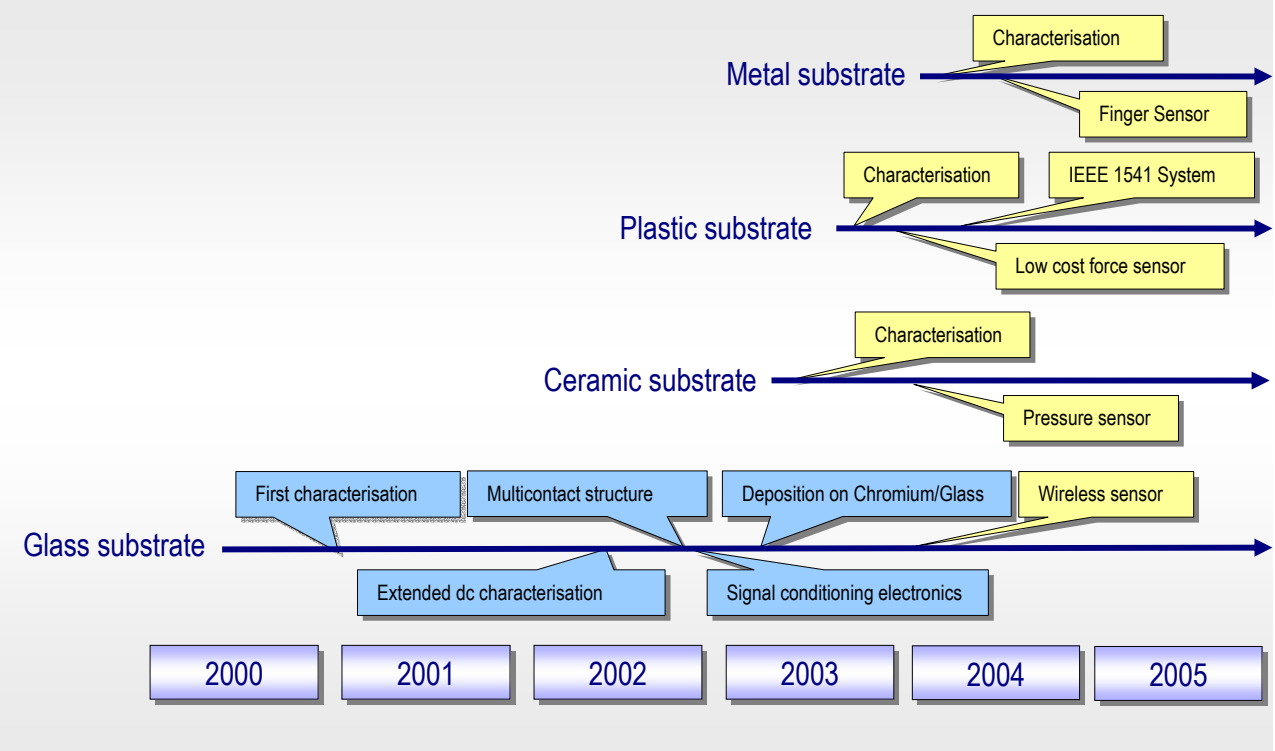
Plastic or ceramic package induced stress measurement

Background
Integrated Circuit devices play a fundamental role in today's world, being used in consumer electronics, household appliance, computer, cars, telecommunication, robot, space and military equipment. A microelectronics package serves a mechanical support and protection for the silicon chip and also allows power and signal transmission to and from the IC using interconnections from the chip surface to leads which extend outside the package. The increasing power densities (especially in microprocessor) and heat generation will lead to higher operating temperature and greater mechanical stress from the silicon die and its plastic carrier. This induced stress can reduce reliability of IC packaging

Solution
Using micro force sensor is possible to characterize the induced stress on packaging during life of the IC when the package is on printed circuit board. Two sensor can be used to evaluate the displacement on top side of plastic/ceramic chip carrier.



Sensor Technology Roadmap



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