Low-cost thick-film force sensors for the 100 N force range
T. Maeder, I. Saglini, G. Corradini, P. Ryser
Ecole Polytechnique Fédérale de Lausanne (EPFL)

Thick-film piezoresistive force & pressure sensors
- Ruggedness, good stability and reliability
- Low cost, repeatable industrial fabrication process
- Cantilever force sensors good for low forces only
- Complex machined load cells expensive
- Up to now, no « simple » sensor for high forces

"MilliNewton" cantilever-type force sensor for 0.2–2 N range. Range is limited in practice by the cantilever and by the solder or glue joint to the sensor base.

Steel + thick-film high range force sensor for total knee arthroplasty - ligament balancing

Mechanical model & examples
Friction at loading points is a source of hysteresis - not a high-accuracy design!

Results
Response of sensors (same substrate thickness) with different amplifier gain settings. Note the significant hysteresis of sample #00.

Detailed results for sample #00: noise, nonlinearity and hysteresis.

Repeated loading of a single sensor, showing good stability.

Conclusions
- Design & fabrication of a low-cost force sensor for the 100 N range has been successfully carried out.
- The force range this design can cover with standard materials is roughly 10–400 N.
- Sensor is sturdy, compact and reliable.
- Friction at loading rings is the most probable cause of hysteresis, and must be addressed to improve precision!