Signal stability of LTCC cantilever force sensors

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Advantage of LTCC cantilever for force sensor: much more sensitivity compared to classical alumina-based device due to:
- Young’s modulus approx. 3 times lower than alumina
- Availability of thinner sheets
- 3D structured beam increases the sensitivity of the piezoresistive bridge

Nevertheless abnormally large although linear response and drift of the signal have been sometimes observed:
Potential causes:
- interaction of piezoresistor & conductor materials with LTCC tape
- plastic deformation of conductor tracks & resistor terminations
- defective bonding between the LTCC layers

Experiments to elucidate the stability problem:

Studied parameters:
- Cantilever thickness
- Placement of 2nd conductor layer: inner (Cin) or top (Cout)
- Resistor firing process: co-firing (Rco) or post-firing (Rpost) with LTCC and conductor terminations
- Lamination mode: between rigid metal plates or with a rubber insert laterally constrained by an aluminium tube

Assembly on batch of the LTCC cantilever (in blue) on no-amplified base for active test. The sensing and structured side of the cantilever faces the base. The force is applied to the ball at the end of the cantilever.

Results: Sensitivity & Drift after loading/unloading cycles

Loading/unloading 15min cycles, Fapplied ~ 50mN

- Dominant response parameter: Thickness
- Lower drift with rubber lamination mode
- Conductor position parameter << thickness & lamination mode
- Tend to lower drift with Rco

Conclusion:
- main parameters = Thickness & lamination mode
- Thinner cantilevers will be manufactured to achieve to 10 mN nominal force