LTCC Hybrid Pressure Transducer
for High Temperature Applications

Jolymar González
University of Puerto Rico, Mayagüez Campus

Dr. Jorge Santiago - Avilés
University of Pennsylvania
Characteristics of LTCC

- Low temperature CO-fired Ceramic
- Composition: 45% alumina, 40% glass and 15% of organic.
- Low thermal Coefficient of Expansion (TCE)
- Before firing is very flexible, soft and easily dissolved; after firing is very strong.
- Low manufacturing process cost
Firing Processes

Semi-sintered process

Fully-fired process
Description of the pressure transducer

- **The diaphragm**: Is the sensitive part of the transducer. When a pressure acts, it deflects.

- **Piezo-resistors**: Change its resistance proportionally to the deflection on the membrane. The sensibility of the deflection is given by the gage factor

\[ FG = \frac{dR}{R}/\varepsilon \] (variation of the resistance due to some deflections.)
Exfoliation

- The layer is semi-sintered.
- The layer is submerged to an hydrofluoridric acid, vertically.
- The layers separate in three sheets. The middle sheet is has the properties to become the diaphragm of the transducer.
Exfoliation Experiment

- The Dupont 951-AT tape has a thickness of 114 µm.
- This layer was dissolved in the hydrofluoridric acid.
- The exfoliation is a good technique to obtain the diaphragm, when the tape is thickest.
- A fully fired layer of this kind of tape without exfoliation is the best choice for the diaphragm.
Sizes of the membranes

Transducer A

Transducer B
Wheatstone bridge

- Consist in four piezo-resistors
- Two piezo resistors measure the tangential deflection
- Two measure the radial deflection

Circuit of the Wheatstone Bridge
The tangential Strain is given by:

\[ \sigma_t = \frac{3w}{8\pi \delta^2 m} \left[ (m + 3) \frac{x^2}{R^2} - (m + 1) \right] \]

The radial Strain is given by:

\[ \sigma_r = \frac{3w}{8\pi \delta^2} \left[ (3m + 1) \frac{x^2}{R^2} - (m + 1) \right] \]
Design of the transducer
Conclusions...

- LTCC and thick film technology result very efficiently for the development of a pressure transducer.
- The low cost and the thermal, mechanical and electrical properties of LTCC, shows a great promise for microelectronics devices.
Future Projections

- Construct the pressure transducer with the proposed design.
- Prove the transducer and compare it with a commercially pressure transducer.
Acknowledgements

- SUNFEST ‘99
- My advisor Dr. Jorge Santiago
- Vladimir Dominko
- Mario Gongora
- The ceramic group:
  - Patricio Espinoza
  - Juan F. Ortiz
  - Seu Wah Low (Mary)
  - Jason Gillman