MEMs devices in LTCC

Amy J. Moll and Donald G. Plumlee
Mechanical Engineering
Boise State University
1910 University Drive
Boise, ID 83725-2075

The current focus for micro-electromechanical (MEMSs) fabrication is based on the use of Si as the primary material. Great progress has been made due to the extensive processing knowledge in the semiconductor device industry. However, Si based devices have some limitations. Few materials can be integrated into standard IC processing techniques.

Multilayer ceramic packaging technology holds considerable promise as a platform for MEMs devices based on the following characteristics:

- Ease of 3-D multi-layering.
- Integration of a wide variety of organic and inorganic materials.
- In the unfired state, tapes are soft, pliable and easily machined. Size features from 10 microns to 10 mm can easily be created.
- Straight forward integration of other devices including integrated circuits and micro electromechanical (MEMS) devices out of Si.
- Adaptability to embedded fluidic structures.
- Elevated temperature fabrication allows for use of the devices in harsh environments.
- Robust thermal budget for joining technologies.
- Ability to be scaled up to mass production.
- Communication between layers by vias (both fluidic and electronic)
- Electronic circuits can be printed on and flow components can be machined in individual layers
- Large number of layers can be laminated together.
- Fabrication techniques are relatively simple and inexpensive.

In the Ceramic MEMs lab at Boise State University the LTCC system is being used to build various devices including a simple pressure sensor and an ion mobility spectrometer (IMS). Designs have also been generated for a micro-combustor, micro-propulsion, and micro-spectrometer (IMS). Designs have also been generated including a simple pressure sensor and an ion mobility spectrometer (IMS). The prototype device was tested at Washington State University. Prototypes are also being built to demonstrate embedded micro-fluidic structures and micro-combustion in LTCC.

The LTCC IMS device is divided into four sections including the Aperture/Collector, Drift Tube, Tyndall Gate and Ionization Tube. Figure 1 shows a cross-section view of the assembled device.

Prototypes of a miniature Ion Mobility Spectrometer have been demonstrated. The IMS measures the time of flight of an ion through an electric field at atmospheric pressure and correlates this time to a distinct chemical species.[2] Current instruments are large, expensive, and have sizable power requirements. Sandia laboratories is also currently investigating the miniaturization of the IMS device.[3] The LTCC IMS described here was designed for permanent deployment below ground to continuously analyze groundwater. Reduction in size and power consumption of the instrument was made possible by the novel use of LTCC.

The prototype device was tested at Washington State University. Prototypes are also being built to demonstrate embedded micro-fluidic structures and micro-combustion in LTCC.

Figure 1: The IMS Cross-Section View describes the top-level assembly and approximate size information.

The prototype device was tested at Washington State University. Prototypes are also being built to demonstrate embedded micro-fluidic structures and micro-combustion in LTCC.

References:

Acknowledgments:
The authors would like to acknowledge the financial support from IMAPS, Sidney J. Stein Educational Foundation Grant and the Environmental Protection Agency, Contract Number X-97031101-0. DuPont Microcircuit Materials provided the materials used in this project. Yasmin Morales, Greta Doyle, and Seth Kuhlman provided assistance in fabricating the devices.