

Study on the Implementation of sintered LTCC and Graphite as a sacrificial material for the fabrication of Microcombustors



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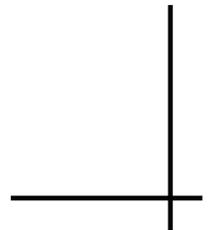
Prof. Jorge Santiago

Combustion

- **Combustion** or **burning** is an exothermic reaction between a substance (the fuel) and a gas (the oxidizer), usually O_2 , to release heat.
- The combustion process takes place as much in human beings as in energy sources.



Example of combustion reaction



Combustor

- Is the place where happens the combustion
- The combustors commonly can be seen in mechanical motors such as in the cars, airplanes, boats, etc.



Cars



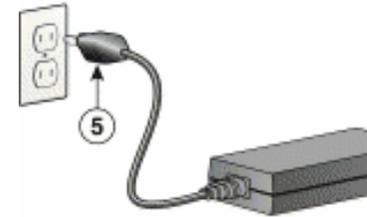
Airplanes



Boats

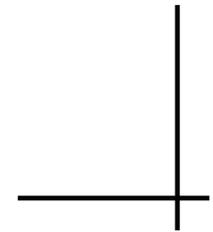
Device of low energy

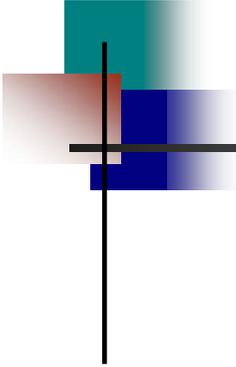
- These, in their majority, are electronics in which the consumption of energy is by means of batteries and electricity and not by combustion.



Device of low energy

Method to consume energy

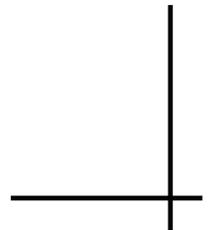


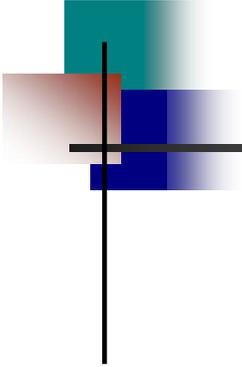


Microcombustor

General Characteristic

- Is a compact, sub-millimeter device that burns hydrocarbon fuels homogeneously as a source of power.
- It efficiently converts heat generated by combustion into electric power, and has the potential to replace batteries in portable applications that require long-term power.

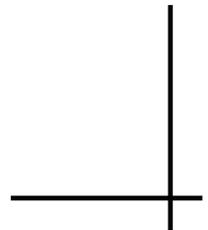




Microcombustor

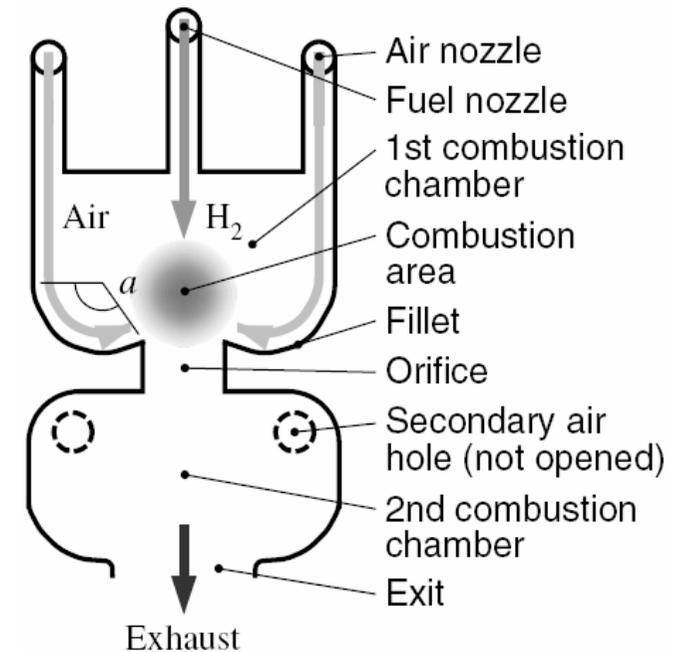
Benefits and Applications

- Provide greater energy and power density
- Higher temperatures
- Greater efficiency as a heat source.
- Military portable systems
- Consumer portable system
- Chemical control reaction.



Main Objectives of the project

- The fabrication of a micro-combustor that contains fundamentally three inputs, one output and a combustion area.
- Simulate a realistic stoichiometric premixed flame system.
- Implement simplistic system in LTCC tapes

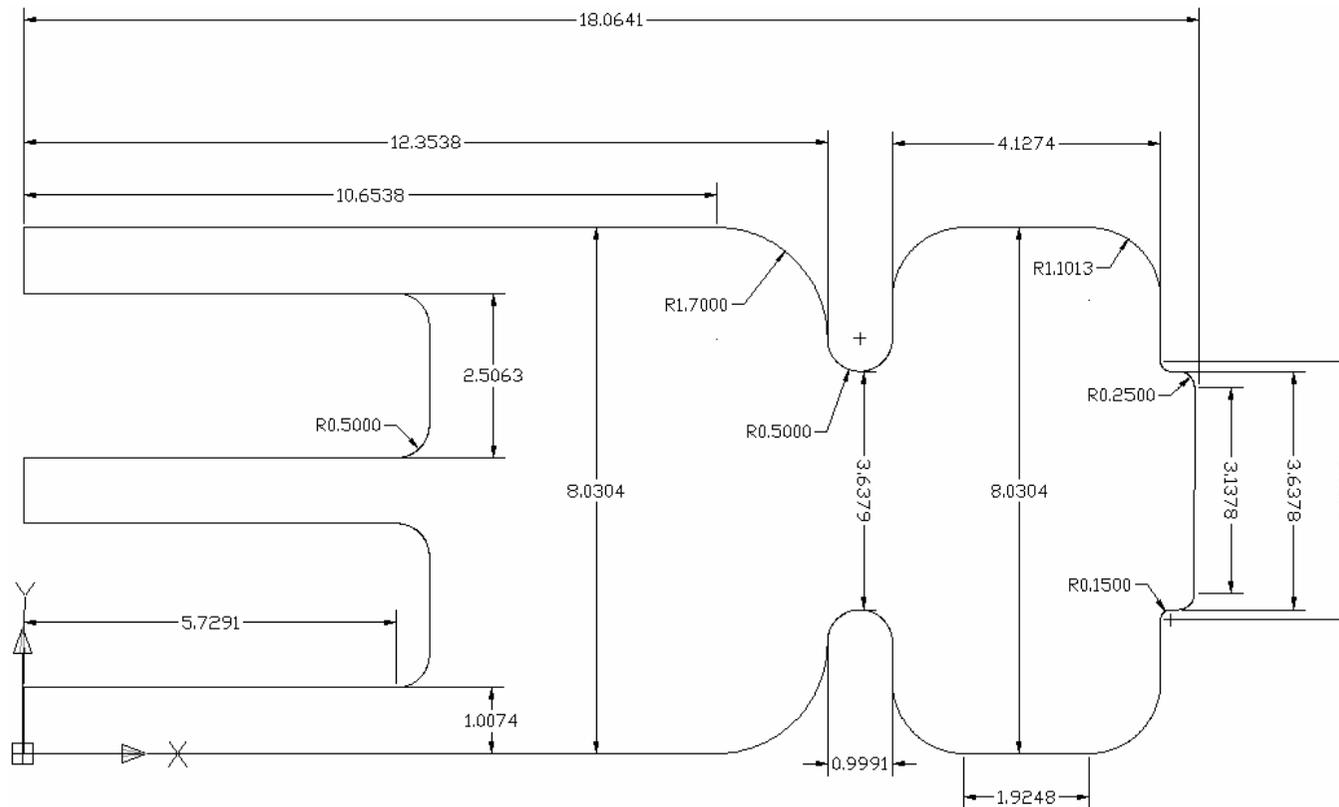


Structure proposed



Dimensions of microcombustor

- We fabricated two models, one to simple scale and the other to 1.5



Model Simple Scale

Instruments for the fabrication

- Computer Numerical Control (CNC)
- Laser
- Heated Press
- Furnace



Laser



Heated Press



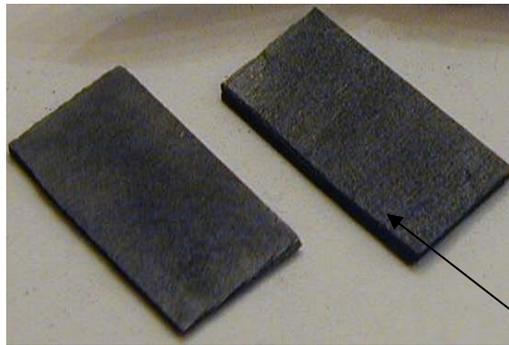
Furnace



CNC

Materials For the fabrication

- Low Temperature Co-Fired Ceramics (LTCC)
- Graphite
- Alumina

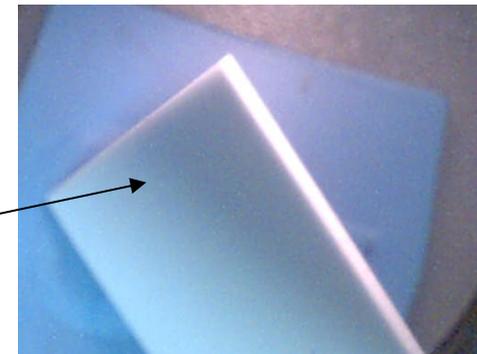


Graphite

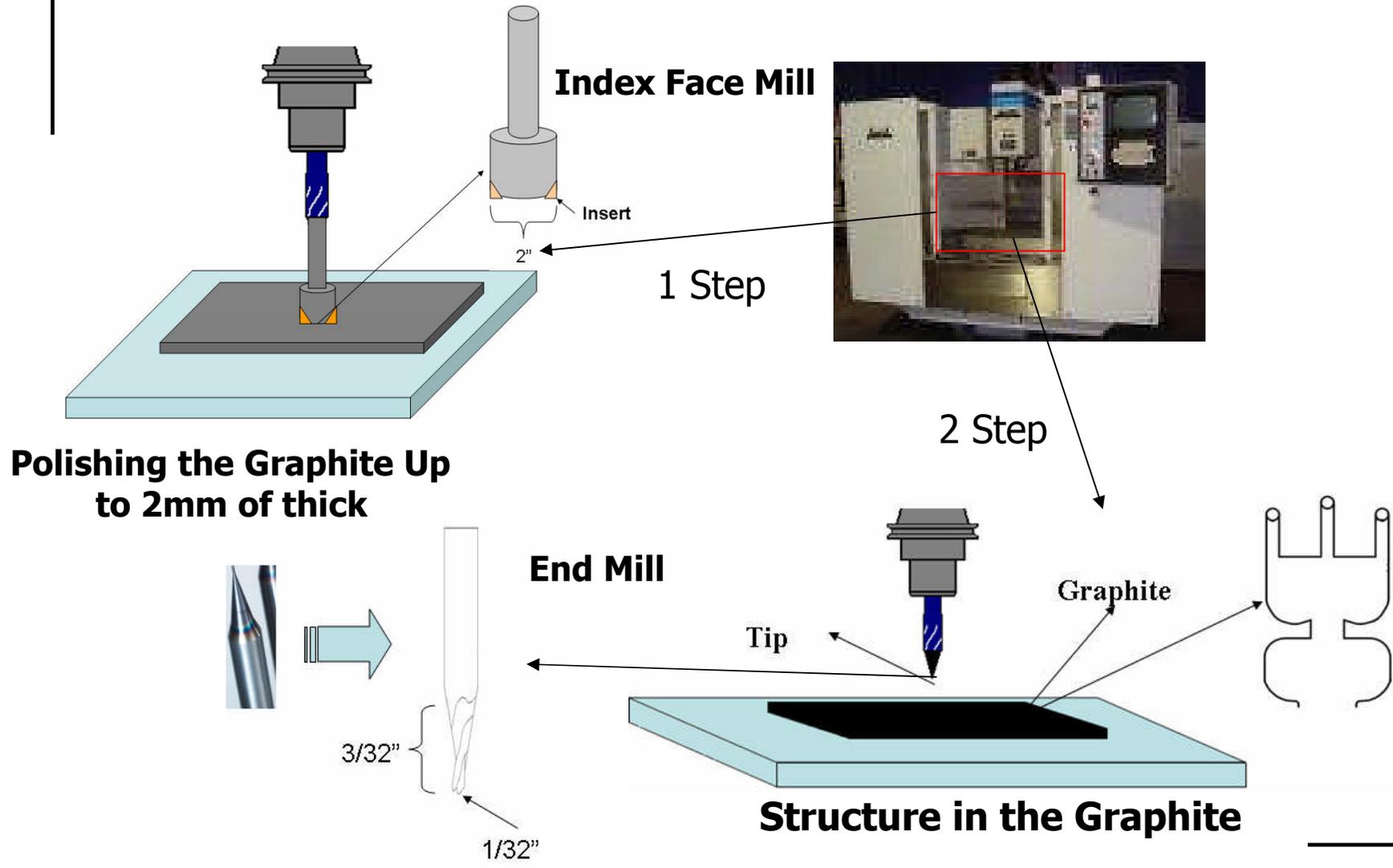
LTCC



Alumina

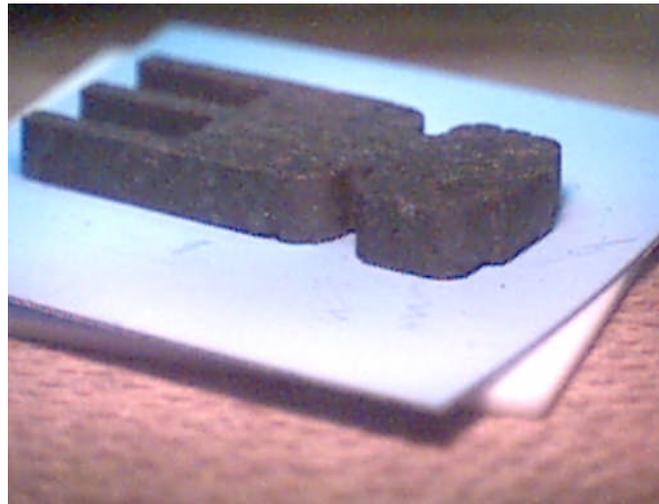


Process with the Computer Numerical Control (CNC)

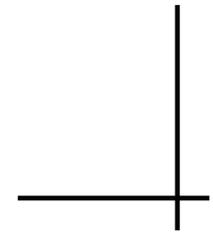


Process with the Computer Numerical Control (CNC)

When finishing

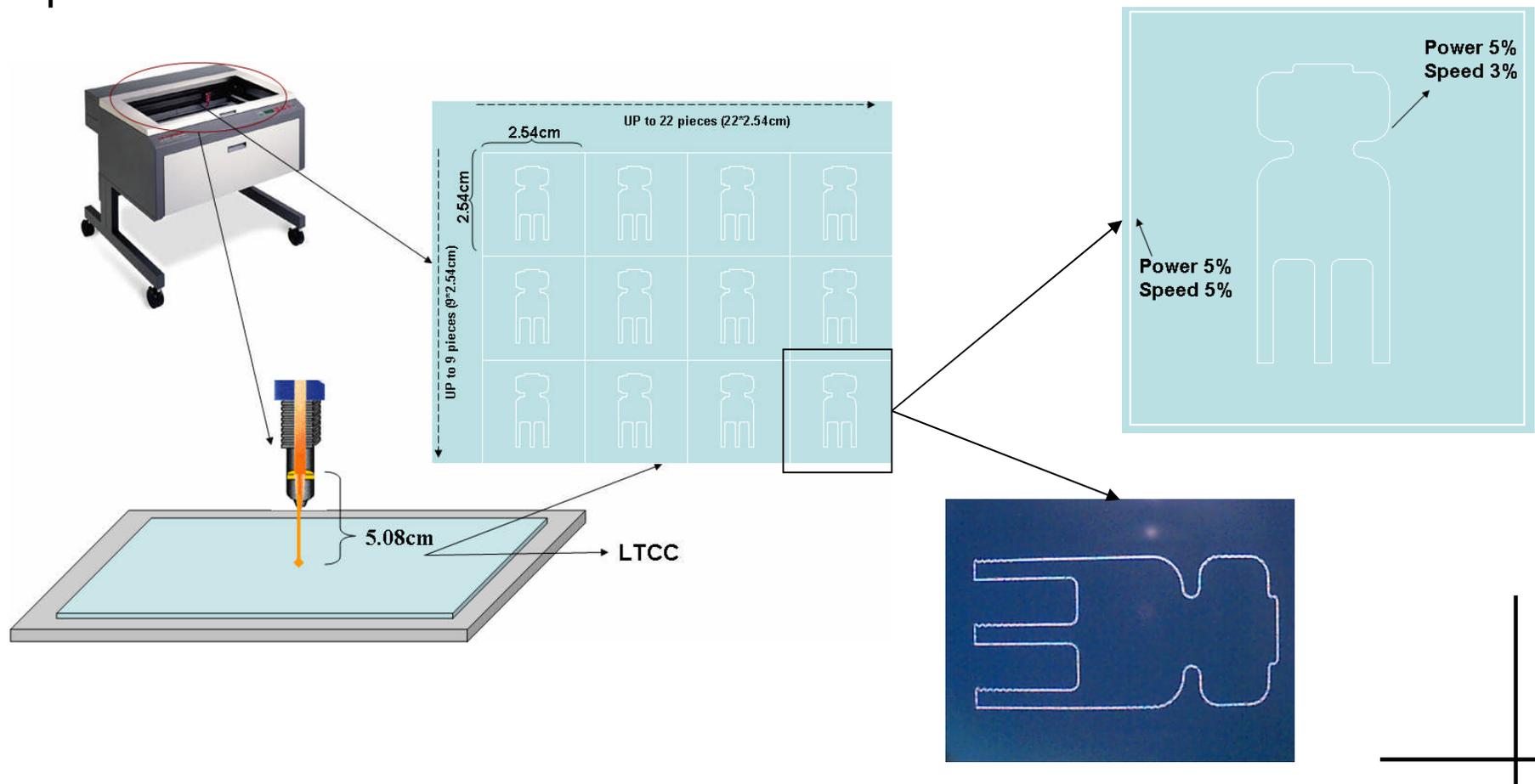


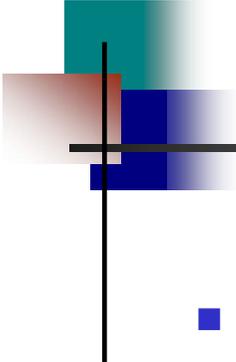
Result of CNC Process



Characterization Process in the LTCC

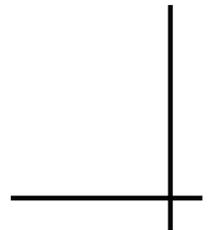
- In this process was used the laser



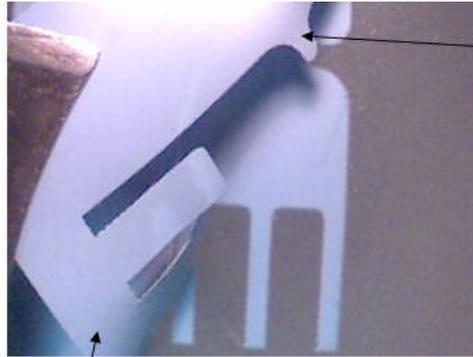


Lamination Process

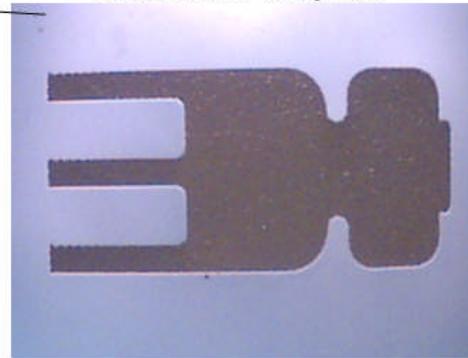
- The lamination is the method or process that due to the heat can reshape a material of way monolithic.
- The lamination of this device consists mainly in putting numerous layers of LTCC on both sides of the graphite



Lamination Process



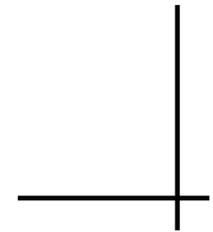
Mold of the Graphite



Adhesive Side



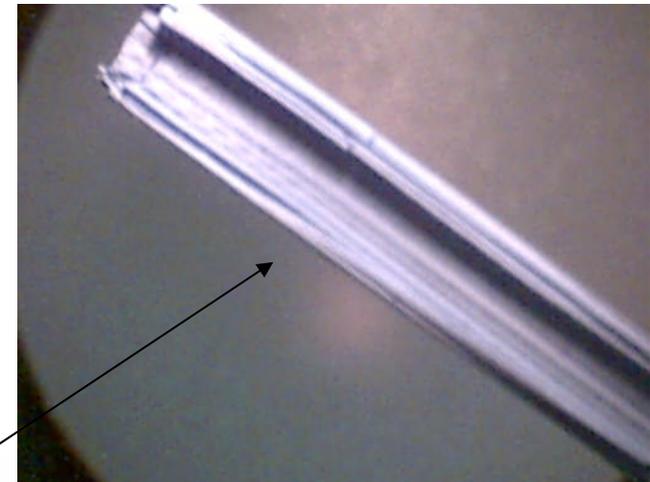
Graphite with more of 20 layer



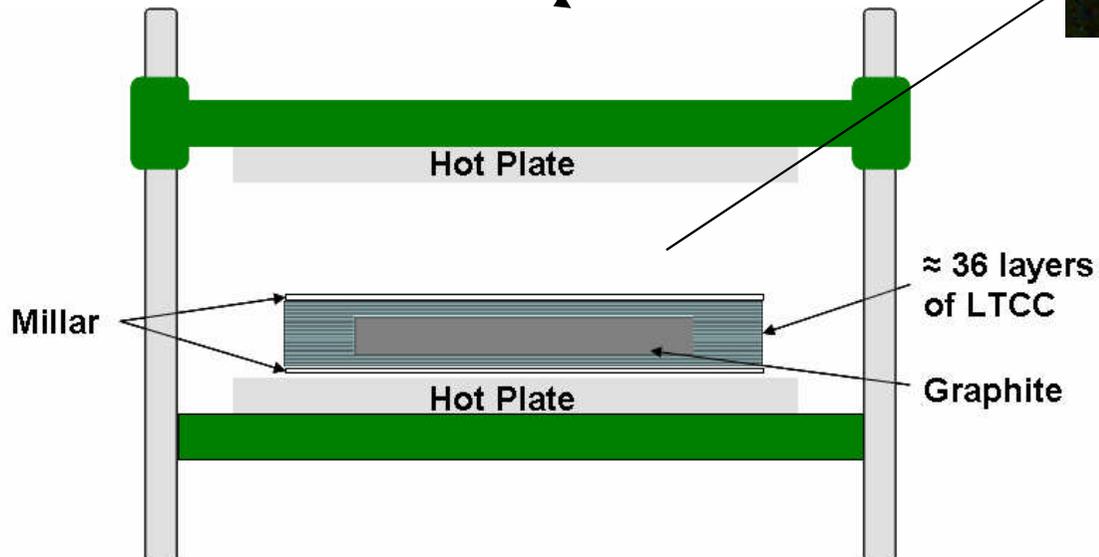
Lamination Process

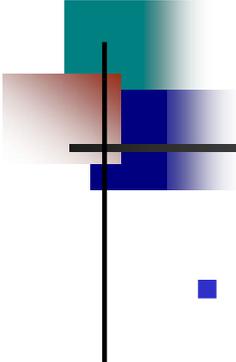


Heated Press



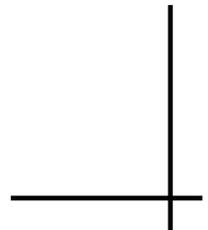
Lamination complete





Sintering Process

- Is the process in which green tape changes from a flexible state to a solid state and from a clear blue color to a darker hue.
- This it consists of placing in a furnace the structure laminated (LTCC and Graphite) upon aluminates it and to burn it from room temperature to 850°C.
- After the structure has been "sinterized" one should observe that the graphite has disappeared and formed the perforations or micro cavities in the LTCC.



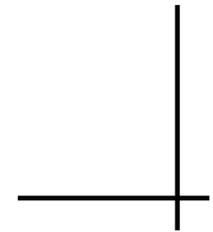
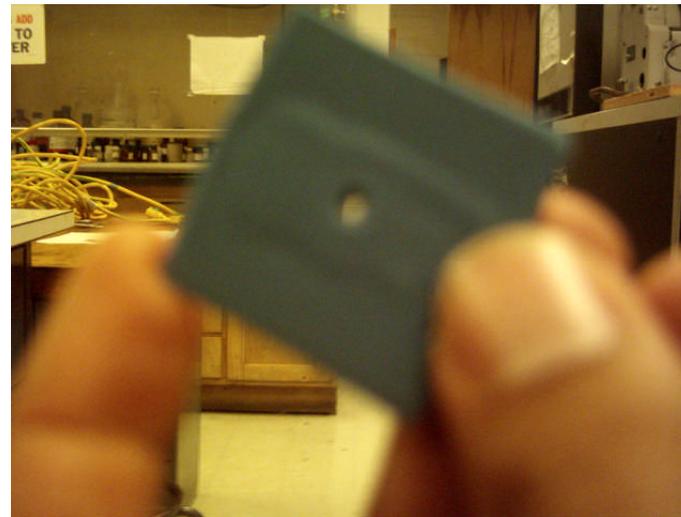
Results

Fabrication



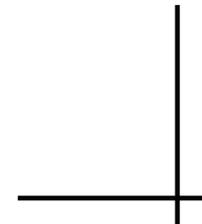
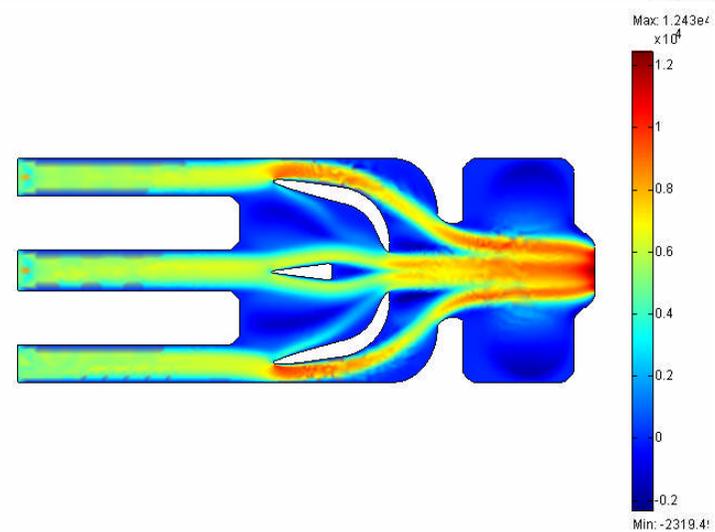
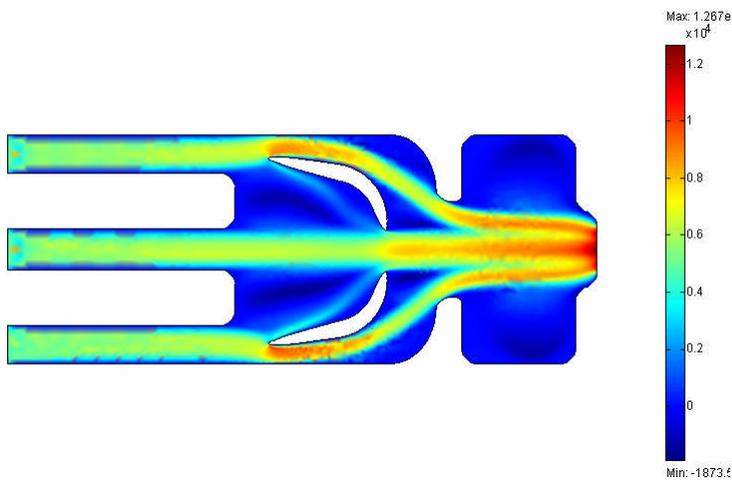
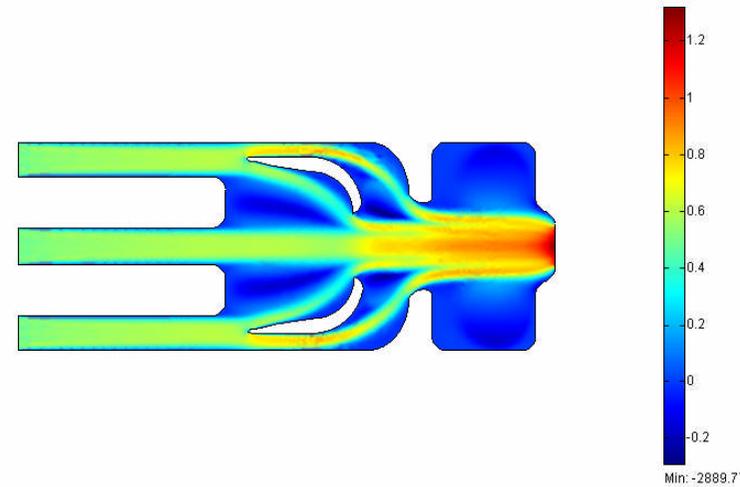
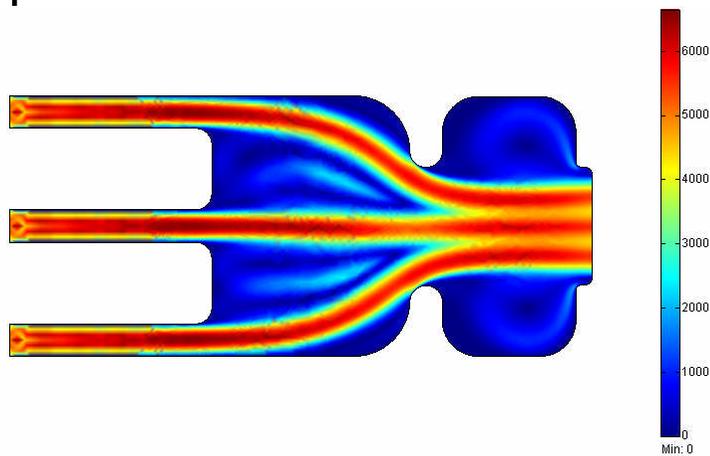
**Microcombustor to simple scale
after of burned in the furnace**

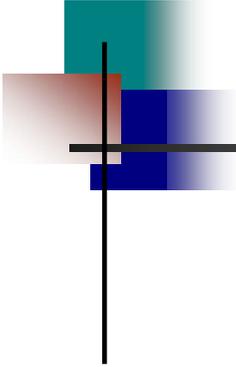
**Microcombustor to 1.5
after of burned in the
furnace**



Results

Some Simulations in FemLaB (Surface Velocity)





Conclusion and Further work

- More Simulation in Femlab
- Manufacture the other models
- Goal mixed the combustion gas with air.

