Micro-rocket Technology

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ECE 6450

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Overview

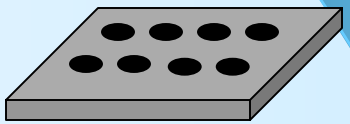
- What is a micro-rocket?
- Combustion chamber and igniter fabrication approaches
- Fuel considerations
- Questions???

What Is a Micro-rocket?

- Definition – micron to millimeter scale propulsion systems that produce thrust levels in the micro- to millinewton range
- Device consists of a combustion chamber, an igniter, and fuel
- Applications
  - Aerospace field – add nozzle and use for attitude control of micro-spacecrafts
  - Medical field – use as a one time micro-valve to open micro-fluidic channels

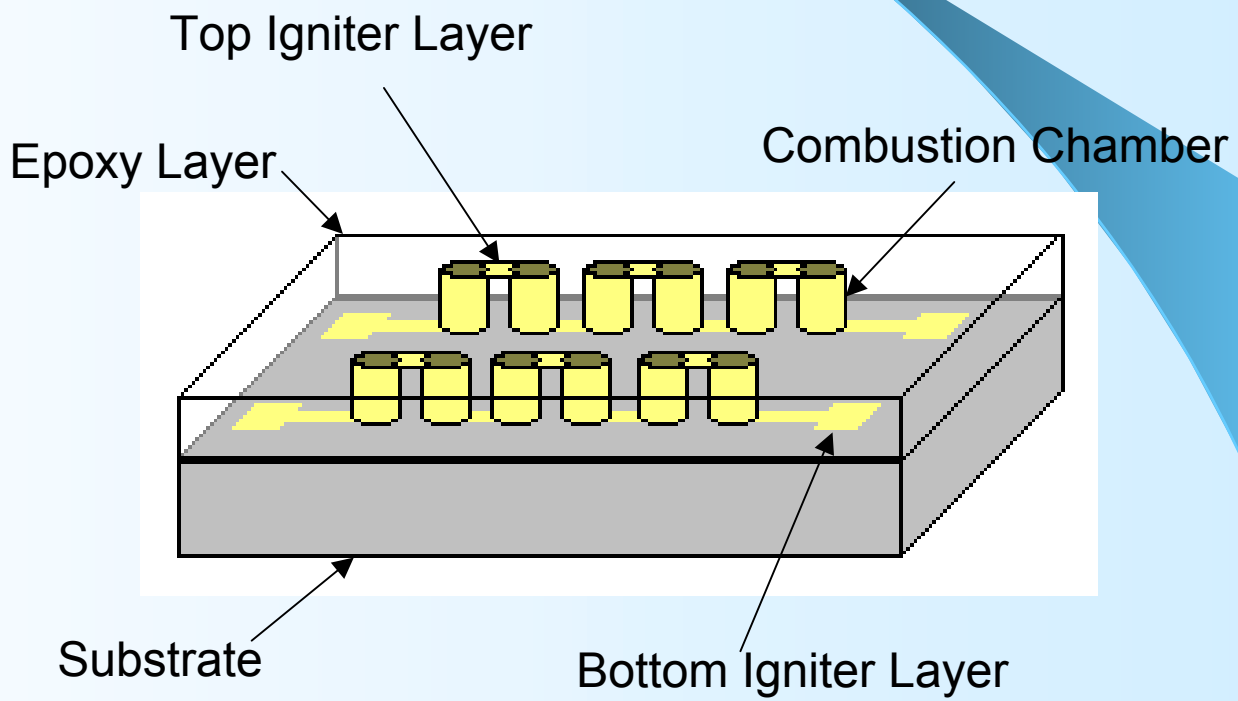
Fabrication Techniques

- Traditional processing techniques (as discussed in class)
  - Silicon chamber
    - Simple
    - Various etching techniques (wet and dry)
  - Resistive heating igniters
    - Doped polysilicon resistors
  - Fabricated in layers and glued together
- Non-traditional processing techniques
  - Polymer substrate
    - Laser-machined chambers



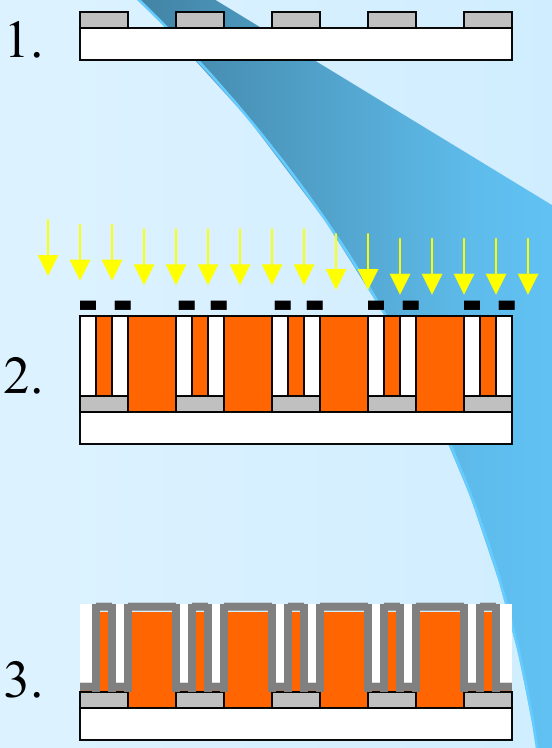
    - Electroless-plated metal igniters
  - Glass substrate
    - Discuss in detail
  - Integrated igniter

Glass Substrate Micro-rocket



Glass Substrate Micro-rocket Fabrication

1. Form bottom igniter contacts
   - Begin with glass substrate sputtered with metal
   - Pattern and wet etch metal layer
2. Form chambers
   - Deposit, and pattern thick layer of SU-8 epoxy (~500μm)
3. Form main igniter
   - Sputter metal

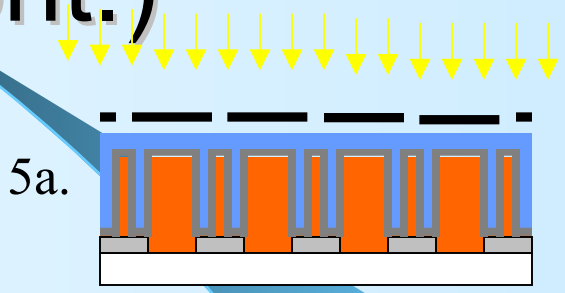


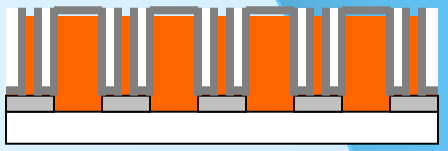
Glass Substrate Micro-rocket Fabrication (Cont.)

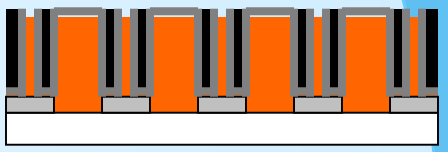
5. Pattern top igniter contacts
   - Apply, expose, and develop positive photoresist

6. Form top igniter contacts
   - Etch metal
   - Strip photoresist

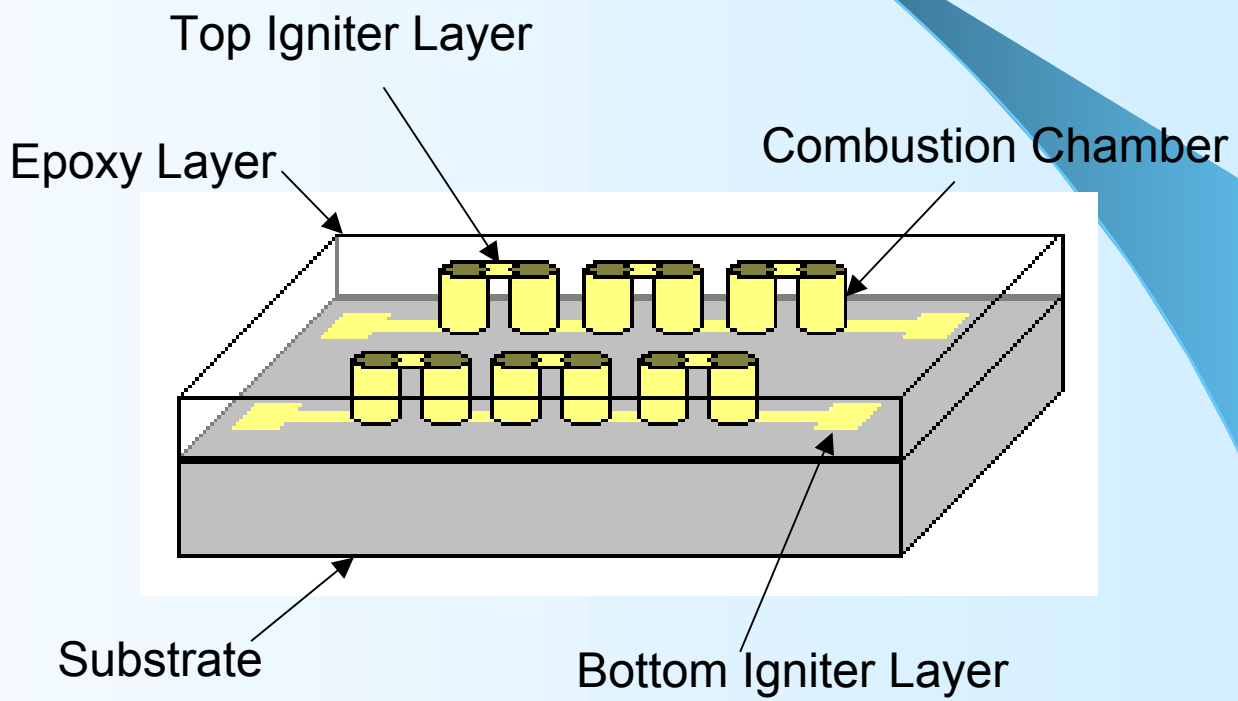
7. Add fuel







Glass Substrate Micro-rocket



Types of Fuel

- Purpose – to provide the propulsive force
  - Generally this actuation is achieved by creating high pressure
    - Recall ideal gas law p=nRT/v
    - Gas expands due to high temperature of combustion
    - Additional gas produced from combustion reaction
- Solid vs. liquid fuel
  - Solid
    - Advantages – higher thrust capabilities, simple fabrication
    - Disadvantages – one time use
  - Liquid
    - Advantages – refilling capabilities
    - Disadvantages – more complex fabrication (piping, pumps, valves)

Solid Fuel

- Requirements
  - Energetic
    - Want to achieve combustion but not catastrophic detonation
  - MEMS processing compatible
    - Capable of being packed into small chambers
- Common examples
  - Ammonium Perchlorate (typical)
  - Ammonium nitrate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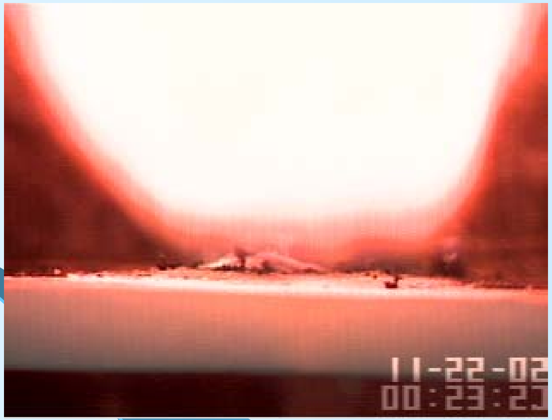
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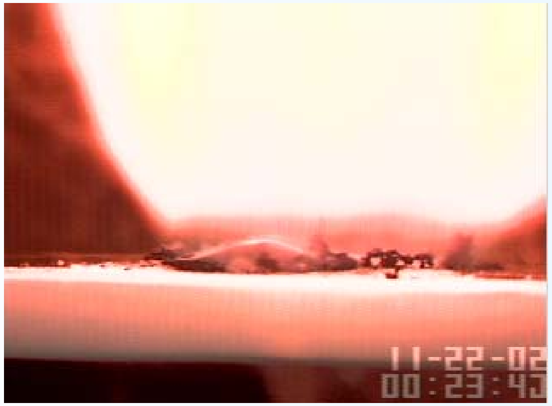
Questions???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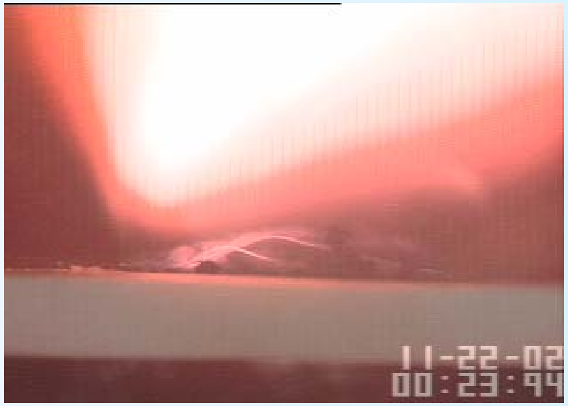
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