Micro Power Generation (MPG) Program at DARPA/MTO

Palm Power Workshop

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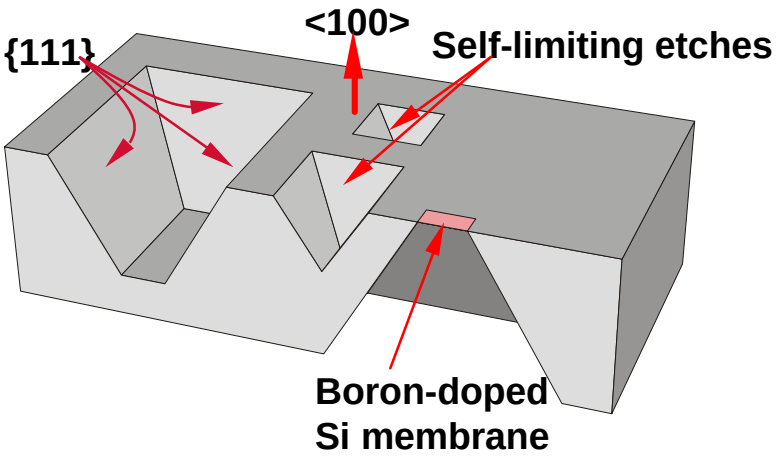
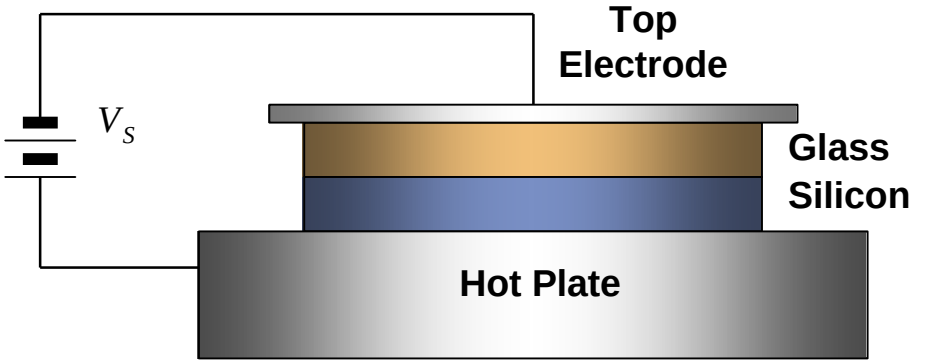
MPG Goals

- Replace batteries for micro-sensors and actuators (ultra-miniaturizing the power source while increasing energy density)
- Co-locate the power source with micro-sensors, actuators, signal processors, computers, and wireless communication circuits (eliminating interconnects)
- Create robust and shock-resistant packaged microsystems with integrated functions

MEMS Fabrication Technologies

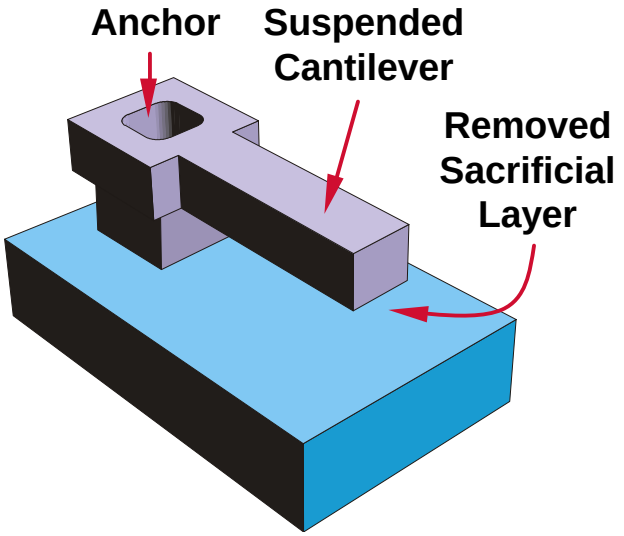


Anisotropic bulk etching

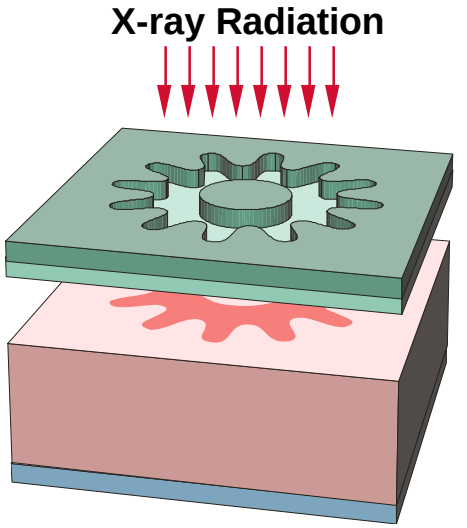


200°C < T < 500°C
200 V < V_S < 1000 V

Anodic wafer bonding



Surface micromachining



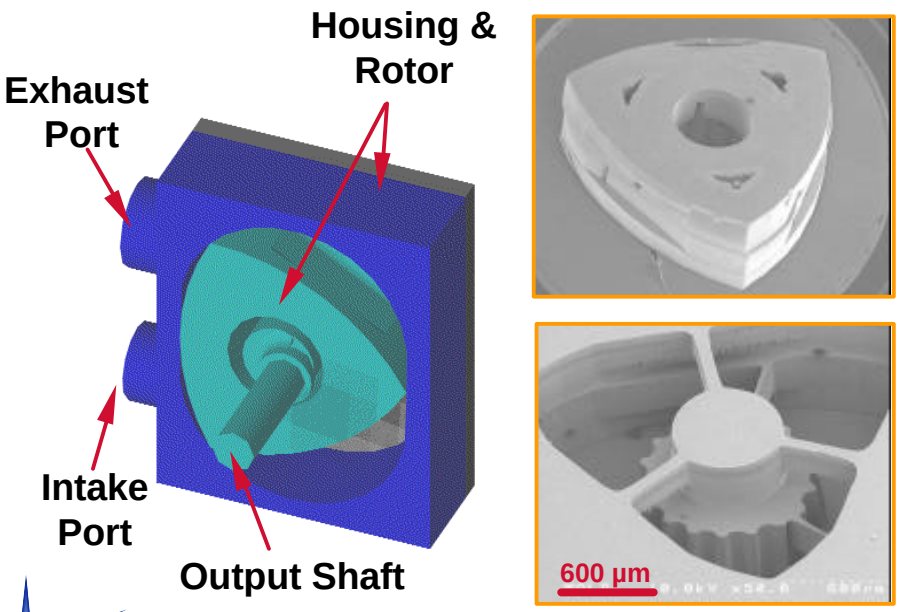
LIGA

Funded MPG Projects

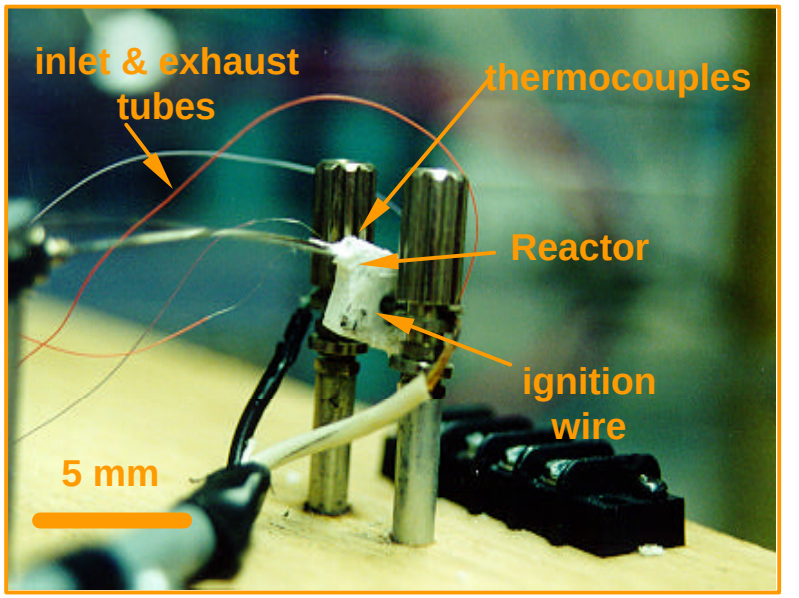
- A 3-D Monolithically-Fabricated Thermoelectric Microgenerator (MicroFIRE)—USC
- Integrated Chemical Fuel Microprocessor for Power Generation in MEMS Applications—MIT
- An Integrated Fuel Cell and Fuel Processor for Microscale Power Generation From Liquid Fuels—PNNL
- Microscale Combustor/Evaporator Development—PNNL
- A Micro Hydrogen-Air Fuel Cell—CWRU
- MEMS Free-Piston Knock Engine—Honeywell
- Permanent Magnet MEMS Arrays and Application to Combustion-Driven Power Generation—Georgia Tech
- MEMS Rotary Internal Combustion Engine—UC Berkeley

Microcombustion (UC Berkeley, Princeton, et al)

- Demonstrated fabrication techniques of high-temp materials (SiC at UCB, alumina at Princeton).
- Demonstrated self-sustained combustion in 1 mm^3 chamber (H_2/Air, Princeton).



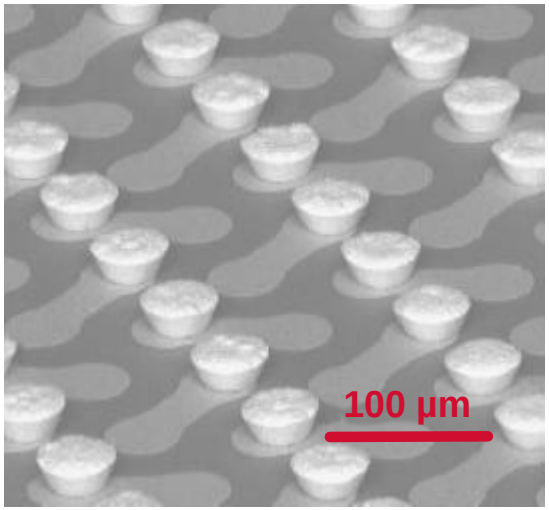
UCB Rotary Engine



Alumina reactor with 200-µm-wide Pt-coated square channels (Princeton)

Thermoelectric Conversion (USC, et al)

- Demonstrated counterflow Swiss-roll combustor
- Pursuing fabrication compatibility with thermoelectric elements (Bi_2Te_3)



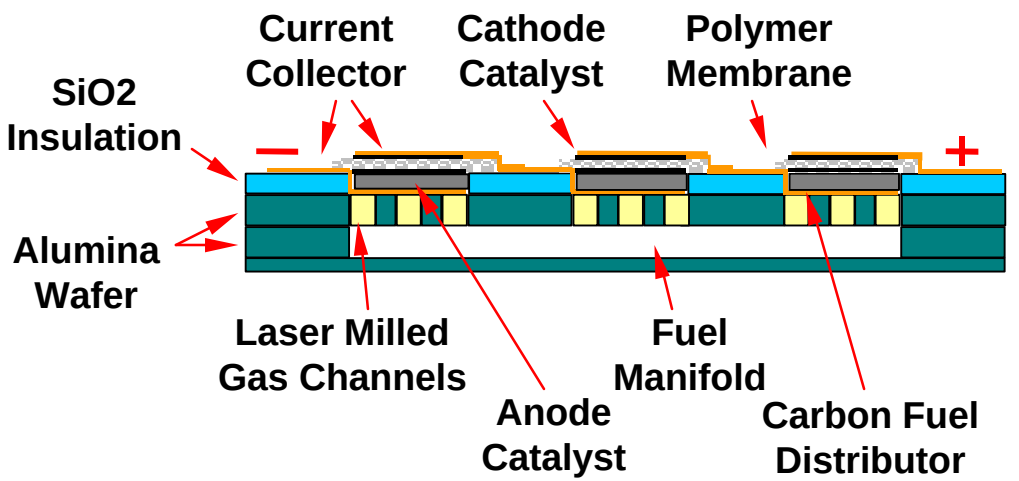
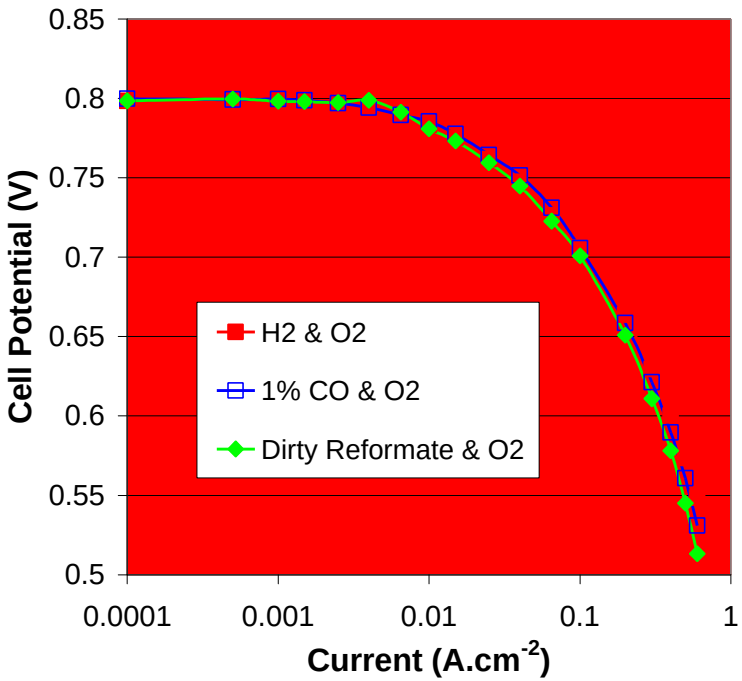
USC/JPL micro TE elements

USC macro Swiss-roll combustor

Simulation of combustion

Micro Fuel Cells (CWRU, et al)

- Demonstrated fabrication of micro fuel cells with built-in super capacitor & PdH layer as H_2 source
- Demonstrated high-temperature (>130°C) fuel cell operation in the presence of CO



CWRU micro fuel cell with palladium hydride