

# Compact, Ceramic Microchannel Heat Exchangers: Design and Fabrication

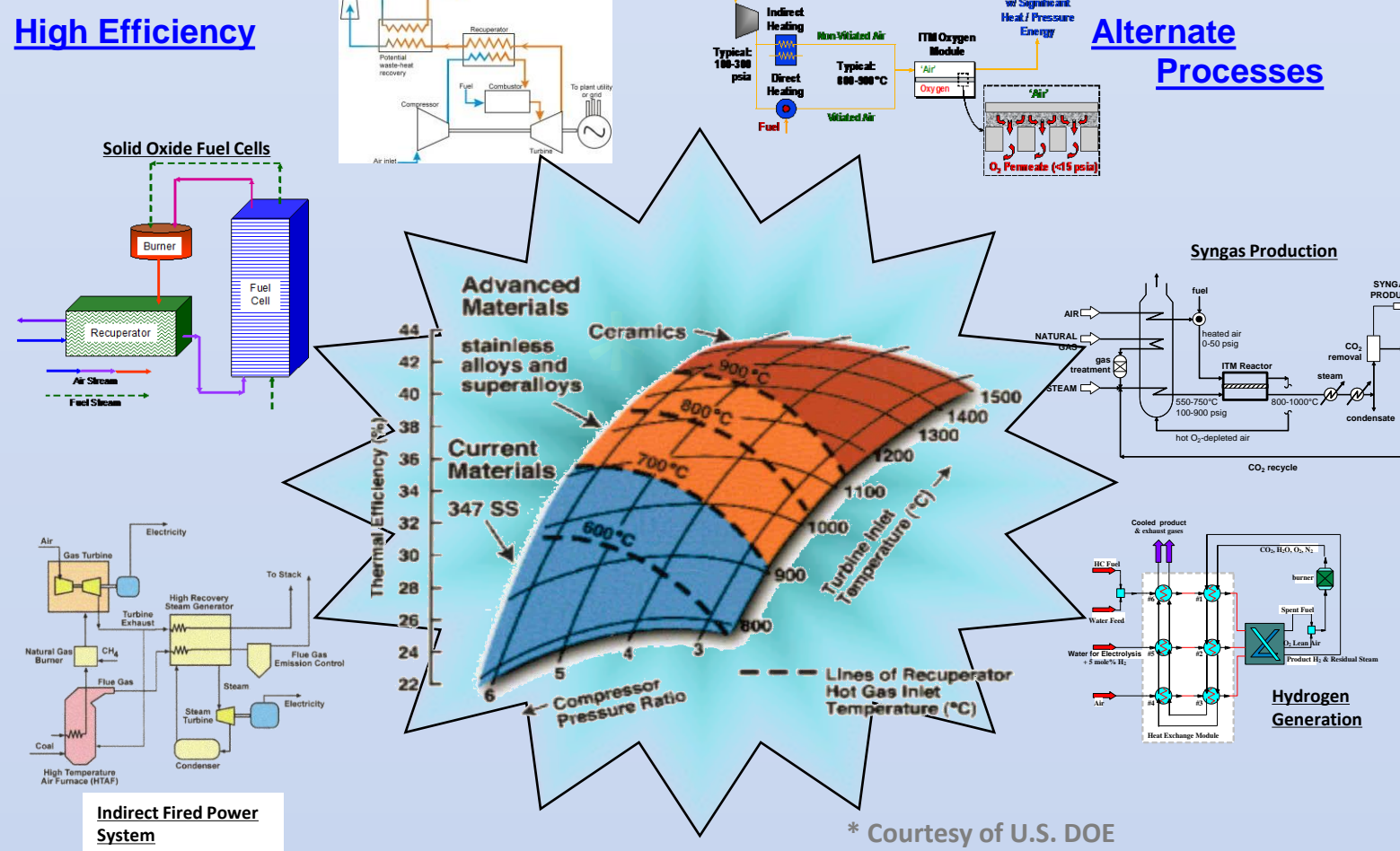
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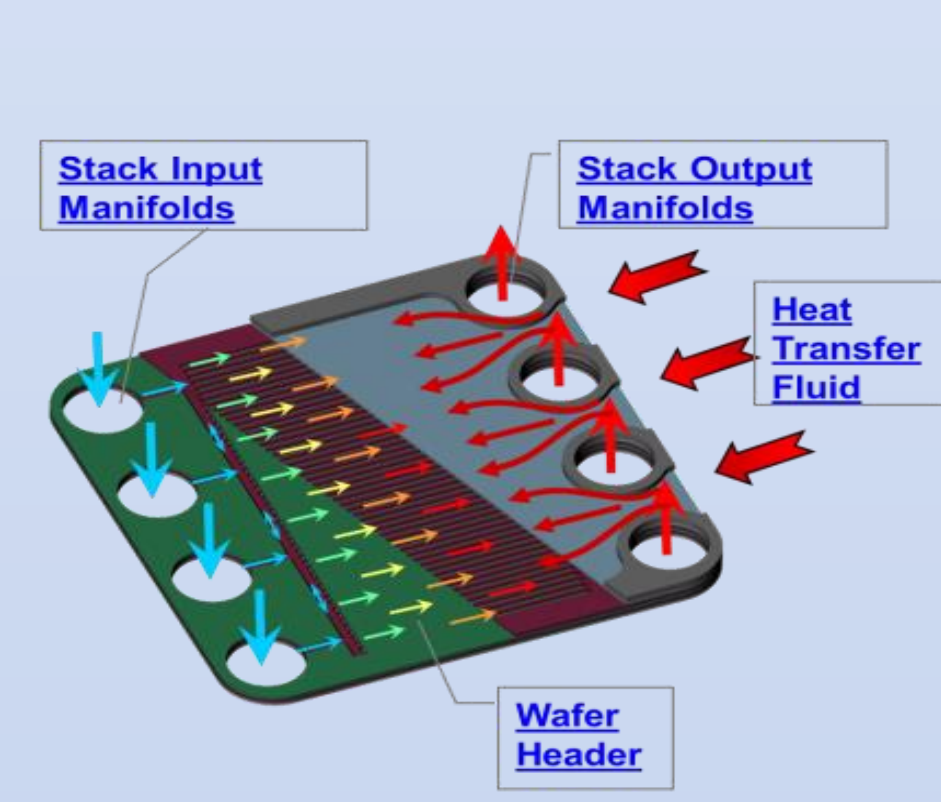


Heat exchangers improve efficiency in numerous applications. Ceramic materials allow for high temperature use and higher efficiency.

Microchannel designs allow materials with moderate thermal conductivity to be used in compact, high efficiency devices.



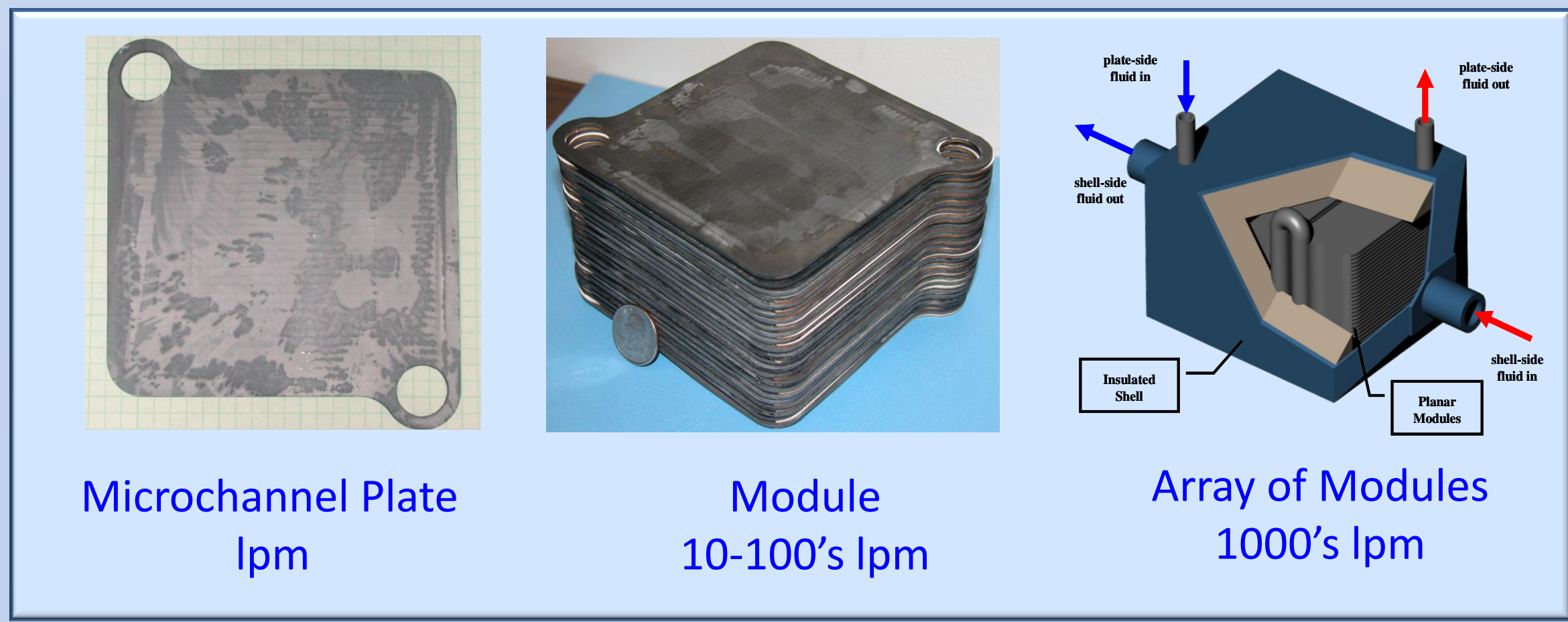
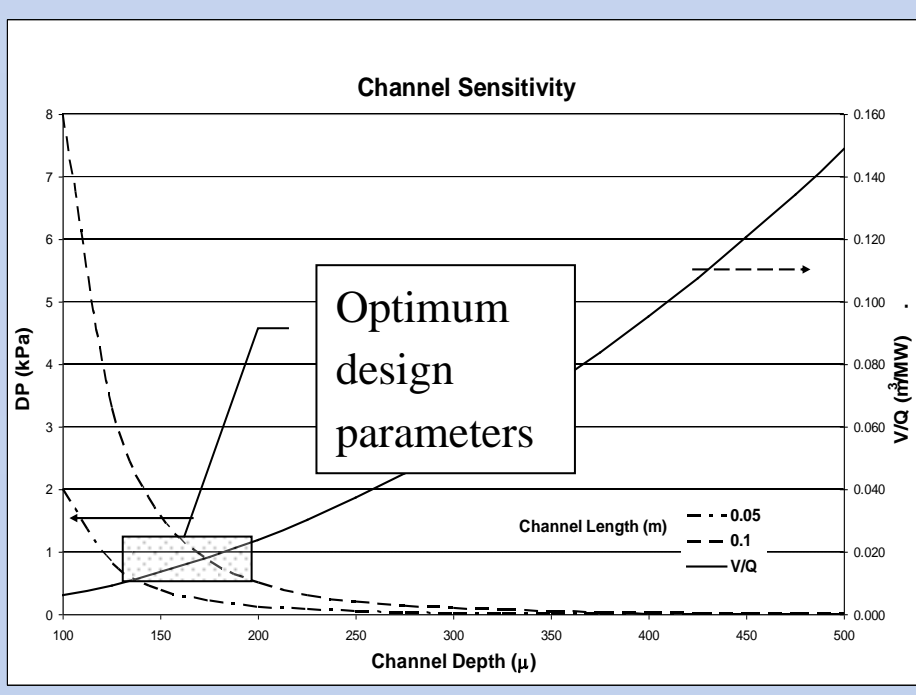
- Allows higher operating temperatures
- Higher efficiency
- Reduced emissions
- Corrosion resistant
- Low cost



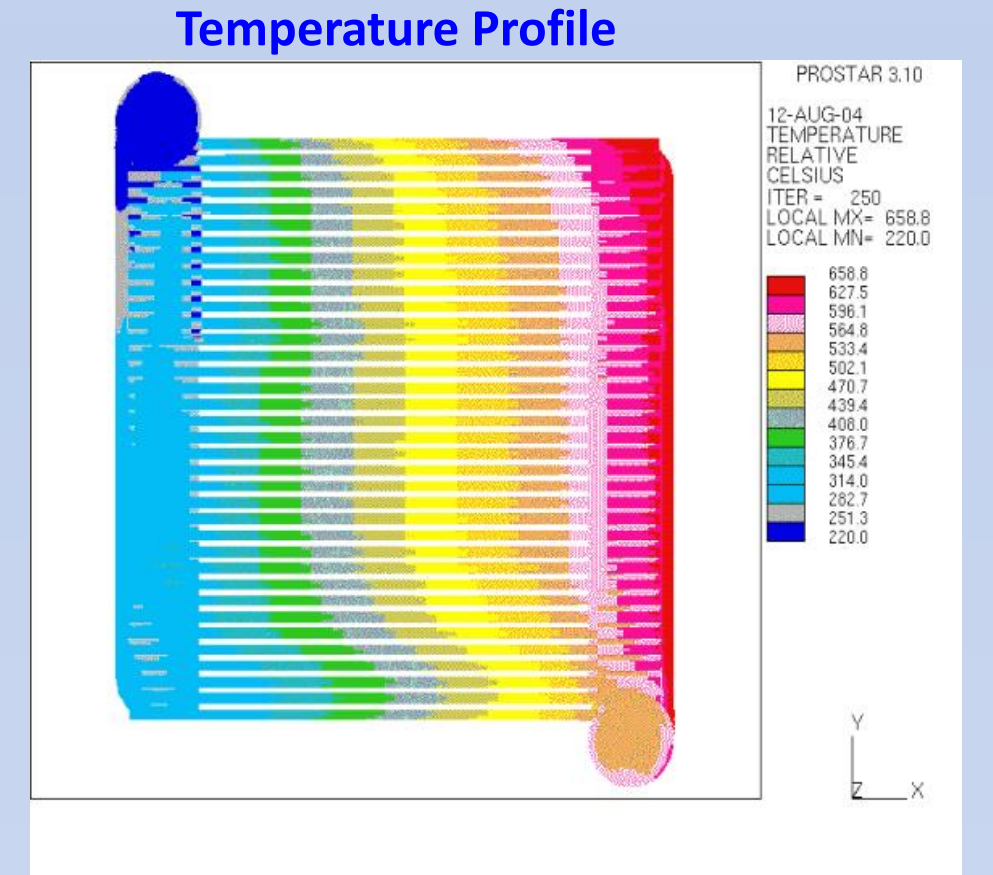
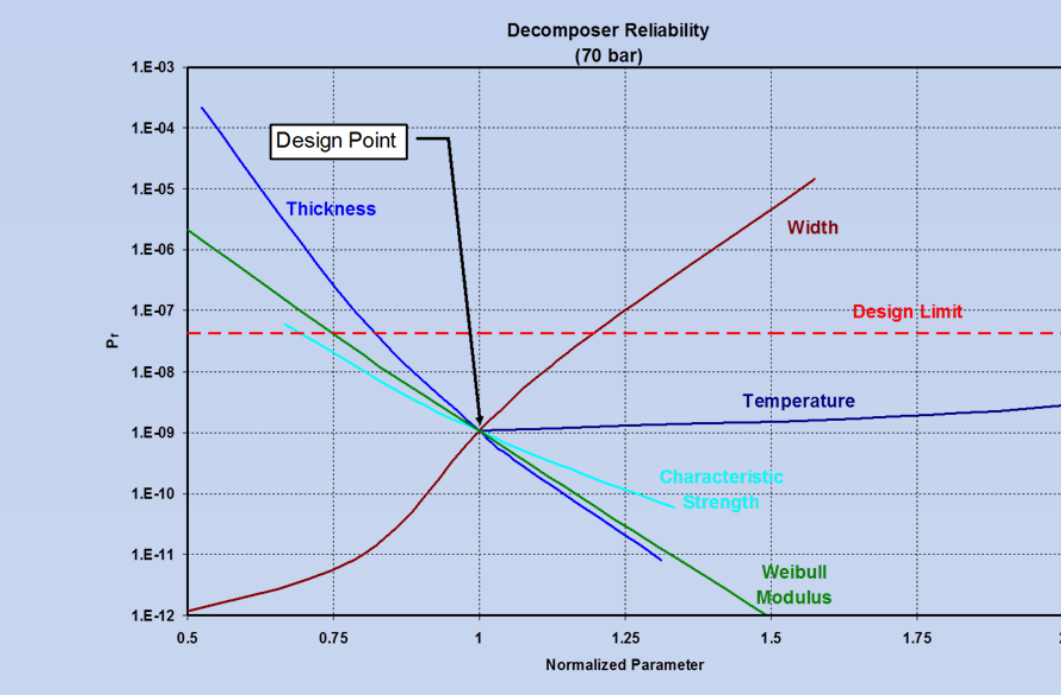
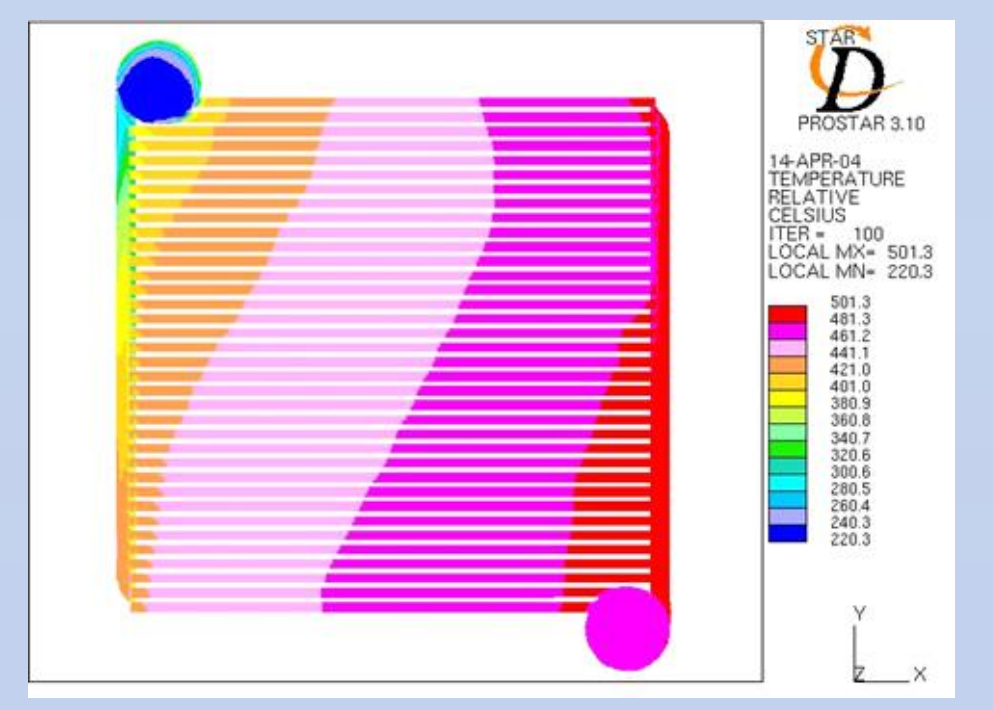
- Short heat and mass-transfer distances
- Low pressure drop (laminar)
- Compact
- Efficient
- Reliable
- Low cost
- Scalable

## Modular Design

Balanced Heat Transfer, Pressure Drop, and Mechanical Reliability



Analysis Guides Design Details



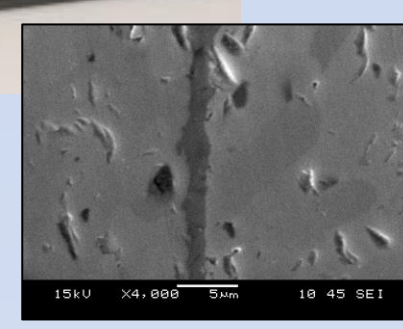
## Fabrication

LAMINATED OBJECT MANUFACTURING FOR PLATE CONSTRUCTION

- Tape casting
- Featuring
- Lamination
- Sintering

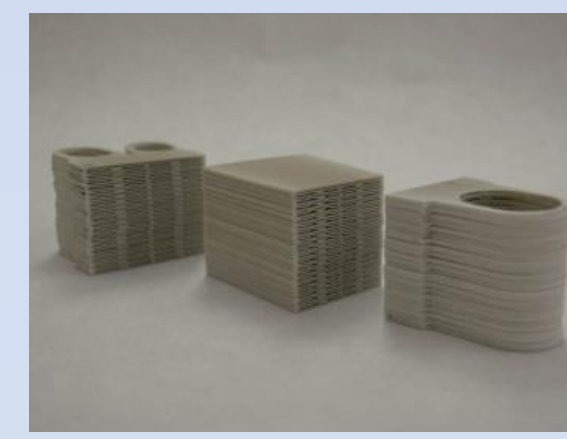


SiC to SiC - 2 micron-thick braze joint



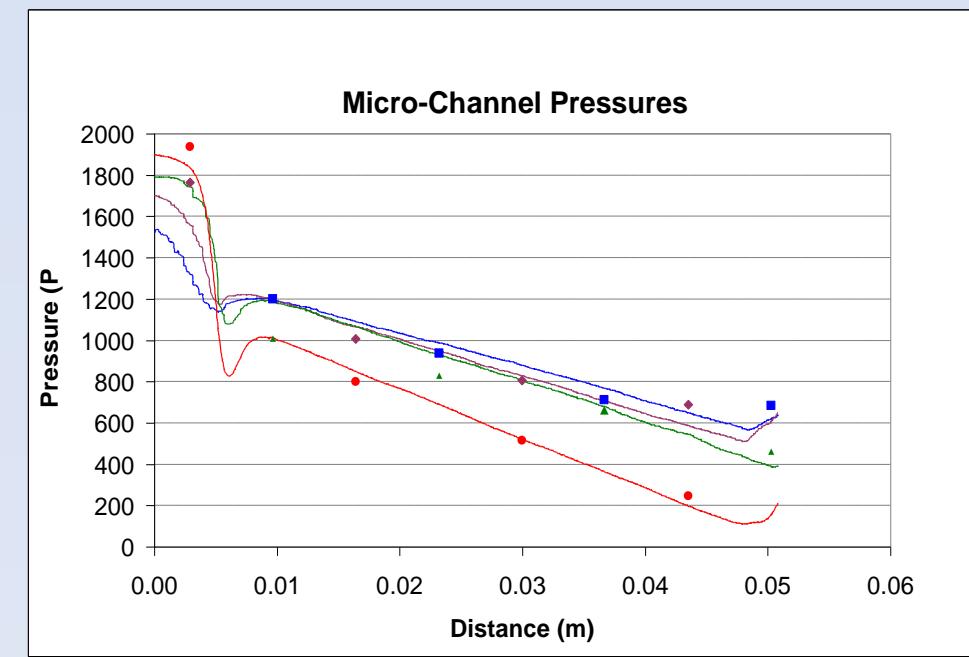
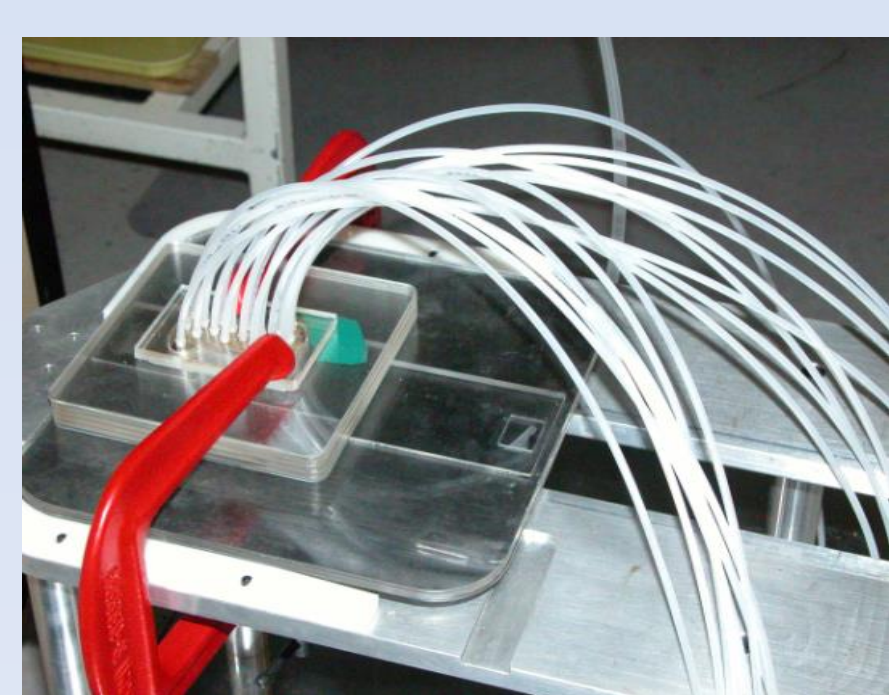
JOINING FOR STACK ASSEMBLY

- Ceramic joint processing
  - Brazing
  - Glass seals
  - Pre-ceramic polymer
  - Diffusion bond
- Ceramic-metal joint processing
  - Mechanical seals
  - Brazing
  - Glass seals



## Performance

Experimental Measurements match CFD Analysis



Typical Specifications

Thermal Duty (kW)	100	4 500
# HX Plates	500	7 500
$T_{hot} - T_{cold}$ (°C)	170	500
DP (kPa)	0.03	0.11
Volume (m <sup>3</sup> )	0.009	0.13