

HEAT RECUPERATION STRATEGIES: APPLICATION TO GAS-PHASE AND CATALYTIC PROPANE/AIR OXIDATION

J. Federici (PhDChE), E. Wetzel*, B. Geil*, and D. Vlachos

University of Delaware . Center for Composite Materials . Department of Chemical Engineering *Army Research Laboratories

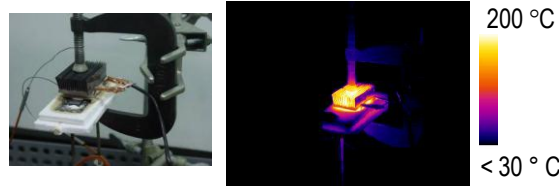
Portable Power Generation Is Necessary

- ◆ Micro-scale burners are emerging as a powerful tool for production of chemicals and/or heat
 - ◇ Ideal for small scale and portable productions
 - ◇ Hydrocarbon energy density is higher than Li based batteries
 - ◇ Microscale reactors are inherently safer than their macro-scale counterparts

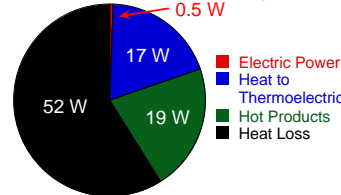
Objectives

- ◆ Develop microburners that are easy to start-up, robust, and sustainable over a range of operating conditions
- ◆ Integrate these reactors with thermoelectric modules and study system performance

Thermal Management is Important



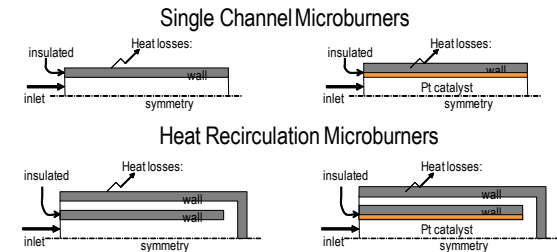
Enthalpy Accounting



- ◆ How can we improve this system?

Federici et al. *J. Power Sources* 2006

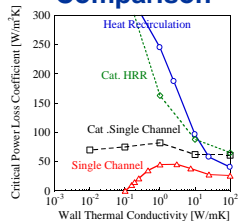
Reactor Description and Model



- ◆ Reactors were modeled using 2D CFD models
- ◆ Propane/air stoichiometric mixtures
- ◆ Uniform inlet flow at ambient temperature (300 K)
- ◆ Non-adiabatic reactor

Fluent 6.2, Fluent Inc.

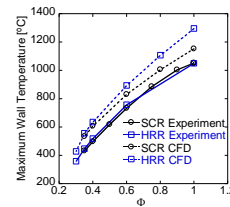
Heat Loss Stability Comparison



- ◆ Heat recirculation is a more stable geometry for both gas-phase and catalytic combustion in the blowout limit

Federici & Vlachos, *Combust. Flame* (2008)
Federici et al. *Int. Sym Comb.* Accepted

Experiments Validate Model Predictions



- ◆ System temperature profiles and extinction limits are similar
- ◆ Walls are moderately conductive

Federici et al. *Comb Flame.* In Preparation

Summary

- ◆ Heat recirculation results in much more stable operation than a single channel using both gas-phase and catalytic combustion for **low-conductivity** walls
- ◆ Provides sufficient thermal transport to allow for higher heat transfer coefficients in the blowout limit
- ◆ There is little improvement for **highly conductive** wall systems
- ◆ Facilitated axial transport provides sufficient preheating, thus there is no significant "excess enthalpy effect"
- ◆ Experiments with a conductive wall, catalytic microburner are consistent with the model predictions

Acknowledgements

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