Pacific Northwest National Laboratory

Micro Chemical and Thermal Systems

1991

- Invested to evaluate the potential of microsystem process technologies for DOE environmental cleanup needs

1992

- Created the concept of Microcomponent Sheet Architecture – enables scaleup by increasing number of units, "numbering up"
- Conceived MicroCATS-based heat pumps and heat engines

1993

- Initiated project to develop microcomponent hardware
- Built first microchannel heat exchangers

1994

- Applied for first PNNL MicroCATS patent application
- Submitted first PNNL MicroCATS publication on energy system miniaturization (ASME monthly magazine, article titled: "Developing New Miniature Energy Systems")
- Demonstrated rapid heat transport in microchannel heat exchangers

1995

- Demonstrated rapid mass transport in a microchannel unit
- Started DARPA-funded MicroCATS project
- Created first micro combustor/evaporator

1996

- Built first catalytic microchannel reactor
- Started DOE project to develop microchannel fuel process components for automotive fuel cells
- Presented first PNNL paper on chemical process miniaturization (AICHE Spring National Meeting)

1997

- Received first MicroCATS patent: Microcomponent Sheet Architecture (5,611,214)
- Started four-year PNNL Lab-Level Initiative on Microsystems Science and Engineering
- Demonstrated laminate microfabrication in metals
- Participated in first International Microreaction Technology Conference (IMRET).

1998

- Demonstrated fast kinetics for steam reforming catalytic reaction
- Received patent: Microcomponent Chemical Process Sheet Architecture (5,811,062)
- Initiated BMI Chemical Sector MicroCATS program
- Demonstrated chemical separations at high rates -- in microchannel gas absorption unit.
- Became a sponsor and organizer for the International Microreaction Technology Conference.

1999

- Started NASA program in MicroCATS development
- Built first microchannel steam reforming reactor
- Received two R&D 100 Awards: a) MicroCombustor and b) Microchannel Gasoline Vaporizer
- Demonstrated first highly effective, recuperative microchannel heat exchanger
- Developed concept for integral combustor/reforming microchannel reactor

2000

- Demonstrated scale-up: 10 kWe microchannel steam reforming system
- Developed Lattice-Boltzman Code for microchannel processing
- Demonstrated gas separations in microchannel gas adsorption unit
- Received patent: Microchannel Laminated Mass Exchanger and Method of Making (6,129,973)
- Received patent: Microcomponent Assembly for Efficient Contacting of Fluid (6,126,723)

2001

- Recipient of National Laboratory Fuel Cell R&D Award from DOE: "...in recognition of outstanding achievement in research and development of microchannel fuel processing technology for automotive fuel cells"
- Established spinoff company to commercialize MicroCATS technology
- Received patent: Active Microchannel Heat Exchanger (6,200,536)
- Received patent: Active Microchannel Fluid Processing Unit and Method of Making (6,192,596)
- Received patent: Method and Catalyst Structure for Steam Reforming of a Hydrocarbon (6,284,217)
- Received patent: Heat Power and Electric-Power-Generating Component Containing a Thermoelectric Device (6,313,393)

2002

- Demonstrated fuel-flexibility in microchannel steam reforming units (for sulfur-free fuels)
- Did first demonstration of differential temperature microchannel reactor (for water-gas shift reaction)
- Received patent: Microchannel Laminated Mass Exchanger and Method of Making (6,352,577)
- Received patent: Chemical Reactor and Method for Gas Phase Reactant Catalytic Reactions (6,488,838)
- Began development of a MicroCATS-based cooling system for soldier applications for the U.S. Army.
- Teamed with Oregon State University to initiate the Microproducts Breakthrough Institute.

Microchannel Fuel Vaporizer

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

OREGON STATE UNIVERSITY

Microproducts Breakthrough Institute