

ECI International Conference on Heat Transfer and Fluid Flow in Microscale

*Whistler, BC, Canada
21-26 September 2008
(Final Program 9/15/08)*

SUNDAY, SEPTEMBER 21, 2008

16:30 - 18:30 Registration

18:30 - 19:30 Opening reception

19:30 - 21:00 Dinner

MONDAY, SEPTEMBER 22, 2008

07:30 - 08:30 Breakfast

08:30 - 08:50 Welcome & Introduction

08:50 - 09:30 Keynote lecture: **UNIQUE ASPECTS OF ADIABATIC TWO-PHASE FLOW IN MICROCHANNELS**
M. Kawaji
University of Toronto, Canada
Keynote chair: G.P. Celata

09:30 - 10:10 Session: **CONDENSATION – CON**
Session chair: G.P. Celata

CONDENSATION OF METHANE IN TWO CIRCULAR MICROCHANNELS
K.A. Marak
The Norwegian University of Science and Technology, Trondheim, Norway

**NEW EXPERIMENTAL AND COMPUTATIONAL RESULTS FOR MACRO- AND MICRO-SCALE
INTERNAL CONDENSING FLOWS**
A. Narain, S. Kulkarni, M.T. Kivisalu, J.H. Kurita and S. Mitra
Michigan Technology University, Houghton, MI, USA

10:10 - 10:40 Coffee-break

10:40 - 11:40 Session: **FLOW BOILING – FB**
Session chair: T. Karayiannis

LIQUID NITROGEN FLOW BOILING IN A PARALLEL MICROCHANNEL ARRAY
R. Webb
University of Colorado Colorado Springs, Colorado Springs, CO, USA

**TRANSIENT SURFACE TEMPERATURE MEASUREMENT DURING FLOW BOILING IN
MICROCHANNELS**
D. Krebs, V. Narayanan, J. Liburdy and D. Pence
Oregon State University, Corvallis, OR, USA

TWO-PHASE FLOW INSTABILITIES IN MICROCHANNELS
D. Bogojevic, K. Sefiane, A.J. Walton, H. Lin and G. Cummins
University of Edinburgh, Edinburgh, UK

12:00 - 13:30 Lunch

13:30 - 14:10 Keynote lecture: **THE SIMPLICITY OF FRACTAL-LIKE FLOW NETWORKS FOR EFFECTIVE HEAT AND MASS TRANSPORT**
D. Pence
Oregon State University, Corvallis, OR, USA
Keynote chair: J. Liburdy

14:10 - 14:50 Session: **FLUID FLOW 1 – FF1**
Session chair: G. Croce

ON THE GAS DIFFUSION LAYERS CA-M DRAINAGE PHASE DIAGRAM

Ez.F. Medici and J.S. Allen
Michigan Technology University, Houghton, MI, USA

ENTRANCE, VISCOUS DISSIPATION AND TEMPERATURE DEPENDENT VISCOSITY EFFECTS ON THE LAMINAR FORCED CONVECTION IN STRAIGHT MICROCHANNELS WITH CONVECTIVE BOUNDARY CONDITIONS

S. Del Giudice, C. Nonino and S. Savino
Università degli Studi di Udine, Udine, Italy

14:50 - 15:10 Session: **ADIABATIC TWO-PHASE FLOW – ATPF**
Session chair: M. Kawaji

EXPERIMENTAL STUDY ON BUBBLE VELOCITY, VOID FRACTION AND PRESSURE DROP FOR GAS-LIQUID TWO-PHASE FLOW IN A CIRCULAR MICROCHANNEL

A. Kawahara, M. Sadatomi, K. Nei and H. Matsuo
Kumamoto University, Kumamoto City, Japan

15:10 - 15:40 Coffee

15:40 - 17:20 Session: **ADIABATIC TWO-PHASE FLOW – ATPF (cont.)**
Session chair: M. Kawaji

HEAT TRANSFER AND FLUID DYNAMICS OF AIR-WATER TWO-PHASE FLOW IN MICRO-CHANNELS

M. Kaji*, T. Sawai*, Y. Kagi* and T. Ueda**
**Kinki University, Wakayama, Japan, **Toyota Central R&D Labs., Inc., Aichi, Japan*

TWO-PHASE FLOW IN CIRCULAR MICRO-CHANNELS

S. Saisorn and S. Wongwises
King Mongkut's University of Technology Thonburi, Bangkok, Thailand

THICKNESS OF THIN LIQUID FILM FORMED IN SLUG FLOW IN MICROTUBE

Y.B. Han and N. Shikazono
The University of Tokyo, Tokyo, Japan

GAS-LIQUID FLOWS IN A FRACTAL-LIKE BRANCHING FLOW NETWORK

Y.H. Kwak, D. Pence, J. Liburdy and V. Narayanan
Oregon State University, Corvallis, OR, USA

DESCRIPTION, UNCERTAINTY ANALYSIS AND SIMULATION OF A NEW TEST RIG FOR REFRIGERANT TWO-PHASE FLOW CHARACTERISATION

S. Dall'Olio, M. Marengo, S. Zinna, C. Antonini and G.E. Cossali
Università degli Studi di Bergamo, Dalmine, Italy

19:30 – 21:00 Dinner

21:00 – 22:00 Social Hour

TUESDAY, SEPTEMBER 23, 2008

07:30 – 08:30 Breakfast

08:30 - 09:10 Keynote lecture: **CONTRIBUTION OF MICRO-LAYER IN BOILING HEAT TRANSFER**
Y. Utaka
Yokohama National University, Yokohama, Japan
Keynote chair: N. Kasagi

09:10 – 10:10 Session: **HEAT EXCHANGERS 1 – HEX1**
Session chair: D. Pence

ADVANCED MICROCHANNEL HEAT EXCHANGER WITH S-SHAPED FINS

N. Tsuzuki, Y. Kato, R. Kajita and K. Nikitin
Tokyo Institute of Technology, Tokyo, Japan

THE PERFORMANCE OF NOVEL, PLASTIC, MICROCAPILLARY FILM HEAT EXCHANGERS

B. Hallmark, C. Dorfling, C.H. Hornung and M.R. Mackley
University of Cambridge, Cambridge, UK

FABRICATION AND EXPERIMENTAL EVALUATION OF AN ENHANCED LIQUID COOLING SYSTEM BASED ON BIOMIMETIC DESIGN

D. Haller, N. Kockmann* and P. Woias
*Albert-Ludwigs-University Freiburg, Freiburg, Germany, *now at Lonza Ltd, Visp, Switzerland*

10:10 - 10:40 Coffee

10:40 - 12:20 Session: **FLUID FLOW 2 – FF2**
Session chair: N. Kasagi

FRICITION FACTOR IN GAS FLOW UNDER LAMINAR, TRANSITION AND TURBULENT FLOW REGIME

G.P. Celata*, M. Lorenzini**, R. Naldini**, S.J. McPhail*, G.L. Morini** and G. Zummo*
**ENEA, Casaccia, Rome, Italy, **Università di Bologna, Bologna, Italy*

STUDY OF HEAT TRANSFER AND FLOW CHARACTERISTICS OF A LAMINAR SLOT-JET IMPINGING ON A PLANE IN A DOUBLE SIDED CLOSED DUCT

D.H. Lee, D. Trainer and J.S. Park
Inje University, Gyeongnam, Republic of Korea

FLOW IN RECTANGULAR MICROCHANNELS: AN EXPERIMENTAL INVESTIGATION

M. Akbari*, M. Bahrami* and D. Sinton**
**Simon Fraser University, Surrey, Canada, **University of Victoria, Victoria, Canada*

LAMINAR FLOW OF A LIQUID THROUGH MICROCHANNELS WITH SUPERHYDROPHOBIC WALLS UNDER WETTING AND NON-WETTING CONDITIONS

B. Woolford, D. Maynes and B.W. Webb
Brigham Young University, Provo, UT, USA

MOLECULAR DYNAMICS SIMULATIONS OF RAYLEIGH INSTABILITY OF LIQUID FILM ON NANOWIRE

A. Shibata and I. Ueno
Tokyo University of Science, Chiba, JAPAN

12:20 - 14:00 Lunch

14:00 - 14:40 Keynote lecture: **SATURATED FLOW BOILING IN SMALL- TO MICRO-DIAMETER METALLIC TUBES: EXPERIMENTAL RESULTS AND MODELLING**
T.G. Karayiannis, D. Shiferaw and D.B.R. Kenning
Brunel University, London, UK
Keynote chair: K. Breuer

14:40 - 15:20 Session: **HEAT TRANSFER 1 – HT1**
Session chair: Y. Utaka

HEAT TRANSFER ENHANCEMENT IN MICROCHANNEL WITH CROSS-FLOW PULSATING FLUID JETS

T.T. Chandratilleke, R. Narayanaswamy and D. Jagannatha
Curtin University of Technology, Perth, Australia

HEAT AND MASS TRANSFER IN A PASSIVE MICROCHANNEL HUMIDIFIER

W. TeGrotenhuis, D. Caldwell, C. Lavender and B. Roberts
Pacific Northwest National Laboratory, Richland, WA, USA

15:20 - 15:40 Session: **MEASUREMENTS – MEAS**
Session chair: R. Lindken

EXPERIMENTAL POOL BOILING INVESTIGATIONS OF FC-72 ON SILICON WITH ARTIFICIAL CAVITIES AND INTEGRATED TEMPERATURE MICRO-SENSORS

C. Hutter*, G. Cummins*, H. Lin*, T.G. Karayiannis**, D.B.R. Kenning**, K. Sefiane* and A.J. Walton*
**University of Edinburgh, Edinburgh, United Kingdom, **Brunel University, Uxbridge, United Kingdom*

15:40 - 16:10 Coffee

16:10 - 17:30 Session: **MEASUREMENTS – MEAS (cont.)**
Session chair: R. Lindken

PIV MEASUREMENTS OF TURBULENT CHANNEL FLOW WITH SUPERHYDROPHOBIC WALLS

B. Woolford, J. Prince, D. Maynes and B.W. Webb
Brigham Young University, Provo, UT, USA

TIME RESOLVED INVESTIGATIONS ON FLOW FIELD AND QUASI WALL SHEAR STRESS OF AN IMPINGEMENT CONFIGURATION WITH PULSATING MICRO JETS BY MEANS OF HIGH SPEED PIV AND A SURFACE HOT WIRE ARRAY

T. Janetzke and W. Nitsche
Berlin Institute of Technology, Berlin, Germany

MICROSCALE MEASUREMENTS AND ANALYSIS OF SURFACE TEMPERATURE AND HEAT FLUX IN SINGLE-BUBBLE NUCLEATE BOILING OF SATURATED FLUOROCARBON LIQUIDS

K. Kiger* and S. Moghaddam**
**University of Maryland, College Park, Maryland, USA, **University of Illinois at Urbana-Champaign, Urbana-Champaign, USA*

MICRO-VELOCIMETRY USING TIME-RESOLVED MEASUREMENTS OF QUANTUM DOTS IN A MICROCHANNEL

J. Guasto and K. Breuer
Brown University, Providence, RI, USA

19:30 – 21:00 Dinner

21:00 – 22:00 Social Hour

WEDNESDAY, SEPTEMBER 24, 2008

07:30 – 08:30 Breakfast

08:30 - 09:10 Keynote lecture: **FILM THICKNESS MEASUREMENT TECHNIQUES APPLIED TO MICRO-SCALE TWO-PHASE FLOW SYSTEMS**

G. Ribatski and C.B. Tibiriça
University of São Paulo, São Carlos, Brazil
Keynote chair: *M. Kawaji*

09:10 - 09:30 Session: **MICROFLUIDIC SYSTEMS 1 – MIS1**

Session chair: *T. Chandratilleke*

ADAPTIVE CHIP COOLING USING ELECTROWETTING

J.T. Cheng and C.L. Chen
Teledyne Scientific Company, Thousand Oaks, CA, USA

09:30 – 10:10 Session: **MICROFLUIDIC SYSTEMS 2 – MIS2**

Session chair: *K. Breuer*

POOL BOILING HEAT TRANSFER FROM A BUNDLE OF TUBES PROVIDED WITH THE NOVEL MICROSTRUCTURE

A. Ustinov*, V. Ustinov** and J. Mitrovic***
Benteler Automotive, Paderborn, Germany, **RWTH Aachen University, Aachen, Germany, *University of Paderborn, Paderborn, Germany*

CLOSED FORM THERMAL ANALYSIS OF PHASE CHANGE MEMORY DEVICES

J.P. Reifenberg, H. Gupta, M. Asheghi and K.E. Goodson
Stanford University, Stanford, CA, USA

10:10 - 10:40 Coffee Break

12:00 – 13:00 Lunch (boxed lunch if requested)

13:00 - 21:00 *ad hoc* meetings, networking, free time, dinner on your own

THURSDAY, SEPTEMBER 25, 2008

07:30 – 08:30 Breakfast

08:30 - 09:10 Keynote lecture: **SINGLE-PHASE CONVECTIVE HEAT TRANSFER IN LAMINAR AND TRANSITIONAL REGIME IN MICROCHANNELS**

G.L. Morini
Università di Bologna, Bologna, Italy
Keynote chair: G.P. Celata

09:10 – 09:50 Session: **HEAT TRANSFER 2 – HT2**

Session chair: G. Ribatski

HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A SQUARE MICROCHANNEL WITH INTERNAL FINS

T.T. Chandratilleke, R. Narayanaswamy and J.L. Foong
Curtin University of Technology, Perth, Australia

NUMERICAL STUDY ON CONVECTIVE HEAT TRANSFER OF GAS-LIQUID SLUG FLOW IN A MICRO TUBE

Q.W. He, Y. Hasegawa and N. Kasagi
The University of Tokyo, Tokyo, Japan

09:50 - 10:10 Session: **NANOFLUIDICS – NAN**

Session chair: M.H. Kim

MODELING, FABRICATION AND SIMULATION OF MICRO-FILTERS

P.R. Waghmare*, S.K. Mitra**, A. Mather*** and J. McLaughin***
Indian Institute of Technology Bombay, Mumbai, India, **University of Alberta, Canada, *University of Ulster, Northern Ireland*

10:10 - 10:40 Coffee

10:40 - 12:00 Session: **NANOFLUIDICS – NAN (cont.)**

Session chair: M.H. Kim

SIMULTANEOUS DROPLET IMPINGEMENT DYNAMICS AND HEAT TRANSFER ON NANO-STRUCTURED SURFACES

J. Shen, C. Graber, D. Pence, J. Liburdy and V. Narayanan
Oregon State University, Corvallis, USA

CONVECTIVE TESTS OF NANOFLUIDS IN A 1.3 MM ELECTRICALLY HEATED TUBE

J.P. Ribeiro, O. Soriano, O. Doche and J.A. Gruss
CEA/DRT/LITEN/DTS, Grenoble, FRANCE

MICROFLUIDIC INVESTIGATION OF DIFFUSION ENHANCEMENT IN NANOPARTICLES SUSPENSIONS

S. Ozturk, Y.A. Hassan and V.M. Ugaz
Texas A&M University, College Station, TX, USA

TIRF MICROSCOPY FOR VISUALIZATION AND CHARACTERIZATION OF MASS TRANSFER IN NANOFLUIDS

J. Veilleux, F. Aristizabal and S. Coulombe
McGill University, Montreal, Canada

12:20 - 14:00 Lunch

14:00 - 14:40 Keynote lecture: **EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE SYMMETRY-BREAKING AND FLOW BIFURCATION IN A T-SHAPED MICROMIXER**
R. Lindken, J. Hussong, J. van Esch and J. Westerweel
Technical University of Delft, Delft, The Netherlands
Keynote chair: D. Pence

14:40 - 15:00 Session: **HEAT EXCHANGERS 2 – HEX2**
Session chair: J. Liburdy

EXPERIMENTAL INVESTIGATION AND NUMERICAL ANALYSIS OF MICROCHANNEL HEATSINKS FOR PHASED ARRAY RADAR COOLING APPLICATIONS

E. Alpsan*, H. Aksel**, C. Sert** and U. Etiz*
**Aselsan Inc., Ankara, Turkey, **Middle East Technical University, Ankara, Turkey*

15:00 - 15:30 Coffee

15:30 - 16:30 Session: **HEAT TRANSFER 3 – HT3**
Session chair: G.L. Morini

GRADIENT-BASED OPTIMIZATION OF SINGLE-PHASE MICROSCALE FRACTAL-LIKE BRANCHING CHANNEL HEAT SINKS

D. Heymann, K. Enfield, D. Pence and V. Narayanan
Oregon State University, Corvallis, OR, USA

SOLUTION OF CONJUGATE FORCED CONVECTION AND HEAT CONDUCTION PROBLEMS IN MICROCHANNEL FLOWS: A HYBRID APPROACH

C. Nonino, S. Savino, S. Del Giudice and L. Mansutti
Università degli Studi di Udine, Udine, Italy

HEAT TRANSFER FROM MICRO IMPINGING JET ARRAYS

T. Lupton, D.B. Murray and A.J. Robinson
Trinity College Dublin, Dublin, Ireland

19:30 – 22:00 Conference Dinner

FRIDAY, September 26, 2008

07:30 – 08:30 Breakfast

08:30 - 09:10 Keynote lecture: **EFFECTS OF NANO-FLUID AND SURFACES WITH NANO STRUCTURE ON THE INCREASE OF CHF**

S.T. Kim, H.D. Kim, H.M. Kim, H.S. Ahn, H.J. Jo, J.W. Kim and M.H. Kim
Pohang University of Science and Technology(POSTECH), Kyungbuk, Republic of Korea
Keynote chair: G.P. Celata

09:10 - 09:50 Session: **HEAT TRANSFER 4 – HT4**

Session chair: S. Del Giudice

THERMAL PERFORMANCE OF CORNING GLASS MICROSTRUCTURES

E.D. Lavric
Corning SAS CETC, Avon, France

PARAMETRIC STUDY ON THE EFFECT OF ENDWALLS ON HEAT TRANSFER AND FLUID FLOW IN MICRO PIN-FIN HEAT SINKS

M. Koz and A. Kosar
Sabanci Universitesi Yurtlari, Istanbul, Turkey

09:50 - 10:30 Coffee

10:30 - 11:30 Session: **FLUID FLOW 3 – FF3**

Session chair: C. Nonino

COMPUTATIONAL ANALYSIS OF GASEOUS FLOW IN COMPLEX GEOMETRIES

G. Croce and P. D'Agaro
Università di Udine, Udine, Italia

AEROSOL FLOW IN MICROSCALE: THEORY, EXPERIMENT, AND APPLICATION TO DIRECT-WRITE MICRO FABRICATION

I.S. Akhatov*, J.M. Hoey*, D. Thompson*, O.F. Swenson*, D.L. Schulz* and A.N. Osipov**
**North Dakota State University, Fargo, USA, **Lomonosov Moscow State University, Moscow, Russia*

NUMERICAL INVESTIGATION OF FLOW IN FIBROUS POROUS MEDIA

A. Tamayol and M. Bahrami
Simon Fraser University, Surrey, Canada

11:30 - 12:00 Summary and future plans

12:00 Lunch