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2013 11th ASME International Conference on Nanochannels, Microchannels and Minichannels (ICNMM)

June 16-19, 2013

Sapporo, Japan

PROGRAM

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ORGANIZERS WELCOME

Dear Colleagues,

It is a pleasure to welcome you to the great city of Sapporo, Japan for the 11th International Conference of Nanochannels, Microchannels, and Minichannels (ICNMM 2013). The conference was first launched in 2003 by Professor Satish Kandlikar, a revered scientist and engineer. This event brings together world experts in heat transfer, mass transfer, fluid mechanics, and biomedical applications specializing in physical processes at diminishing length scales.

This year we decided to consolidate the tracks and selected thirteen focused topics ranging from single- and two-phase flows, liquid/vapor phase change, electronics cooling, electrokinetic flow, fuel cells, biomedical applications, measurements and instrumentation, modeling and simulation, and mixing and chemical reactions. One topic, nuclear application, did not receive much traction.

Without the diligent work of co-chairs Professor Daniel Attinger and Professor Vinod Narayanan and the conference local chairs, Professor Takemi Chikahisa and Professor Yas Takata, this conference could not have come to fruition. I would also like to thank all the conference track organizers for their help throughout the year. Special thanks to Professor Norbert Kockmann who tirelessly worked to bring a cadre of exceptional keynote and plenary speakers.

I hope you will enjoy the conference and the beautiful city of Sapporo. I'm certain you will find the talks and discussions stimulating and educating. On behalf of the organizing committee, I would like to thank all of you for making this conference possible. I hope to see you next year in Chicago, IL for ICNMM 2014.

Yoav Peles

2013 ICNMM Conference Chair

Yoav Peles
Conference Chair

Daniel Attinger
Co-Chair

Vinod Narayanan
Co-Chair

Takemi Chikahisa
Local Chair

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ACKNOWLEDGEMENT

The 11th Annual International Conference on Nanochannels, Microchannels, and Minichannels is sponsored by the Fluids Engineering and Heat Transfer Technical Divisions of the American Society of Mechanical Engineers (ASME). With the support and collaboration of the Japanese Society of Mechanical Engineers (JSME), the conference is intended to provide a platform for researchers to exchange information and identify research needs in this emerging area encompassing micro thermal systems, MEMS, microfluidics, bio-medical and many other frontier research disciplines.

HOKKAIDO UNIVERSITY

Hokkaido University is an international university with a long tradition of excellence in teaching and research, attracting outstanding staff and students from Japan and around the globe. The student enrollment stands at approximately 18,000, including students from more than 85 countries. The stunning main campus is located in downtown Sapporo, within walking distance of almost everything the beautiful city has to offer. With an additional campus in the coastal city of Hakodate, Hokkaido University has become the frontier of real innovation in northern Japan.

REGISTRATION

Registration will be located in the foyer on the Mezzanine Level of the conference hall. The hours are as follows:

Sunday, June 16, 2013	4:00pm–7:00pm
Monday, June 17, 2013	8:30am–5:00pm
Tuesday, June 18, 2013	8:30am–12:00pm
Wednesday, June 19, 2013	8:30am–4:00pm

NAME BADGES

Please wear your name badge at all times. Admission to all conference functions will be by the badges only (unless noted otherwise). Your badge also provides a helpful introduction to other attendees.

TICKETED FUNCTIONS/ITEMS

Some conference functions will require a ticket for admittance. Please check with a conference representative if you have any questions regarding specific events. If you would like to bring a guest to the banquet, you must purchase a ticket on their behalf.

CONFERENCE PAPERS / PUBLICATION

Upon arrival at the registration area on-site at the conference, each attendee will receive a CD Rom containing all of the scheduled technical presentations for the 11th International Conference on Nanochannels, Microchannels and Minichannels. The conference proceedings will be produced and published at the conclusion of the 2013 ICNMM conference. The proceedings will be available for purchase on the ASME Digital Library.

REGISTRANTS WITH DISABILITIES

Whenever possible, we are pleased to make arrangements for registrants with disabilities. Advance notice may be required for certain requests. For on-site assistance, please visit the registration area and ask to speak with a conference representative.

HAVE QUESTIONS ABOUT THE MEETING?

If you have any questions or need assistance, an ASME representative will be located in the registration area.

BANQUET — Keio Plaza Hotel

The Honors & Awards Banquet will be held on Tuesday, June 18th from 6:30pm–8:30pm. *Tickets are available for purchase (attendees = $10 and guests = $50).*

COMMITTEE MEETING – ICNMM ORGANIZERS — Engineering Building

The 2013 Conference Organizers will hold a committee meeting immediately following the Opening Reception on Sunday, June 16th from 7:00pm– 9:30pm.

OPENING RECEPTION — Restaurant Elm

The Opening Reception will be held on Sunday, June 16th from 5:00pm– 7:00pm. Enjoy socializing with attendees and take the time to meet the conference organizers. Tickets are required unless you are wearing a conference badge.

TOURS/ECURSIONS

The conference program includes free time on Tuesday, June 18th from 1:00pm– 5:30pm. *This break in the program will allow attendees to participate in one of 2 possible excursions. Registration for the tours is handled outside of the main conference registration. Any questions or comments pertaining to the tours should be directed towards:*

ICNMM2013 Conference Agency
c/o Kinki Nippon Tourist Hokkaido Co., Ltd.
Sapporo Corporate Travel Branch
6th Floor, Nittsu Sapporo Bldg., N3 W2,Chuo-ku, Sapporo, JAPAN 060-0003
Phone: +81-11-280-8855; Fax : +81-11-280-2732
E-mail: s-convention-1@or.knt-h.co.jp

CLOSING CEREMONY/SOCIAL — Centennial Hall

The closing ceremony will be held on Wednesday, June 19th from 4:40pm– 6:00pm. Attendees will enjoy final remarks from the conference organizers and other speakers.

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Monday, June 17 **9:30am–10:20am**
Room A

Bubble Coalescence and Moving Contact Line Evaporation During Flow Boiling in a Single Minichannel

Peter Stephan
Institute for Technical Thermodynamics, Technische Universitat Darmstadt

Abstract: Cooling systems which incorporate flow boiling in mini- and microchannels achieve very high thermal performance. Many investigations on flow boiling in small channels have already been conducted. Kandlikar [1] summarized investigations related to this subject and proposed three fundamental questions for researchers: 1. How does the small passage dimension affect the bubble dynamics and the two-phase flow? 2. How is the heat transfer and pressure drop affected in these channels? 3. What is the difference in performance between single and multiple parallel channels? Despite the numerous conducted investigations related to the subject the basic phenomena of the heat transfer mechanisms are not yet understood.

In this study a comprehensive measurement technique is used for the investigation of flow boiling in a single rectangular minichannel. This technique allows the measurement of local heat flux and temperature with a very high spatial and temporal resolution in combination with a synchronized flow regime observation [2]. In that way, an insight into the basic phenomena is possible and will contribute to the fundamental understanding of the process. The experimental results show different phenomena such as bubble nucleation and coalescence in the flow. These results and the connection with pool boiling experiments [3] show an indication of the basic heat transfer mechanisms.

A single rectangular minichannel (2 mm width x 0.5 mm height) is manufactured into an aluminium block. The temperature of the aluminium block and, therefore, of two sides of the channel is controlled by a constant temperature loop. The top of the channel is closed by a window for optical access for high speed video recording. The reverse side of the channel is covered by a 25 ?m thick stainless steel foil which is heated by electric current. The temperature of the outer side of the foil is measured by IR thermography with a spatial resolution of 30 ?m and a frame rate of 1000 fps. FC-72 is used as working fluid.

Several flow pattern regimes such as bubbly flow, slug flow and partial wall dry-out were observed. From an energy balance at each pixel element of the thermographic recordings the local transient heat flux could be calculated and compared to the flow pattern video recordings. Further heating foils with artificial nucleation sites were investigated to observe the bubble nucleation in present of a forced convective liquid flow.

[1] Kandlikar S.G., Fundamental issues related to flow boiling in minichannels and microchannels, Exp. Thermal and Fluid Science 26 (2002) [2] Schweizer N., Freystein M., Stephan P., High resolution measurement of wall temperature distribution during forced convective boiling in a single minichannel, Proc. of the 8th International Conference on Nanochannels, Microchannels, and Minichannels, 2010, Montreal (Canada) [3] Schweizer N., Multi-Scale Investigation of Nucleate Boiling Phenomena in Microgravity, Dissertation, TU Darmstadt, 2010

Tuesday, June 18 **9:00am–9:50am**
Room A

Laser-Based Measurement Techniques for Interfacial Transport Phenomena in Microchannels

Koichi Hishida
Keio University

Abstract: This paper summarized our recent works of the laser-based measurement techniques for investigating micro- and nano-scale transport phenomena. Micron-resolution particle image velocimetry combined with the laser induced fluorescence (LIF) technique was developed for analyzing velocity and ion concentration distributions simultaneously. The measurement system was based upon a confocal microscopy to realize the depth-resolution of approximately 2 m, and this technique was applied to liquid-liquid mixing flows, gas-liquid two-phase flows and gas permeation phenomena through membranes. To evaluate the electrostatic potential at solid-liquid interface (i.e., zeta-potential), the LIF technique was advanced with the evanescent wave illumination. Fluorescent dye within approximately 100 nm from a microchannel wall was irradiated. This technique was applied to microdevices with a surface modification pattern, and the zeta-potential distribution was successfully visualized. Two proposed techniques will contribute to novel applications related to microscale multiphase flows or electrokinetics.

Wednesday, June 19 **9:00am–9:50am**
Room A

Adiabatic Two-Phase Flow in Microchannels

Masahiro Kawaji
CUNY Energy Institute and University of Toronto

Abstract: Studies on adiabatic two-phase flow in microchannels started in the late 1990's have flourished in the past decade. In this presentation, past experimental and numerical studies on adiabatic gas-liquid two-phase flows in microchannels with diameters less than 500 microns will be reviewed as well as some liquid-liquid flows. Initial studies indicated the existence of two-phase flow patterns similar to those in minichannels but some differences were identified such as a ring film flow pattern. The effects of inlet geometry and method of gas and liquid injection have also been found to be much more significant compared to those in minichannels. Two-phase flow patterns, void fraction and friction pressure drop were found to be significantly affected by the diameter of the inlet section relative to the microchannel and how the gas and liquid phases are injected and mixed upstream of the microchannel. Using a tee junction of the same diameter as the microchannel as the inlet, the two-phase flow pattern in the microchannel is mostly intermittent with short gas and liquid slugs flowing with nearly equal velocities. The void fraction then conforms nearly to that of a homogeneous two-phase flow, and two-phase friction multiplier applicable to larger channels is obtained. However, when the diameter of the inlet section is larger than the microchannel, the two-phase flow characteristics in the microchannel become highly dependent on the flow characteristics in the inlet section. Long gas slugs become prevalent and the void fraction decreases to values far below those given by a homogeneous void fraction. Liquid-liquid flows in microchannels also show similar flow patterns as in gas-liquid flow but a strong influence of the wetting characteristics between the channel wall and the two liquids is observed. Practical implications for designing microchannel devices utilizing gas-liquid and liquid-liquid two-phase flows will be described.

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Monday, June 17 **10:30am–12:10pm**
Room B

State of Art Modelling in the Transitional Flow Regime

Irina Graur
Aix Marseilles University

Abstract: The transitional flow regime is the most complicated for the simulation gas flow regime. The different approaches, continuum and kinetic, which are available for the flow simulation in this regime, will be presented. The examples of application of these approaches together with the conditions of their application will be given. Different comparisons between the simulations and the experimental results will be presented.

Monday, June 17 **10:30am–12:10pm**
Room D

Microscale Transport Phenomena in Porous Materials for Fuel Cell Applications

Dominik P.J. Barz
Queen's University

Abstract: The Queen's-RMC Fuel Cell Research Centre (FCRC) is Canada's leading university-based research and development organization dedicated to advancing the knowledge of fuel cell applications. Research at FCRC spans over a wide range of subjects including but not limited to fuel reforming, hydrogen storage, Proton Exchange Membrane and Solid Oxide Fuel Cells. In this talk, we give an overview of recent research and development on microstructural components in stationary and portable fuel cell systems. In detail, we focus on transport phenomena in the porous transport layers and electrocatalyst layers of fuel cell electrode assemblies which have numerous important functions. Additionally, we will discuss the transport phenomena in catalytic layers within fuel processors where hydrocarbon or alcohol fuels are reformed prior to entering the fuel cell stack.

Monday, June 17 **1:00pm–2:40pm**
Room A

Microbubble-liquid Interaction Observed in Channel Flows from Laminar, Transition, and Turbulent Regimes

Yuichi Murai
Hokkaido University

Abstract: Microbubble mixture shows complex behavior as dispersive two-phase turbulent flow, and there are still unknown properties that influence flow transition and controllability of turbulence. Different from ordinary bubble size, relative motion between microbubbles and liquid is strongly restricted due to viscosity, but their non-zero slip velocity rather creates highly organized flow structure via preferential concentration and spatio-temporal coherent motion of microbubbles. Furthermore, bubble-bubble interaction and local instant increase in effective viscosity provide new functions in flow control from laminar, transition, and turbulent flow regimes in wall boundary layer. These new topics will be introduced in the presentation.

Monday, June 17 **1:00pm–2:40pm**
Room B

Analytical Models in Microfluidics: From Rigorous Solutions to Engineering Correlations

Steffen Hardt
Technical University of Darmstadt

Abstract: Many phenomena in fluid dynamics, specifically in microfluidics, can only be modeled using numerical approaches, while analytical solutions rarely exist. However, the computational cost of some numerical models and the level of insight coming along with analytical descriptions call for simplified, or in the ideal case, analytically solvable models. The most widespread strategy for obtaining such models is based on perturbation expansions. In microfluidics, the most popular example for the latter is probably the lubrication approximation, applying to shallow flow domains. On the other end of the spectrum there exist engineering correlations which are much less rigorous in terms of their representation of the physical degrees of freedom of a problem. Between these two extremes there is a continuum of approaches with an increasing level of mathematical/physical rigor that is largely unexplored. For many problems, "almost" correct analytical solutions can be determined if in certain parts of a mathematical derivation heuristic instead of rigorous arguments are used. This is exemplified by computing the flow field over a cavity containing a second immiscible fluid and the flow along a superhydrophobic surface.

Monday, June 17 **1:00pm–2:40pm**
Room C

Lab-on-a-Chip Systems with Embedded 3-D Structures for Chemical Applications

Dong-Pyo Kim
POSTECH

Abstract: The microfluidic device containing a patterned surface or embedded structure is more advantageous for better mixing, as the incorporated microstructures or a patterned surface inside a channel generates transverse flows. Furthermore, the complex structures in the microfluidic systems could be applied to heterogeneous catalytic chemical reactions. However, these embedded structures have been fabricated mostly by a high cost process such as MEMS technique. Recently reported approaches such as multi-beam interference lithography are also required with sophisticated instruments and high-resolution UV resin only with limited availability. Herein, we present practical methods to generate 3D microstructures within microfluidic channel by incorporating top-down and bottom-up fabrication techniques. In detail, macroporous fluoropolymer, peptide nanowires and silica bead-packed structures, dual-channel were embedded in the microchannels for applications as mixers, heterogeneous catalytic supporters and gas-liquid reactions. At first, monolithic 3D silica bead packed microstructure was fabricated by assembly of silica beads, transfer printing and thermal decomposition of the binder. The robust packed structure after thermal treatment at 900? can be embedded inside a SU-8 microchannel by a site- and shape-selective photolithographic technique, which was effective in enhancing the mixing performance [1]. And the porous fluoropolymeric structures were built into microfluidic system with solvent resistance by combining with photolithography, that is useful for organic microchemical reaction by depositing Pd nanoparticles [2]. And vertically-aligned peptide

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nanowires with excellent stability were grown in soft polymeric microchannel under mild condition, deposited Pd nanoparticles on nanowires for heterogeneous microreactor system application [3]. In addition, catalytic Au or Pd nanoparticles was immobilized on -SH functionalized inorganic mesopores by using self-assembly diblock copolymer, then fixed-bed microfluidic systems incorporated with metal nanoparticles were employed to perform heterogeneous catalytic microchemical reactions. Finally, various dual-channels microreactor with gas permeable PDMS membrane offers the efficient gas-liquid reactions with high selectivity such as oxidative Heck reactions, photooxygenation. In particular, the non-gas permeable coated dual-channel microreactor enabled self-generation of toxic and explosive reagent within, its complete separation, and subsequent reaction to yield desired products.

Monday, June 17 **3:00pm–4:40pm**
Room A

Electrokinetic Flows - Characterization and Applications

Chun Yang
Nanyang Technological University

Abstract: An electrokinetic phenomenon is a generic term applied to effects associated with the movement of ionic solutions near charged interfaces. Implementation of electrokinetic phenomena in microfluidics has been demonstrated for pumping liquid phase based on electroosmosis and for separating charged species (e.g., DNA sequencing) based on electrophoresis. Electrically driven flow, also known as electroosmotic flow, offers a useful alternative to pressure-driven flow for aqueous media like water, and has numerous advantages including ease of fabrication and control, no need for moving parts and hence no noise, and high reliability. In this talk, I will report our several years' research activities on both linear and non-linear electrokinetically driven flows; the former refers to the flow velocity is linearly proportional to the strength of an applied electric field, and the letter refer to the non-linear dependence of the electrokinetic flow velocity on the electric field strength. Specifically, for linear electrokinetically driven flows, a novel technique is developed for characterizing steady and transient electrokinetic flows in a microchannel by using the micro-PIV system with an ordinary PIV CCD camera. The application of the linear electrokinetically driven flow for pumping and actuation will be reported. In addition, microfluidic concentration of solutes and DNAs will be demonstrated using electrokinetically induced temperature gradient focusing in an electrokinetic flow. For non-linear electrokinetically driven flows, a theoretical advancement on induced-charge electrokinetics will be reported for deriving an effective electric boundary condition on the liquid-solid interface. The derived boundary condition is general such that the widely used electrokinetic boundary conditions over electrical insulating surface and conducting surface are only two limiting cases. The implementation of non-linear electrokinetically driven flows under AC with DC offset

Monday, June 17 **3:00pm–4:40pm**
Room B

Multi-Scale Simulation of Internal Rarefied Gas Flows

Duncan Lockerby
University of Warwick

Abstract: This paper describes the development and application of a multiscale method for the efficient simulation of a large class of low-speed internal rarefied gas flows. The method is an extension of the hybrid atomistic-continuum approach recently proposed by Borg et al (2013) [J. Comp. Phys., 233, pp 400-413] for the simulation of micro/nano flows of high-aspect ratio. The extension is twofold: 1) a modification to accommodate fluid compressibility; and 2) implementation using a direct simulation Monte Carlo (DSMC) method for the treatment of dilute rarefied gas flows. The method is applied to a pair of internal-flow configurations: flow through a converging-diverging channel and eccentric cylindrical Couette flow. For validation/verification purposes, the multiscale simulation results are compared to those obtained from a full-scale DSMC simulation: very close agreement is obtained in all cases. The multiscale simulation is an order of magnitude more computationally efficient than the full-scale DSMC for the first test case, and two orders of magnitude more efficient for the second case.

Monday, June 17 **3:00pm–4:40pm**
Room C

Scaling-up Microchannel Emulsification Foreseeing Novel Bioactives Delivery Systems

Marcos Neves
Alliance for Research on North Africa (ARENA)

Abstract: In the recent years, emulsification technologies that generate droplets individually have attracted a great deal attention in various fields, e.g., for chemicals, cosmetics, foods, and pharmaceuticals. Such drop-by-drop emulsification technologies include membrane emulsification using microporous membranes and microchannel (MC) emulsification, among others. The authors developed MC emulsification chips, consisting of parallel microgrooves or compactly arranged straight through-holes. Using this MC emulsification technique, the authors have evaluated the formulation a two-phase system consisting of size-controlled O/W emulsions loaded with bioactive molecules, such as Beta-carotene or Gamma-oryzanol, PUFAs or polyphenols. The MC emulsification process enabled the production of ?-carotene-loaded O/W emulsions with average droplet size (dav) of 27.6 micrometer and coefficient of variation (CV) of 2.3% and Gamma-oryzanol-loaded droplets with dav of 28.8 micrometer and CV of 3.8%. The highly monodisperse O/W emulsions were physically stable during up 4 months storage in darkness at 5 C. In addition, we investigated the formation characteristics of O/W emulsion droplets in the presence of electrolyte by MC emulsification using differently charged surfactants. Droplet formation was conducted by pressurizing a dispersed phase (refined soybean oil) through the MC silicon chip into a continuous phase containing 1.0 wt% of sodium dodecyl sulfate (SDS) or polyoxyethylene (20) sorbitan monolaurate (Tween 20), and an electrolyte (NaCl) (0-1.0 mol/L). Monodisperse O/W emulsions with an dav of 26 micrometer and a CV below 5% were produced when the NaCl concentration was lower than a threshold level that is 0.3 mol/L for SDS and 0.5 mol/L for Tween 20. The authors also developed a large MC emulsification device including a newly designed asymmetric MC array chip to realize the mass production of uniformly sized droplets

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on a liter per hour scale, so that satisfying the minimum droplet productivity needed for industrial-scale production. The large MC emulsification device has a potential droplet productivity exceeding several tons per year, which could satisfy a minimum industrial-scale production of monodisperse microdispersions containing emulsion droplets, microparticles, and microcapsules loaded with bioactive compounds. Such systems have as continuously increasing potential application in the formulation of functional foods, providing a good opportunity to improve the solubility of bioactive compounds, so that increasing their bioavailability.

Monday, June 17 **3:00pm–4:40pm**
Room D

Optimal Flow Channel Designs of PEM Fuel Cells

Wei-Mon Yan
National University of Tainan

Abstract: In this work, the optimal designs of the flow field for a single serpentine PEM fuel cell was examined with an optimization approach that integrates a simplified conjugate-gradient method (SCGM) and a three-dimensional, two-phase, non-isothermal proton exchange membrane (PEM) fuel cell model. The output power density Pcell of the PEM fuel cell is selected to be the objective function and would be maximized with the channel heights and channel widths as the search variables. Compared with the basic design with all heights and widths setting as 1 mm, the optimal output power density Pcell was increased about 22.51%. The reduced channel heights of channels considerably increase the sub-rib convection to effectively transport oxygen to and liquid water out of gas diffusion layer. The proposed combined approach is effective in optimizing the flow channel designs of PEM fuel cells.

Wednesday, June 19 **10:00am–12:00pm**
Room A

Recent Developments in Micro/Nanochannel Emulsification for Controlled Production of Monodisperse Emulsions

Isao Kobayashi
National Food Research Institute

Abstract: Emulsification is a commonly used process in food, pharmaceutical, cosmetic, and chemical industries. Microfluidic techniques for producing emulsions have been proposed over the last decade. Major advantages of microfluidic techniques include the production of monodisperse emulsions with a coefficient of variation (CV) of typically <5%, superior controllability of droplet size and monodispersity, and in situ microscopic monitoring. Monodisperse emulsions produced by microfluidic techniques have potential high-tech applications, e.g., monodisperse microparticles as spacers for electronic devices and monodisperse micro-carriers for drug delivery systems (DDS). Microchannel (MC) emulsification, proposed by our research group, is a unique and robust technique to produce monodisperse emulsions with controlled droplet sizes of >1 um. In MC emulsification, droplet generation via MC arrays does not require any external shear/elongational stress; i.e., the dispersed phase that passed through MCs is transformed spontaneously into uniform droplets due to hydrodynamic instability of the oil-water interface. Here we present some of the recent findings obtained from MC emulsification studies and the controlled production of monodisperse submicron emulsions by novel nanochannel (NC) emulsification. The first topic on MC emulsification is the influence of operating temperature (10 to 70 oC) on production of oil-in-water (O/W) emulsions using a surface-oxidized silicon MC array plate with an MC depth of 8 um. The droplet generation results were correlated well with the contact angle of the dispersed phase to the MC walls that was measured using a novel method using parallel long MCs. Another topic on MC emulsification is the development of stainless-steel MC emulsification devices. Stainless-steel MC array plates with an MC depth of 100 or 150 um were mechanically fabricated using an end mill. The use of the stainless-steel MC array plates enabled stably producing monodisperse O/W emulsions with an average droplet diameter of up to 550 um. We also recently developed silicon NC array plates with an NC depth of 50 to 250 nm. NC emulsification experiments demonstrated successful production of monodisperse submicron O/W emulsions with an average droplet diameter of 480 to 890 nm. The diameter of the droplets generated by NC emulsification was measured by a novel technique that exploits nanospace.

Wednesday, June 19 **10:00am–12:00pm**
Room C

Optimal Design and Operation of Microdevices for Chemical Production

Osamu Tonomura
Kyoto University

Abstract: Microreactors with gas and liquid slugs can achieve more efficient mass transfer between two phases than conventional reactors such as bubble columns, because of regular flow pattern, large interfacial area and high mass transfer rate given by internal circulation within the liquid slugs. While the basic research on gas-liquid flow characteristics in microchannels is carried out by many researchers, gas-liquid reactions are also performed in microchannels. According to a result of previous papers, it was shown that the space-time yields of the oxidation of ethyl lactate for producing ethyl pyruvate in microreactors were ten times larger than those in conventional reactors. However, the design and operation conditions of microreactors with gas and liquid slugs are determined by trial-and-error. Namely, there is no established design method available for them. Therefore, the objective of this research is to develop a method that can derive optimal design and operation variables of microreactors with gas and liquid slugs under constraints on production. Although computational fluid dynamics (CFD) simulation is a powerful tool for analyzing the characteristics of multiphase flow with reactions, it is not realistic to directly apply CFD to optimal design problems of microreactors, because CFD simulation requires huge amount of computational time. In this work, a design approach based on compact models describing the laminar flow of multiphase fluids in microchannels is proposed to efficiently derive an optimal microreactor, and its usefulness is assessed through case studies.

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Wednesday, June 19 **1:00pm–2:40pm**
Room B

Integrated Microfluidic Pumping and Cooling

Arjan J.H. Frijns
Eindhoven University of Technology

Abstract: Temperature management in microsystems is a technical problem with an increasing importance: although the power consumption of integrated circuits is not increasing, due to further miniaturization the local power density is still increasing. Moreover, in the near future more and more micro components will be integrated in flexible system-in-foil (SIF) packages. These packages can contain ultra-thin (8 – 50 micron) flexible embedded silicon chips combined with polymer electronics, optical systems and microfluidic channels e.g. for point-of-care diagnostics. However, the low thermal conductivity of the polymeric package is aggravating the heat management problem. The life span of micro components, but also the performance of some micro components, like (O)LEDs, can be strongly temperature dependent. Therefore an adequate temperature control is required.

The thermal management problems can potentially be addressed by embedding micro-channels containing a flowing cooling medium in close proximity and preferably directly underneath the electronic circuit. However, many applications do not allow for external In this pumps and therefore pumping needs to be integrated in these channels as well.

In this paper some promising integrated micro pumping techniques, like AC-electro osmosis and ferrofluidic pumping, will be described and discussed. The multi-physics modeling approach will be presented and the numerical results will be analyzed and compared with flow fields that are measured by 3D astigmatism micro particle tracking velocimetry (3D micro-PTV).

Wednesday, June 19 **1:00pm–2:40pm**
Room C

Pressure Measurement Techniques Based on Luminescent Molecules for Micro Gas Flows

Yu Matsuda
Nagoya University

Abstract: In micro gas flows, some specific phenomena at/near a wall, such as velocity slip, temperature jump, and thermal transpiration, play an important role; thus, the measurement technique, which measures a physical quantity at a wall, is very important. The pressure-sensitive paint (PSP) technique has potential as a diagnostic tool for pressure measurement on a solid surface. However, the application of PSP to micro-devices is very difficult because conventional PSPs are very thick compared to the dimension of micro-devices owing to polymer binders. Moreover, they do not have sufficient spatial resolution for pressure measurement in micro-scale because of the aggregation of the luminescent molecules in polymer binders. The authors developed pressure-sensitive molecular film (PSMF) with ordered molecular assemblies by using the Langmuir-Blodgett method. The spatial uniformity of PSMF luminescent intensity is much smoother than that of conventional PSP, indicating that the spatial resolution of PSMF is much higher than that of conventional PSP. The pressure distribution in a micro nozzle was successfully measured by PSMF. As the second solution, we also developed a micro channel by the PDMS micro-molding technique with mixing a pressure-sensitive dye into PDMS: i.e., a micro channel fabricated by PSP, which is named PSCC (pressure-sensitive channel chip). In the speech, we will present the PSMF/PSCC fabrication procedure, characteristics, and the applicability of them to micro gas flow measurement.

Wednesday, June 19 **1:00pm–2:40pm**
Room C

Application Process Tomography to Measure Particle Migration in Microchannel

Masahiro Takei
Chiba University

Abstract: Nowadays, fluid flow in a microchannel has emerged as an important area of research. This has been motivated by their various applications such as medical and biomedical use, computer chips, and chemical separations. Usually, electrical impedance tomography (EIT) is visualized, into a cross-sectional image representing the distribution of density. EIT is recently developed imaging technique, with which images of the conductivity or permittivity of the subject can be rapidly collected with channels of external electrodes. Therefore, we considered application of EIT to the microchannels. In this paper, we develop the EIT for microchannel nano particles concentration in microchannel with 60 multi-layer electrodes and measured using cross-sectional impedance measurement technique. Based on the reconstructed image using the EIT system and analytical calculation using Maxwell equation, we discuss the initial concentration condition effect and the stream transitional migration to estimate particle migration behaviors in the fluid flow. The measured results shows up to 24% particles moved from upstream to downstream cross-section, where the particles move away from center streamlines to near wall vicinity area and the number of the particles migration towards wall vicinity area is clearly increased near the outlet area. The stream transitional particle migration due to inertia lift forces is investigated with the effect of the initial particle concentration.

Wednesday, June 19 **1:00pm–2:40pm**
Room D

Influence of AC Electrohydrodynamic Flows on the Electric Field Driven Assembly of Colloidal Spheres

Aristides Docoslis
Queen's University at Kingston

Abstract: The use of spatially non-uniform electric fields for the contact-free assembly of sub-micron and nanoparticles into ordered structures of various length scales is an emerging research area of great interest. In the present work, we combine numerical simulations with experimental observations in order to advance our understanding of the physical mechanisms that govern this colloidal assembly process and their relation to the electric field characteristics and colloidal system properties. The simulations are based on a thermodynamic framework, according to which the forces on the particles and fluid are calculated in terms of a chemical potential gradient, where electrical and entropic terms are taken to be the two primary contributions. Our simulation results help to explain the origin of the experimentally observed - but still largely unaddressed- microfluidic flow patterns that develop over a wide range of experimental conditions during the application of an AC electric field. Our work shows that these microfluidic flows can strongly affect both the shape and size of the formed nanoparticle assemblies.

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Wednesday, June 19 **3:00pm–4:40pm**
Room B

Experimental Investigation on the Minichannel Cold Plate for High Temperature Uniformity Based on a Compact Thermal Model

Xiaobing Luo
Huazhong University of Science and Technology

Abstract: A compact thermal model for multiple heat sources mounted minichannel cold plate to achieve high temperature uniformity was presented in the authors' previous work. In this paper, based on this compact thermal model, a fractal tree-like minichannel cold plate was designed and fabricated to obtain high temperature uniformity, its thermal performance was tested under different working conditions by experiments. The comparison reveals that the measured temperatures are close to the ones predicted by the compact thermal model. The cold plate designed based on the compact thermal model can help multiple heat sources achieve high temperature uniformity, and the maximum temperature difference among the heat sources is 1.3?. Moreover, a straight minichannel cold plate was designed and tested under the same conditions. The measured results show that there exists relatively large temperature gap among the heat sources, and the maximum value is 6.7?, which is much higher than 1.3? in the fractal tree-like minichannel. Therefore, the fractal tree-like microchannel or minichannel cold plate has an advantage over the straight one in obtaining temperature uniformity for multiple heat sources.

Wednesday, June 19 **3:00pm–4:40pm**
Room C

Experimental Techniques Using Nano Hot-film for Micro/nanoscale Heat Transfer

Koji Takahashi
Kyushu University

Abstract: This paper treats micro/nanoscale experimental techniques using nano Pt hot-film sensor. Individual nanomaterial specimen represented by carbon nanotube is bonded on the film by using electron-beam induced deposition method in SEM chamber with a manipulator. When the specimen is set as bridging between the hot-film and a heat sink, we can obtain its thermal conductivity using a steady heat conduction model of hot-film with additional heat path. When the specimen is set as a cantilever, we can measure the surface temperature with 100nm resolution. CNT-based SThM is developed and its feasibility of quantitative measurement is confirmed by using feedback control of hot-film. By using the cantilever-type specimen on a hot-film, heat transfer coefficient of nanomaterial is also successfully measured in various gases. Further direction of the nano hot-film technique for heat transfer research is also addressed.

Wednesday, June 19 **5:00pm–6:40pm**
Room A

Photothermal Actuation for Flexible Control of Microfluidic Bubbles and Drops

Masahiro Motosuke
Tokyo University of Science

Abstract: Remarkably increasing interests has been gathered toward the application of multiphase flow in microfluidic system with the advantages of discrete volumes of bubbles or drops as highly efficient microreactors with rapid mixing of fluids. Although lots of studies on the generation of microfluidic bubble and drop have been reported, there have been limited studies about the control techniques for them. We have investigated a potential of remote manipulation of bubble and drop in a microfluidic platform using photothermal Marangoni actuation. With the use of localized heated area close to a bubble and drop, spontaneous interfacial flow around them occurs by an interfacial-tension gradient induced by the temperature difference. The interfacial flow could give a force on the microfluidic bubble or drop to move toward an area with low interfacial tension; the direction and speed of the transportation is decided by the temperature sensitivity of the interfacial tension. Bubbles and drops having negative and positive temperature dependence on the tension were controlled by spatially-characterized laser heating, respectively. It is found that scanning laser spot and patterned light irradiation are effective to control microfluidic bubbles and drops in noncontact manner.

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MONDAY, JUNE 17

TRACK 1 Single Phase Gas Flow

Track Organizer: **Stéphane Colin**
Track Co-Organizer: **Chungpyo Hong,** *Kagoshima University, Kagoshima, Kagoshima, Japan*

1-1 Single Phase Gas Flow I

Room C **10:30am–12:10pm**

Three Dimensional Thermo-Fluid Analyses on Convective Heat Transfer and Friction Loss in Micro/Mini Channel Based on High Order LES Model
Technical Publication. ICNMM2013-73117
Debasish Biswas, Aya Kitoh, *Toshiba Corporation, Kawasaki, Japan*

Heat Transfer Characteristics of Developing Gaseous Slip-Flow in Parallel Plate Microchannel
Extended Abstract. ICNMM2013-73068
Kabar Yassine, *Université de Jijel, Jijel, Algeria, Bessaih Rachid, UMC, Constantine, Algeria,* Rebay Mourad, *URCA Reims, Reims, France*

Computational Analysis of Conjugate Heat Transfer in Gaseous Micro Channels
Technical Publication. ICNMM2013-73119
Giulio Croce, Olga Rovenskaya, Paola D'Agaro, *University of Udine, Udine, Italy*

Measurement of Semi-Local Friction Factor of Gas Flow in Micro-Tube
Technical Publication. ICNMM2013-73091
Daisuke Kawashima, *Tokyo Metropolitan University, Hachioji, Tokyo, Japan,* Yutaka Asako, *Tokyo Metropolitan University, Tokyo, Tokyo, Japan*

TRACK 3 Two-Phase Flow

Track Organizer: **Masahiro Kawaji,** *City College of New York, New York, NY, United States*
Track Co-Organizers: **Niro Nagai,** *University of Fukui, Fukui, Japan,* **Gherhardt Ribatski,** *Department of Mechanical Engineering - University of São Paulo - São Carlos, São Carlos, Brazil,* **Vijayaraghavan Chakravarthy,** *Praxair, Inc., Tonawanda, NY, United States*

3-1 Theoretical or Numerical Analysis of Two-Phase Flow

Room A **10:30am–12:10pm**

Lattice Boltzmann Modeling for Analysis of Water-Splitting Over Nanorods with Emphasis on Reactive Mass Transport
Technical Publication. ICNMM2013-73098
Hedvig Paradis, Bengt Sunden, *Lund University, Lund,Sweden,* Costas Grigoropoulos, *University of California, Berkeley, CA, United States*

An Experimental Study of Two Phase Flow in Impinging Micro Channels
Technical Publication. ICNMM2013-73073
Liang-han Chien, Han-Yang Liu, Wun-Rong Liao, *National Taipei University of Technology, Taipei, Taiwan*

Flow Boiling of R134a and R245fa in a 1.1 mm Diameter Tube
Technical Publication. ICNMM2013-73090
Emily Pike-Wilson, Tassos G. Karayiannis, *Brunel University, Middlesex, United Kingdom,* Mohamed M. Mahmoud, *Zagazig University, Cairo, Egypt*

An Analysis of the Pressure Drop Associated with Liquid-Liquid Slug Flows
Technical Publication. ICNMM2013-73097
Marc Mac Giolla Eain, Jeff Punch, Patrick Walsh, *University of Limerick, Limerick, Ireland,* Vanessa Egan, *Stokes Research Institute, Limerick, Ireland,* Edmond Walsh, *University of Oxford, Osney, United Kingdom*

Experimental Investigation of Enhanced Absorption of Carbon Dioxide in Diethanolamine in a Microreactor
Technical Publication. ICNMM2013-73162
Harish Ganapathy, Amir Shooshtari, Serguei Dessiatoun, Michael Ohadi, *University of Maryland, College Park, MD, United States,* Mohamed Alshehhi, *The Petroleum Institute, Abu Dhabi, Abu Dhabi, United Arab Emirates*

Fluid Dynamics and Transport Performance of Two-Phase Flow in Microstructured Devices
Technical Presentation Only. ICNMM2013-73203
Guangsheng Luo, Kai Wang, Jianhong Xu, Yangcheng Lu, *Tsinghua University, Beijing, Beijing, China*

TRACK 7 Fuel Cells

Track Organizer: **Debjyoti Banerjee,** *Texas A&M Universitu, College Station, United States*
Track Co-Organizer: **Shohji Tsushima,** *Tokyo Institute of Technology, Tokyo, Japan*

7-1 Fuel Cells I

Room D **10:30am–12:10pm**

Microscale Transport Phenomena in Porous Materials for Fuel Cell Applications
Technical Publication. ICNMM2013-73225
Dominik P.J. Barz, Brant Peppley, Jon Pharoah, *Queen's University, Kingston, Canada*

Developments of MEMS-based Thermocouple Array for Sensing Effects of a Flow Channel on PEMFC Local Temperature Distribution
Technical Publication. ICNMM2013-73198
Toshiki Sugimoto, Yuhei Horiuchi, Takuto Araki, *Yokohama National University, Yokohama, Kanagwa, Japan*

Analysis of Water Transport in the Vicinity of Micro-Porous Layer in PEFC with Freezing Method
Extended Abstract. ICNMM2013-73124
Yusuke Aoyama, Kengo Suzuki, Yutaka Tabe, Takemi Chikahisa, *Hokkaido University, Sapporo, Hokkaido, Japan*

Proton and Methanol Transport Characteristics of Laminated Graphene Oxide Nanoplatelets
Technical Presentation Only. ICNMM2013-73077
Abhilash Paneri, Saeed Moghaddam, *University of Florida, Gainesville, FL, United States*

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In-situ Observation of Operating Polymer Electrolyte Fuel Cell (PEFC) by Neutron Small-Angle Scattering
Technical Presentation Only. ICNMM2013-73105
Satoshi Koizumi, *Ibaraki University, Hitachi, Ibaraki, Japan*

TRACK 12 Modeling and Simulation

Track Organizer: **Ali Beskok**
Track Co-Organizers: **Jun-ichiro Shiomi,** *The University of Tokyo, Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Halifax, NS, Canada*

12-1 Modeling and Simulation I

Room B **10:30am–12:10pm**

State of Art Modelling in the Transitional Flow Regime
Technical Publication. ICNMM2013-73227
Irina Graur

A New Partial Slip Boundary Condition for the Lattice-Boltzmann Method
Technical Publication. ICNMM2013-73026
Marc-Florian Uth, Alf Crüger, Heinz Herwig, *Hamburg University of Technology, Hamburg, Germany*

Molecular Dynamics Simulation of the Hydrogen Bonding Structure of Water Mo-lecules inside Carbon Nanotube
Technical Publication. ICNMM2013-73032
Ning Zhang, Cong Chen, Yujing Feng, Qingnan Pang, Weizhong Li, *Dalian University of Technology, Dalian, China*

Effect of the Surface Tension of Liquid-Solid Interface on Liquid Flow in Parallel-Plate Sub-Micron Channels using Multi-Body Dissipative Particle Dynamics
Technical Publication. ICNMM2013-73054
Toru Yamada, Bengt Sunden, *Lund University, Lund, Sweden,* Yutaka Asako, *Tokyo Metropolitan University, Tokyo, Tokyo, Japan,* Mohammad Faghri, *Univesity of Rhode Island, Kingston, RI, United States*

An Atomistic-continuum Hybrid Approach for Modelling Transport Phenomena at the Micro- and Nano-Scale
Technical Publication. ICNMM2013-73071
Alessio Alexiadis, Duncan Lockerby, *University of Warwick, Coventry, United Kingdom, United Kingdom,* Matthew Borg, Jason Reese, *Strathclyde University, Glasgow, United Kingdom*

TRACK 3 Two-Phase Flow

Track Organizer: **Masahiro Kawaji,** *City College of New York, New York, NY, United States*
Track Co-Organizers: **Niro Nagai,** *University of Fukui, Fukui, Japan,* **Gherhardt Ribatski,** *Department of Mechanical Engineering - University of São Paulo - São Carlos, São Carlos, Brazil,* **Vijayaraghavan Chakravarthy,** *Praxair, Inc., Tonawanda, NY, United States*

3-2 Experimental Investigation of Two-Phase Flow

Room A **1:00pm–2:40pm**

An Experimental Investigation of Gas-Liquid Heat Transfer in Rectangular Micro-Channels
Technical Publication. ICNMM2013-73070
Sira Saisorn, Piyawat Kuaseng, Chompunut Nuibutr, Wattana Chanphan, *King Mongkut's Institute of Technology Ladkrabang Chumphon Campus, Chumphon, Chumphon, Thailand,* Somchai Wongwises, *King Mongkut's University of Technology Thonburi, Bangkok, Bangkok, Thailand*

Air Bubble Injection into a Liquid Stream in a Minichannel
Technical Publication. ICNMM2013-73082
Randy Samaroo, Masahiro Kawaji, *City College of New York, New York, NY, United States*

Drag Reduction for Nanobubble Mixture Flows through Micro-apertures
Technical Publication. ICNMM2013-73085
Akiomi Ushida, Hasegawa Tomiichi, Takatsune Narumi, *Niigata University, Niigata, Japan,* Toshiyuki Nakajima, *Tech Corporation Co. Ltd., Hiroshima, Japan*

Effect of Tube Diameters on the Flow Phenomena of Gas-liquid Two-phase Flow in Microchannels
Technical Publication. ICNMM2013-73096
Ide Hideo, *Kagoshima University, Kagoshima, Japan,* Masahiro Kawaji, *City College of New York, New York, NY, United States*

TRACK 7 Fuel Cells

Track Organizer: **Debjyoti Banerjee,** *Texas A&M Universitu, College Station, United States*
Track Co-Organizer: **Shohji Tsushima,** *Tokyo Institute of Technology, Tokyo, Japan*

7-2 Fuel Cells II

Room D **1:00pm–2:40pm**

Evaluation of Effect of Binder Distribution in Lithium Ion Battery Electrode by Numerical Analysis
Technical Publication. ICNMM2013-73199
Gen Inoue, *Kyoto University, Kyoto, Kyoto, Japan,* Takahiro Matsuoka, *Kyushu University, Fukuoka, Japan*

Molecular Dynamics Study of Nano-scale Liquid-gas Interface Inspired by Fuel Cell Catalyst Layer
Technical Presentation Only. ICNMM2013-73100
Youngmin Kim, Nobuyuki Oshima, Masao Watanabe, Kazumichi Kobayashi, *Hokkaido University, Sapporo, Hokkaido, Japan,* Hisao Yaguchi, *Gunma National College of Technology, Maebashi, Gunma, Japan*

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Transient Analysis of Gas Distribution in the Anodic Flow Field in a Fuel Cell Stack
Technical Publication. ICNMM2013-73219
Yasushi Ichikawa, *Nissan Motor Co., Ltd., Yokosuka, Japan,* Nobuyuki Oshima, *Hokkaido University, Sapporo, Hokkaido, Japan*

Molecular Dynamics Study of Proton and Water Transport in Nafion Membrane
Technical Publication. ICNMM2013-73084
Takuya Mabuchi, Takashi Tokumasu, *Tohoku University, Sendai, Miyagi, Japan*

Numerical Simulation of Condensed Water Behavior in Gas Diffusion Layers of PEFC using the Lattice Boltzmann Method
Extended Abstract. ICNMM2013-73111
Yutaka Tabe, Ryuji Kamijo, Yuji Honjo, Kengo Suzuki, Takemi Chikahisa, *Hokkaido University, Sapporo, Hokkaido, Japan*

TRACK 10 Biomedical and Lab-on-a-Chip

Track Organizer: **Michael King**
Track Co-Organizer: **Koji Miyazaki,** *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

10-1 Biomedical and Lab-on-a-Chip I

Room C **1:00pm–2:40pm**

Lab-on-a-Chip Systems with Embedded 3-D Structures for Chemical Applications
Keynote Presentation. ICNMM2013-73193
Dong-Pyo Kim, *Pohang University of Science and Techanology, Pohang, Kyungbuk, Korea (Republic)*

Individual DNA Base Identification at the Transport Through Graphene Nanopor
Technical Publication. ICNMM2013-73053
Kazuya Takeuchi, Tatiana Zolotoukhina, *Toyama University, Faculty of Engineering, Toyama, Toyama-ken, Japan*

Microspot with Integrated Wells (MSIW) for the Detection of E.coli
Technical Publication. ICNMM2013-73037
Naga Siva Kumar Gunda, Selvaraj Naicker, Maryam Ghoraishi, Subir Bhattacharjee, Thomas Thundat, Sushanta Mitra, *University of Alberta, Edmonton, AB, Canada*

Pump Head Improvement of Diffuser/nozzle Valve-less Micro-Pump
Technical Publication. ICNMM2013-73127
Seiichi Tanaka, Seiji Fujiwara, *Akashi National College of Technology, Akashi, Hyogo, Japan,* Koji Miyazaki, *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

Propagation of Human Spermatozoa Along an Invaginated Microchannel: An Example of Sperm Cell Incidental Cooperation?
Extended Abstract. ICNMM2013-73128
Petr Denissenko, *University of Warwick, Coventry, West Midlands, United Kingdom,* Vasily Kantsler, *University of Cambridge, Cambridge, United Kingdom,* David J. Smith, Jackson Kirkman-Brown, *University of Birmingham, Birmingham, United Kingdom*

TRACK 12 Modeling and Simulation

Track Organizer: **Ali Beskok**
Track Co-Organizers: **Jun-ichiro Shiomi,** *The University of Tokyo, Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Halifax, NS, Canada*

12-2 Modeling and Simulation II

Room B **1:00pm–2:40pm**

Analytical Models in Microfluidics: From Rigorous Solutions to Engineering Correlations
Keynote. ICNMM2013-73215
Steffen Hardt, *Technical University of Darmstadt, Darmstadt, Germany*

Molecular Dynamics Simulation on Vapor-Liquid Coexistence of Water in Nanocylinder
Technical Presentation Only. ICNMM2013-73094
Toshiki Mima, Ikuya Kinefuchi, Yuta Yoshimoto, Nobuya Miyoshi, Shu Takagi, Yoichiro Matsumoto, *The University of Tokyo, Tokyo, Japan,* Akinori Fukushima, *Tohoku University, Miyagi, Japan,* Takashi Tokumasu, *Tohoku University, Sendai, Japan*

Characterization and Modeling of Micro Swimmers with Helical Tails and Cylindrical Heads Inside Circular Channels
Technical Publication. ICNMM2013-73101
Alperen Acemoglu, Fatma Zeynep Temel, Serhat Yesilyurt, *Sabanci University, Istanbul, Turkey*

An Open Source, Dynamic Wetting Code for the Impact of Blood Droplets, with Relevance to the Forensic Discipline of Bloodstain Pattern Analysis
Technical Presentation Only. ICNMM2013-73166
Adam Donaldson, *Dalhousie University, Halifax, NS, Canada,* Daniel Attinger, *Mechanical Engineering, Ames, IA, United States*

The Appropriate Blend Proportional Factor Value of Two Staggered Grid used in the Free Energy Based LBM with Large Density Ratio
Technical Publication. ICNMM2013-73122
Jiaming Gong, Nobuyuki Oshima, Yutaka Tabe, *Hokkaido University, Sapporo, Hokkaido, Japan*

TRACK 1 Single Phase Gas Flow

Track Organizer: **Stéphane Colin**
Track Co-Organizer: **Chungpyo Hong,** *Kagoshima university, Kagoshima, Kagoshima, Japan*

1-2 Single Phase Gas Flow II

Room A **3:00pm–4:40pm**

Experimental Investigation on Gas-to-gas Micro Heat Exchanger with Three Flow Arrangements
Technical Publication. ICNMM2013-73125
Yahui Yang, Gian Luca Morini, *University of Bologna, Bologna, Italy,* Jürgen Brandner, *Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany, Germany*

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Hydrogen Viscosity Measurements with Capillary Tube under High Pressure
Technical Publication. ICNMM2013-73139
Temujin Uehara, Kosuke Yoshimura, Masamichi Kohno, Yasuyuki Takata, *Kyushu University, Fukuoka, Japan,* Elin Yusibani, *Syiah Kuala University, Banda Aceh, Indonesia,* Kanei Shinzato, *National Institute of AIST, Fukuoka, Japan*

Total Temperature Measurement of Turbulent Gas Flow at Microtube Exit
Technical Publication. ICNMM2013-73180
Chungpyo Hong, *Kagoshima University, Kagoshima, Kagoshima, Japan,* Kyohei Isobe, Ichiro Ueno, *Tokyo University of Science, Noda, Chiba, Japan,* Yutaka Asako, *Tokyo Metropolitan University, Tokyo, Tokyo, Japan*

Under-Expanded Gas Flow at a Straight Micro-Tube Exit
Technical Publication. ICNMM2013-73041
Takahiro Yoshimaru, *Tokyo Metropolitan University, Hachioji, Tokyo, Japan,* Yutaka Asako, *Tokyo Metropolitan University, Tokyo, Tokyo, Japan,* Toru Yamada, *Lund University, Lund, Sweden*

Electrokinetic Flows - Characterization and Applications
Technical Presentation Only. ICNMM2013-73182
Chun Yang, *Nanyang Technological University, Singapore, Singapore*

TRACK 7 Fuel Cells

Track Organizer: **Debjyoti Banerjee,** *Texas A&M Universitu, College Station, United States*
Track Co-Organizer: **Shohji Tsushima,** *Tokyo Institute of Technology, Tokyo, Japan*

7-3 Fuel Cells III

Room D **3:00pm–4:40pm**

Optimal Flow Channel Designs of PEM Fuel Cells
Technical Presentation Only. ICNMM2013-73224
Xiao-Dong Wang, *North China Electric Power University, Beijing, China,* Chin-Hsiang Cheng, *National Cheng Kung University, Tainan, Taiwan,* Wei-Mon Yan, *National University of Tainan, Tainan, Taiwan*

Development of Porous Collector by Electrodeposition with Hydrogen Bubble Template Method
Technical Publication. ICNMM2013-73196
Gen Inoue, *Kyoto University, Kyoto, Kyoto, Japan,* Yuki Inaba, *Kyushu University, Fukuoka, Japan*

Performance Improvement in Redox Flow Battery with Flow-through Channel Geometry
Technical Publication. ICNMM2013-73209
Shohji Tsushima, Sho Sasaki, Takahiro Suzuki, Phengxay Deevanhxay, Shuichiro Hirai, *Tokyo Institute of Technology, Tokyo, Japan*

The Cross Flow Mechanism in the Micro Channel of a Polymer Electrolyte Fuel Cell
Technical Publication. ICNMM2013-73115
K.M. Salahuddin, Nobuyuki Oshima, *Hokkaido University, Sapporo, Japan,* Litan Kumar Saha, *University of Dhaka, Dhaka, Bangladesh*

Analysis of Gas Transport in Micro Porous Layers using Structure Constructed from X-ray Nano CT
Technical Presentation Only. ICNMM2013-73212
Ikuya Kinefuchi, Yoichiro Matsumoto, *The University of Tokyo, Tokyo, Japan,* Junpei Oyama, Koji Yokoyama, Norio Kubo, *FC-Cubic, Tokyo, Japan,* Takashi Tokumasu, *Tohoku University, Sendai, Japan*

TRACK 10 Biomedical and Lab-on-a-Chip

Track Organizer: **Michael King**
Track Co-Organizer: **Koji Miyazaki,** *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

10-2 Biomedical and Lab-on-a-Chip II

Room C **3:00pm–4:40pm**

Scaling-up Microchannel Emulsification Foreseeing Novel Bioactives Delivery Systems
Technical Publication. ICNMM2013-73116
Marcos Neves, *University of Tsukuba, Tsukuba, Ibaraki, Japan,* Isao Kobayashi, *National Food Research Institute, NARO, Tsukuba, Ibaraki, Japan,* Mitsutoshi Nakajima, *University of Tsukuba, Tsukuba, Japan*

Traction Force Measurement During Collective Cell Migration Measured by Multichannel Micropillar Device
Extended Abstract. ICNMM2013-73163
Toshiro Ohashi, Akito Sugawara, *Hokkaido University, Sapporo, Japan*

A Microfluidic Culturing System for Observation of Free-Floating Microorganisms
Technical Publication. ICNMM2013-73164
Katsuo Mogi, Yasuhiko Sugii, Teruo Fujii, Yoichiro Matsumoto, *University of Tokyo, Tokyo, Japan*

Micro-cavity Microelectrode Based Cell Electrofusion Chip
Technical Presentation Only. ICNMM2013-73183
Ning Hu, Sang W Joo, *Yeungnam University, Gyongsan, Korea (Republic),* Shizhi Qian, *Old Dominion University, Norfolk, VA, United States*

Effects of Chemical and Physical Shear-stress Stimulation of Human Placenta-derived Multipotent Stem Cells in Microchannel
Technical Publication. ICNMM2013-73194
Chia-Wen Tsao, Meng-Zhi Chiang, *National Central University, Jhongli City, Taiwan, China,* Y.C. Cheng, *Department of Medical Research, Taipei, Taiwan, China*

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TRACK 12 Modeling and Simulation

Track Organizer: **Ali Beskok**
Track Co-Organizers: **Jun-ichiro Shiomi,** *The University of Tokyo, Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Halifax, NS, Canada*

12-3 Modeling and Simulation III

Room B **3:00pm–4:40pm**

Multi-scale Simulation of Internal Rarefied Gas Flows
Technical Publication. ICNMM2013-73204
Duncan Lockerby, Alex Patronis, *University of Warwick, Coventry, Warwickshire, United Kingdom,* Matthew Borg, Jason Reese, *Strathclyde University, Glasgow, United Kingdom*

Non-Markovian Dissipative Particle Dynamics of Lennard-Jones Fluids: Bottom-up Construction of Coarse-Grained Models Based on Molecular Dynamics Simulation
Technical Presentation Only. ICNMM2013-73123
Yuta Yoshimoto, Toshiki Mima, Ikuya Kinefuchi, Shu Takagi, Yoichiro Matsumoto, *The University of Tokyo, Tokyo, Japan,* Akinori Fukushima, *Tohoku University, Miyagi, Japan,* Takashi Tokumasu, *Tohoku University, Sendai, Japan*

Lateral Migration of Large and Small Droplets Suspended in Channel Flow
Extended Abstract. ICNMM2013-73126
Masato Makino, Masako Sugihara-Seki, *Kansai University, Suita, Japan*

Molecular Simulations of Adsorbed Water on Mesoporous Silica Thin Films
Technical Publication. ICNMM2013-73131
Kyohei Yamashita, Hirofumi Daiguji, *The University of Tokyo, Kashiwa, Japan*

Simulation of Conjugate Convective-conductive Heat Transfer in a Microchannel within the Slip Regime using GPU Accelerated Lattice Boltzmann Method
Technical Publication. ICNMM2013-73133
Adhika Widyaparaga, *Gadjah Mada University, Yogyakarta, Indonesia, Indonesia,* Pranowo Pranowo, *Atma Jaya University, Yogyakarta, Indonesia, Indonesia*

TRACK 4 Boiling and Condensation

Track Organizer: **Peter Stephan,** *Institute for Technical Thermodynamics, Technische Universität Darmstadt, Darmstadt D-64287, Germany*
Track Co-Organizers: **Ichiro Ueno,** *Tokyo University of Science, Noda, Chiba, Japan,* **Theodorian Borca-Tasciuc, Saeed Moghaddam,** *University of Florida, Gainesville, FL, United States*

4-1 Boiling and Condensation I

Room A **5:00pm–6:40pm**

Photothermal Actuation for Flexible Control of Microfluidic Bubbles and Drops
Technical Publication. ICNMM2013-73221
Masahiro Motosuke, *Tokyo University of Science, Tokyo, Japan*

Visualization Study of Dropwise Condensation on a Super-hydrophobic Surface
Technical Publication. ICNMM2013-73046
Lanlan Li, Shiqiang Liang, Dawei Tang, *Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, China,* Liang Chen, *Beijing Jiaotong University, Beijing, China*

Condensation and Collapse of Vapor Bubble Injected to Subcooled Pool
Technical Publication. ICNMM2013-73190
Ichiro Ueno, Takahito Saiki, Tomohiro Osawa, *Tokyo University of Science, Noda, Chiba, Japan,* Chungpyo Hong, *Kagoshima University, Kagoshima, Kagoshima, Japan*

Effect of Micro-structured Surface on Dropwise Condensation Heat Transfer
Technical Publication. ICNMM2013-73200
Atsushi Tokunaga, *Ube National College of Technology, Ube, Yamaguchi, Japan,* Masaki Mizutani, Gyoko Nagayama, Takaharu Tsuruta, *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

TRACK 9 Nano and Micro-Structures for Heat Transfer Enhancement

Track Organizer: **Evelyn Wang,** *MIT, Cambridge, MA, United States*
Track Co-Organizer: **Masahiko Shibahara,** *Osaka University, Osaka, Japan*

9-1 Nano and Micro-Structures for Heat Transfer Enhancement I

Room D **5:00pm–6:40pm**

Theoretical Conclusions about the Claims of Anomalous Heat Transfer Enhancement Associated with Nanofluids
Technical Publication. ICNMM2013-73056
Wenhao Li, Chen Yang, Akira Nakayama, *Shizuoka University, Hamamatsu, Japan*

Large Eddy Simulation of Two-Dimensional Jet Impingement Heat Transfer Enhanced by Submilli-Scale Ribs
Technical Publication. ICNMM2013-73114
Yutaka Oda, Kenichiro Takeishi, *Osaka University, Suita, Osaka, Japan*

Molecular Dynamics Study on the Influences of Nanoparticle Adherent Layer on Interfacial Thermal Resistance at a Liquid-Solid Interface
Extended Abstract. ICNMM2013-73086
Masahiko Shibahara, Tatsuya Koike, *Osaka University, Osaka, Japan*

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TRACK 10 Biomedical and Lab-on-a-Chip

Track Organizer: **Michael King**
Track Co-Organizer: **Koji Miyazaki,** *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

10-3 Biomedical and Lab-on-a-Chip III

Room C **5:00pm–6:40pm**

3D Focusing of Micro-Particles by Sheath Flow Warping
Technical Publication. ICNMM2013-73207
Claire Perfetti, Frank Dubois, *Université Libre de Brussels, Brussels, Brussels, Belgium,* Carlo Saverio Iorio, *University of Brussels, Brussels, Belgium*

3D Focusing of Microparticles by Acoustic Standing Waves in a Flow Through Channel
Technical Publication. ICNMM2013-73208
Carlo Saverio Iorio, *University of Brussels, Brussels, Belgium,* Claire Perfetti, Valérie Vancauwenberghe, Frank Dubois, *Université Libre de Brussels, Brussels, Brussels, Belgium*

Transdermal Transport Pathways: Passive and Active Electroppration Delivery
Technical Publication. ICNMM2013-73210
Sid Becker, *University of Canterbury, Christchurch, New Zealand,* Nataaa Pavaelj, Barbara Zorec, Damijan Miklavcic, *University of Ljubljana, Slovenia*

Transport of Magnetic Particles under an Uniform Magnetic Field in Microchannels
Technical Publication. ICNMM2013-73047
Gui-Ping Zhu,Nam-trung Nguyen, *Nanyang Technological University, Singapore, Singapore, Singapore*

Identifying Complex Fluids by Pattern Recognition of Stains
Technical Presentation Only. ICNMM2013-73157
Namwon Kim, *Texas A&M International University, Laredo, TX, United States,* Zhenguo Li, Shih-Fu Chang, *Columbia University, New York, NY, United States,* Cedric Hurth, Frederic Zenhausern, *University of Arizona, Chandler, AZ, United States,* Daniel Attinger, *Mechanical Engineering, Ames, IA, United States*

TRACK 12 Modeling and Simulation

Track Organizer: **Ali Beskok**
Track Co-Organizers: **Jun-ichiro Shiomi,** *The University of Tokyo, Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Halifax, NS, Canada*

12-4 Modeling and Simulation IV

Room B **5:00pm–6:40pm**

A Hybrid Fokker-Planck-DSMC Solution Algorithm for the Whole Range of Knudsen Numbers
Technical Publication. ICNMM2013-73141
Hossein Gorji, Stephan Kuechlin, Patrick Jenny, *ETH Zurich, Zurich, Switzerland*

A Device Concept for Demixing of Gas Species Based on Excitation of Internal Energy Modes
Technical Publication. ICNMM2013-73142
Hossein Gorji, Patrick Jenny, *ETH Zurich, Zurich, Switzerland*

Reduced Order Models of Low Mach Number Isothermal Flows in Microchannels
Technical Publication. ICNMM2013-73150
Leila Issa, Lebanese American University, Beirut, Lebanon, Issam Lakkis, *American University of Beirut, Beirut, Lebanon*

Simulation of Magnetic Actuation of Ferrofluids in Microtubes
Technical Publication. ICNMM2013-73153
Arzu Ozbey, Mehrdad Karimzadehkhouei, Evrim Kurtoglu, Ali Kosar, *Sabanci University, Istanbul, Turkey*

A Molecular Dynamics Analysis of Quantum Effect on the Thermodynamic Properties of Liquid Hydrogen.
Technical Publication. ICNMM2013-73161
Hiroki Nagashima, *Tohoku University, Sendai, Miyagi, Japan,* Shin-ichi Tsuda, *Shinshu University, Nagano, Nagano, Japan,* Nobuyuki Tsuboi, *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan,* Mitsuo Koshi, *University of Tokyo, Tokyo, Japan,* Koichi Hayashi, *Aoyama Gakuin University, Kanagawa, Japan,* Takashi Tokumasu, *Tohoku University, Sendai, Japan*

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TUESDAY, JUNE 18

TRACK 4 Boiling and Condensation

Track Organizer: **Peter Stephan,** *Institute for Technical Thermodynamics, Technische Universität Darmstadt, Darmstadt, Germany*
Track Co-Organizers: **Ichiro Ueno,** *Tokyo University of Science, Noda, Chiba, Japan,* **Theodorian Borca-Tasciuc, Saeed Moghaddam,** *University of Florida, Gainesville, FL, United States*

4-2 Boiling and Condensation II

Room A **10:00am–12:00pm**

Study on Nucleate Boiling Heat Transfer by Measuring Spatially Instantaneous Local Surface Temperature and Observing Instantaneous Bubble/Liquid Fluid Behavior
Technical Publication. ICNMM2013-73060
Yasuo Koizumi, Kenta Hayashi, *Shinshu University, Ueda, Japan*

Contribution of Microlayer Evaporation to Bubble Growth in Pool Saturated Boiling of Water
Technical Publication. ICNMM2013-73211
Tomohide Yabuki, Takuya Saitoh, Japan, Osamu Nakabeppu, *Meiji University, Kawasaki, Japan*

Photographic Study on the Effects of Hydrophobic-spot Size and Subcooling on Local Film Boiling
Technical Publication. ICNMM2013-73069
Bambang Joko Suroto, Masahiro Tashiro, Sana Hirabayashi, Sumitomo Hidaka, Masamichi Kohno, Koji Takahashi, Yasuyuki Takata, *Kyushu University, Fukuoka, Japan*

Pool Boiling Heat Transfer with Binary Mixture on Open Microchannel Surface
Technical Publication. ICNMM2013-73044
Ankit Kalani, Satish Kandlikar, *Rochester Institute of Technology, Rochester, NY, United States*

Effect of Decreasing Heat Transfer Surface Size on Boiling Heat Transfer
Technical Publication. ICNMM2013-73059
Yasuo Koizumi, Morita Yoshiki, *Shinshu University, Ueda, Japan*

Visualization of Boiling Heat Transfer on Micro Porous Coated Surface in Confined Space
Technical Publication. ICNMM2013-73175
Chien-Yuh Yang, Chien-Fu Liu, *National Central University, Jhongli, Taiwan*

TRACK 9 Nano and Micro-Structures for Heat Transfer Enhancement

Track Organizer: **Evelyn Wang,** *MIT, Cambridge, MA, United States*
Track Co-Organizer: **Masahiko Shibahara,** *Osaka University, Osaka, Japan*

9-2 Nano and Micro-Structures for Heat Transfer Enhancement II

Room D **10:00am–12:00pm**

An Experimental Study of Heat Transfer Enhancement in Microchannels
Extended Abstract. ICNMM2013-73057
Yingying Wang, Yoav Peles, *Rensselaer Polytechnic Institute, Troy, NY, United States*

Enhanced Flow Boiling in Microchannels with Walls Fenced by Si Nanotips
Technical Presentation Only. ICNMM2013-73028
Fanghao Yang, Xianming Dai, Chen Li, *University of South Carolina, Columbia, South Carolina, United States*

Subcooled Flow Boiling over Nanostructured Plate Integrated into a Rectangular Channel
Technical Publication. ICNMM2013-73154
Ebru Demir, Turker Izci, Ali Kosar, *Sabanci University, Istanbul, Turkey,* Muhsincan Sesen, *Monash University, Melbourne, Australia,* Wisam Khudhayer, Tansel Karabacak, *University of Arkansas at Little Rock, Little Rock, AR, United States*

On Bubble Growth on Asymmetrically Microtextured Surfaces
Technical Presentation Only. ICNMM2013-73192
Logan Strid Vinod Narayanan, *Oregon State University, Corvallis, OR, United States,* Naveenan Thiagarajan, Sushil H. Bhavnani, *Auburn, Auburn, AL, United States*

TRACK 12 Modeling and Simulation

Track Organizer: **Ali Beskok**
Track Co-Organizers: **Jun-ichiro Shiomi,** *The University of Tokyo, Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Halifax, NS, Canada*

12-5 Modeling and Simulation V

Room B **10:00am–12:00pm**

Molecular Dynamics Simulation Study of How Surface Characteristics Effect Water-surface Interaction During Heating
Technical Presentation Only. ICNMM2013-73108
James Cannon, Jun-ichiro Shiomi, *The University of Tokyo, Tokyo, Japan*

Numerical Study on Interfacial Phenomena of Ferrofluid by Lattice Boltzmann Method
Technical Publication. ICNMM2013-73173
Wenning Zhou, Yuying Yan, *University of Nottingham, Nottingham, United Kingdom,* Xiaoping Luo, *South China University of Technology, Guangzhou, China*

Semi-Analytical Solutions to the Extended Graetz Problem in Rectangular Microchanel Flow Driven by Electroosmosis
Technical Publication. ICNMM2013-73179
Leandro Sphaier, Debora C. Moreira, *Universidade Federal Fluminense, Niterói, RJ, Brazil*

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Numerical Analysis on Heat Transfer Characteristics of Looped Minichannel using Phase-change VOF Method
Technical Publication. ICNMM2013-73184
Hajime Onishi, Motoya Kawamura, Yukio Tada, Akira Takimoto, *Kanazawa University, Kanazawa, Japan*

Mass Transport Characteristics of Water/IPA at Silica-Liquid Interfaces
Technical Publication. ICNMM2013-73195
Takeo Nakano, *Tokyo Electron Ltd., Tsukuba, Ibaraki, Japan,* Shuichi Kosaka, *Tohoku University, Sendai, Miyagi, Japan,* Gota Kikugawa, Taku Ohara, *Institute of Fluid Science, Tohoku University, Sendai, Miyagi, Japan*

Numerical Analysis of Two-phase Flow in Sintered Copper Wick by Lattice Boltzmann Method
Extended Abstract. ICNMM2013-73205
Tomohiko Yamaguchi, Qian Wang, Yuying Yan, *University of Nottingham, Nottingham, Notts, United Kingdom*

TRACK 14 Mixing and Chemical Reactions

Track Organizer: **Norbert Kockmann,** *TU Dortmund University, Dortmund, Germany*
Track Co-Organizer: **Chun Yang,** *Nanyang Technological University, Singapore, Singapore*

14-1 Mixing and Chemical Reactions

Room C **10:00am–12:00pm**

Optimal Design and Operation of Microdevices for Chemical Production
Technical Publication. ICNMM2013-73138
Osamu Tonomura, *Kyoto University, Kyoto, Japan*

A Microscale Combustor- Heat Exchanger for Low Temperature Applications- Experimental Results
Technical Presentation Only. ICNMM2013-73039
Mohammad Ghazvini, Vinod Narayanan, *Oregon State University, Corvallis, OR, United States*

Preliminary Development of Minifluidic OFR Technology
Technical Presentation Only. ICNMM2013-73075
Adam Donaldson, *Dalhousie University, Halifax, NS, Canada*

Mixing and Selecting Microdrops with Micofluidics Bistable Autopulsed Oscillator
Extended Abstract. ICNMM2013-73080
Khelfaoui Rachid, Chekifi Tawfiq, Dennai Brahim, *University Bechar, Bechar, Algeria*

Diffusion and Mixing in Microchannel Analyzed by the Luminol Chemiluminescence
Technical Publication. ICNMM2013-73113
Ruru Matsuo, Ryosuke Matsumoto, *Kansai University, Osaka, Japan*

Motion of Passive Particles Carried by Viscoelastic Fluid Flow in the Curvilinear Microchannel
Technical Publication. ICNMM2013-73144
Xiao-Bin Li, Dong-Yang Li, Hong-Na Zhang, Feng-Chen Li, *School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, China*

Study on Effect of Hydrophilic-hydrophobic Patch Boundary Conditions on Mixing Efficiency in Passive Micromixer.
Technical Publication. ICNMM2013-73132
Suresh Gosavi, Sukratu Barve, Mrinalini Amritkar, *University of Pune, Pune, India,* Tanay Deshpande, *BITS, Pilani Goa, Goa, India*

WEDNESDAY, JUNE 19

TRACK 2 Single Phase Liquid Flow

Track Organizer: **Tatiana Gambaryan-Roisman,** *Technische Universitat Darmstadt, Darmstadt, Germany*
Track Co-Organizer: **Diana-andr Borca-Tasciuc, Heinz Herwig,** *TU Hamburg-Harburg, Hamburg, Germany*

2-1 Single Phase Liquid Flow

Room B **10:00am–12:00pm**

Performance Evaluation of the Flow in Micro Junctions: Head Change Versus Head Loss Coefficients
Technical Publication. ICNMM2013-73031
Bastian Schmandt, *Hamburg University of Techology, Hamburg, Germany,* Heinz Herwig, *TU Hamburg-Harburg, Hamburg, Germany*

Effects of Temperature Dependent Properties on the Laminar Forced Convection in Straight Microchannels with Uniform Wall Temperature
Technical Publication. ICNMM2013-73093
Stefano Del Giudice, Stefano Savino, Carlo Nonino, *University of Udine, Udine, Italy*

Single-Phase Heat Transfer in the Straight and Helically Coiled Tubes
Technical Publication. ICNMM2013-73109
Jatuporn Kaew-On, Santiphap Nakkaew, *Thaksin University, Phattalung, Thailand,* Somchai Wongwises, *King Mongkut's University of Technology Thonburi, Bangkok, Bangkok, Thailand*

Heat Transfer Enhancement with Iron Oxide Nanoparticle Based Ferrofluids
Technical Publication. ICNMM2013-73146
Evrim Kurtoglu, Devrim Gözüaçik, Ali Kosar, Alihan Kaya, *Sabanci University, Istanbul, Turkey,* Havva F. Yagci Acar, *Koc University, Istanbul, Turkey*

Studies on Micropump/Minipump using Rotational Motion of Magnetic Material Balls
Technical Publication. ICNMM2013-73160
Hiroshige Kumamaru, Fuma Sakata, Akira Ohue, Kazuhiro Itoh, Yuji Shimogonya, *University of Hyogo, Himeji, Hyogo, Japan*

Application of Nanofluids in a Shell-and-tube Heat Exchanger
Technical Publication. ICNMM2013-73104
Jonathan Cox, *Georgia Institute of Technology, Atlanta, GA, United States,* Anoop Kanjirakat, *Texas A&M University at Qatar, Doha, Qatar,* Reza Sadr, *Texas A&M University at Qatar, Collage Station, United States*

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TRACK 3 Two-Phase Flow

Track Organizer: **Masahiro Kawaji,** *City College of New York, New York, NY, United States*
Track Co-Organizers: **Niro Nagai,** *University of Fukui, Fukui, Japan, Gherhardt Ribatski, Department of Mechanical Engineering - University of São Paulo - São Carlos, São Carlos, Brazil,* **Vijayaraghavan Chakravarthy,** *Praxair, Inc., Tonawanda, NY, United States*

3-3 Two-Phase Flow

Room C **10:00am–12:00pm**

Recent Developments in Micro/Nanochannel Emulsification for Controlled Production of Monodisperse Emulsions
Technical Publication. ICNMM2013-73107
Isao Kobayashi, *National Food Research Institute, NARO, Tsukuba, Ibaraki, Japan,* Katerina Butron Fujiu, Marcos Neves, *Mitsutoshi Nakajima, University of Tsukuba, Tsukuba, Japan*

Microfluidic Control of Microbeads and Ferrofluid in a Microtube
Technical Publication. ICNMM2013-73187
Yuichi Shibata, Osamu Okamoto, *Ibaraki National College of Technology, Hitachinaka, Japan,* Masahiro Kawaji, *City College of New York, New York, NY, United States*

Novel Electrical Control in Droplet Microfluidics using an AC Electric Field
Technical Publication. ICNMM2013-73061
Say Hwa Tan, Jean-Christophe Baret, Benoit Semin, *Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany*

Effects of Curved Section on Gas-Liquid Two-Phase Flow in Milli-Channel
Technical Publication. ICNMM2013-73186
Kazuki Takeda, Shinpei Okamoto, Kenji Yoshida, Isao Kataoka, *Osaka University, Osaka, Japan*

Microchannel Device for Droplet Generation, Mixing, and Phase Separation for Continuous Counter-current Flow Extraction
Technical Publication. ICNMM2013-73106
Norbert Kockmann, Alexander Holbach, *TU Dortmund University, Dortmund, Germany*

Experimental Investigation of Degree of Premixing on Isothermal Air-water Two-phase Flow Through Minichannel
Technical Publication. ICNMM2013-73088
Hemantkumar B. Mehta, Jyotirmay Banerjee, Jukesh Dodiya, Sanket Solanki, *S. V. National Institute of Technology, Surat, Gujarat, India*

TRACK 4 Boiling and Condensation

Track Organizer: **Peter Stephan,** *Institute for Technical Thermodynamics, Technische Universität Darmstadt, Darmstadt D-64287, Germany*
Track Co-Organizers: **Ichiro Ueno,** *Tokyo University of Science, Noda, Chiba, Japan,* **Theodorian Borca-Tasciuc, Saeed Moghaddam,** *University of Florida, Gainesville, FL, United States*

4-3 Boiling and Condensation III

Room A **10:00am–12:00pm**

Experimental Study of the Heat Transfer Characteristic in Vertical Rectangular Capillary Microgrooves Heat Sink Under An Electric Field
Technical Publication. ICNMM2013-73052
Xiazhen Fang, Xuegong Hu, Dong Yu, Cong Guo, *Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, Beijing, China*

Physics of Membrane-based Phase Separation in Flow Boiling of a Binary Mixture
Technical Publication. ICNMM2013-73076
Rasool Nasr Isfahani, Saeed Moghaddam, *University of Florida, Gainesville, FL, United States*

An Experimental Investigation on the Evaportion And
Technical Presentation Only. ICNMM2013-73216
Jeehoon Choi, Yunkeun Lee, *Zalman Tech Co., Ltd., Seoul, Korea (Republic),* Hwankook Kang, *Dongeun ATS, Bucheon, Korea (Republic),* Wataru Sano, Weijie Chang, *Rensselaer Polytechnic Institute, Troy, NY, United States,* Diana-andr Borca-Tasciuc

Principles of Refrigerant Circuiting in Single Row Microchannel Evaporators
Technical Publication. ICNMM2013-73137
Sunil Mehendale, *Michigan Technological University, Houghton, MI, United States*

Vertical Falling Film Evaporation of Pure Refrigerant HCFC123 in a Plate-fin Heat Exchanger
Technical Publication. ICNMM2013-73213
Junichi Ohara, *National Fisheries University, Shimonoseki, Yamaguchi, Japan,* Shigeru Koyama, *Kyushu University, Ksuga, Japan*

Generation of Nanosuspensions by Applying of Microstrutured Evaporators, Quenching, and Full Condensation
Technical Presentation Only. ICNMM2013-73188
Wolf Wibel, Jürgen Brandner, Roland Dittmeyer, *Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany,* Andreas Waldraff, Karlheinz Schaber, *Karlsruhe Institute of Technology, Karlsruhe, Germany*

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TRACK 9 Nano and Micro-Structures for Heat Transfer Enhancement

Track Organizer: **Evelyn Wang,** *MIT, Cambridge, MA, United States*
Track Co-Organizer: **Masahiko Shibahara,** *Osaka University, Osaka, Japan*

9-3 Nano and Micro-Structures for Heat Transfer Enhancement III

Room D **10:00am–12:00pm**

Boiling Heat Transfer on Superhydrophilic, Superhydrophobic, and Superbiphilic Surfaces
Technical Presentation Only. ICNMM2013-73159
Amy R. Betz, *Kansas State University, Manhattan, KS, United States,* **James Jenkins,** *Chang-jin Kim, UCLA, Los Angeles, CA, United States,* **Daniel Attinger,** *Mechanical Engineering, Ames, IA, United States*

A Role of Graphene Film on Enhanced Boiling During Pool Boiling
Technical Presentation Only. ICNMM2013-73185
Ho Seon Ahn, Jin Man Kim, *POSTECH, Pohang, Kyungsangbukdo, Korea (Republic), Moo Hwan Kim*

Heat Transfer Enhancement Effect of Nanostructure Surface Made of Carbon Nanotube on SiC Ceramics.
Technical Publication. ICNMM2013-73170
Hiroki Noguchi, *Japan Atomic Energy Agency, Oarai-Machi, Ibaraki, Japan*

Effect of Electric Field Distribution Generated in a Micro Space on Pool Boiling Heat Transfer
Technical Publication. ICNMM2013-73118
Ichiro Kano, *Yamagata University, Yonezawa, Japan,* **Kyohei Sato,** *Graduate School of Science and Engineering, Yamagata University, Yonezawa, Yamagata, Japan*

Emissivity of Wavelength-selective Radiator with Periodic Microcavities
Technical Publication. ICNMM2013-73064
Tsuyoshi Totani, Masashi Wakita, Harunori Nagata, *Hokkaido University, Sapporo, Hokkaido, Japan,* **Minoru Iwata,** *Kyushu Institute of Technology, Kitakyushu, Fukuoka, Japan*

Experimental Techniques using Nano Hot-film for Micro/Nanoscale Heat Transfer
Technical Publication. ICNMM2013-73222
Koji Takahashi, *Kyushu University, Fukuoka, Japan*

TRACK 5 Electronics Cooling

Track Organizer: **Tomoyuki Hatakeyama,** *Toyama Prefectural University, Imizu, Toyama, Japan*
Track Co-Organizers: **Mark Steinke,** *International Business Machines Corp., Research Traingle Park, NC, United States,* **Ali Kosar,** *Sabanci University, Istanbul, Turkey, Shirish Mulay*

5-1 Electronics Cooling I

Room B **1:00pm–2:40pm**

Integrated Microfluidic Pumping and Cooling Applications
Technical Publication. ICNMM2013-73147
Arjan J.H. Frijns, Zhipeng Liu, Roy J.S. Derks, Michel F.M. Speetjens, Anton A. Van Steenhoven, *Eindhoven University of Technology, Eindhoven,Netherlands*

Measurement of Performance Characteristics of a Piezoelectric Micro Blower
Technical Publication. ICNMM2013-73092
Takashi Fukue, Koichi Hirose, *Iwate University, Morioka, Japan,* **Hirotoshi Terao,** *ALPS Electronic Co., Ltd., Osaki, Japan*

Cryogenic Single-phase Heat Transfer in Microscale Heat Sinks
Technical Presentation Only. ICNMM2013-73151
Erfan Rasouli, Eric D. Truong, Vinod Narayanan, *Oregon State University, Corvallis, OR, United States*

Study of Supersonic Micro-channel for Cooling Electronic Devices
Technical Publication. ICNMM2013-73134
Yuya Takahashi, Junnosuke Okajima, Atsuki Komiya, *Tohoku University, Sendai, Miyagi, Japan,* **Yuka Iga,** *Tohoku University, Miyagi Miyagi, Japan,* **Wu-Shung Fu,** *National Chiao Tung University, Hsinchu, Taiwan,* **Shigenao Maruyama,** *Tohoku University, Sendai, Japan*

TRACK 6 Electrokinetic Flow

Track Organizer: **Dominik P.J. Barz,** *Queen's University, Kingston, Canada*
Track Co-Organizers: **Hirofumi Daiguji,** *The University of Tokyo, Kashiwa, Japan,* **Carolyn Ren,** *University of Waterloo, Waterloo, ON, Canada*

6-1 Electrokinetic Flow I

Room D **1:00pm–2:40pm**

Influence of AC Electrohydrodynamic Flows on the Electric Field Driven Assembly of Colloidal Spheres
Technical Publication. ICNMM2013-73226
Aristides Docoslis, *Queen's University at Kingston, Kingston, Canada*

Regulating Bionanoparticle Translocation through Nanopores with Polyelectrolyte Brushes
Technical Presentation Only. ICNMM2013-73168
Li-Hsien Yeh, *Department of Chemical and Materials Engineering, National Yunlin University of Science and Technology, Yunlin, Taiwan, China,* **Sang W. Joo,** *School of Mechanical Engineering, Yeungnam University, Gyeongbuk, Korea (Republic),* **Shizhi Qian,** *Institute of Micro/Nanotechnology, Old Dominion University, Norfolk, VA, United States*

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Thermal Effect on Electroosmotic Flow in a Slit Microchannel
Technical Publication. ICNMM2013-73055
Yi Zhou, Chun Yang, Cunlu Zhao, *Nanyang Technological University, Singapore, Singapore*

TRACK 8 Thin Film, Interfacial Phenomena, and Surface Tension Driven Flows

Track Organizer: **Daniel Attinger,** *Mechanical Engineering, Ames, IA, United States*
Track Co-Organizers: **Koji Takahashi,** *Kyushu University, Fukuoka, Japan,* **Kripa Varanasi**

8-1 Thin Film, Interfacial Phenomena, and Surface Tension Driven Flows

Room A **1:00pm–2:40pm**

Empirical Verification of Theoretical Models on Performance Characteristics of Micro-Pillar Wick Structures
Technical Publication. ICNMM2013-73149
David Horner, Sai Tej, Saeed Moghaddam, *University of Florida, Gainesville, FL, United States*

Absorption Characteristics of Thin Lithium Bromide (LiBr) Solution Film Constrained by a Porous Hydrophobic Membrane
Technical Publication. ICNMM2013-73158
Rasool Nasr Isfahani, Saeed Moghaddam, *University of Florida, Gainesville, FL, United States*

The Molecular Beam Study of Scattering Behavior of Water Molecules on Graphite Surface
Technical Presentation Only. ICNMM2013-73136
Kenichi Osuka, Shohei Hodota, Nobuya Miyoshi, Ikuya Kinefuchi, Shu Takagi,Yoichiro Matsumoto, *The University of Tokyo, Tokyo, Japan*

Microfluidic Generation of Microbubbles Coated with Ultra-thin Oil Films Flowing in the Water Phases
Technical Presentation Only. ICNMM2013-73202
Kai Wang, Qin Kang, Tao Wang, Guangsheng Luo, *Tsinghua University, Beijing, Beijing, China*

Numerical Investigation of Coalescence of Viscous Particles with Solid Cores
Technical Publication. ICNMM2013-73189
Ram Dayal, Eberhard Abele, Tatiana Gambaryan-Roisman, *Technische Universitat Darmstadt, Darmstadt, Germany*

TRACK 11 Measurements and Instrumentation

Track Organizer: **Masahiro Motosuke,** *Tokyo University of Science, Tokyo, Japan*
Track Co-Organizer: **David Sinton, David Nobes,** *Univeristy of Alberta, Edmonton, Canada*

11-1 Measurements and Instrumentation I

Room C **1:00pm–2:40pm**

Application Process Tomography to Measure Particle Migration in Microchannel
Technical Publication. ICNMM2013-73129
Nur Tantiyani Ali Othman, Masahiro Takei, *Chiba University, Chiba, Japan,* Hiromichi Obara, *Tokyo Metropolitan University, Tokyo, Japan*

Pressure Measurement Techniques Based on Luminescent Molecules for Micro Gas Flows
Technical Presentation Only. ICNMM2013-73220
Yu Matsuda, Hiroki Yamaguchi, Tomohide Niimi, *Nagoya University, Nagoya, Japan*

3D Velocity Measurement by Orthogonal-Plane Micro PIV for Electrokinetic Enhancement of Surface Reaction
Technical Publication. ICNMM2013-73214
Akihiko Ishida, Daisuke Ichimura, Masahiro Motosuke, *Tokyo University of Science, Tokyo, Japan*

A Microfluidic Setup for Polymerization Reactions
Technical Presentation Only. ICNMM2013-73171
Jürgen Brandner, Juergen Bucko, *Karlsruher Institute of Technology, Eggenstein-Leopoldshafen, Germany*

Experimental Investigations on the Shapes of Meniscus in Open Rectangular Microgrooves Heat Sink with Micro-PIV
Technical Publication. ICNMM2013-73051
Dong Yu, Xuegong Hu, Chaohong Guo, Dawei Tang, Xuelei Nie, *Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, Beijing, China,* Linghong Hu, Fei Gao, *Guizhou Yonghong Aviation Machinery Co., Ltd, Guiyang, Guizhou, China,* Tao Zhao, *Wuxi Yonghong Heat Exchanger Engineering Research Center , AVIC Heavy Machinery Co., Ltd, Wuxi, China*

TRACK 5 Electronics Cooling

Track Organizer: **Tomoyuki Hatakeyama,** *Toyama Prefectural University, Imizu, Toyama, Japan*
Track Co-Organizers: **Mark Steinke,** *International Business Machines Corp., Research Traingle Park, NC, United States,* **Ali Kosar,** *Sabanci University, Istanbul, Turkey,* **Shirish Mulay**

5-2 Electronics Cooling II

Room B **3:00pm–4:40pm**

Experimental Investigation on the Minichannel Cold Plate for High Temperature Uniformity based on a Compact Thermal Model
Technical Publication. ICNMM2013-73027
Xiaobing Luo, Zhangming Mao, *Huazhong University of Science and Technology, Wuhan, Hubei, China*

Estimation of Heat Generation from Power Si MOSFET using Electro-Thermal Analysis
Technical Publication. ICNMM2013-73169
Risako Kibushi, Tomoyuki Hatakeyama, Masaru Ishizuka, *Toyama Prefectural University, Imizu, Toyama, Japan*

Thermal Performance of Oscillating Heat Pipes with Nanofluid: A Theoretical Study
Extended Abstract. ICNMM2013-73178
Hamid Reza Seyf, Sejung Kim, Yuwen Zhang, *University of Missouri, Columbia, MO, United States*

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TRACK 11 Measurements and Instrumentation

Track Organizer: **Masahiro Motosuke,** *Tokyo University of Science, Tokyo, Japan*
Track Co-Organizer: **David Sinton, David Nobes,** *Univeristy of Alberta, Edmonton, Canada*

11-2 Measurements and Instrumentation II

Room C **3:00pm–4:40pm**

Development of Organic Electroluminescent Sensor for Pressure/Oxygen Measurement
Technical Publication. ICNMM2013-73063
Yu Matsuda, Kaori Ueno, Hiroki Yamaguchi, Tomohide Niimi, *Nagoya University, Nagoya, Japan,* Yasuhiro Egami, *Aichi Institute of Technology, Toyota, Japan*

Simultaneous Imaging of Temperature and Concentration of Aqueous Solutions using the Near-infrared Absorption Characteristics of Water
Technical Presentation Only. ICNMM2013-73155
Naoto Kakuta, *Tokyo Metropolitan University, Hachioji, Tokyo, Japan,* Hidenobu Arimoto, *National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan,* Katsuya Kondo, *Tottori University, Tottori, Japan,* Daisuke Kawashima, *Tokyo Metropolitan University, Hachioji, Tokyo, Japan,* Yukio Yamada, *The University of Electro-Communications, Chofu, Tokyo, Japan*

Dimensional and Hydrodynamic Characterisation of 3-D Printed Microchannels
Technical Publication. ICNMM2013-73036
John O'Connor, *Stokes Institute, Limerick, Ireland, Jeff Punch, University of Limerick, Limerick, Ireland,* Nick Jeffers, *Paul Ahern, Bell Labs Ireland, Dublin, Ireland*

Viscosity Measurements of Nanofluids at Elevated Temperatures and Pressures
Technical Publication. ICNMM2013-73103
Anoop Kanjirakat, Khalifa Taimour, Mohammed Al-Jubouri, Mahmood Amani, *Texas A&M University at Qatar, Doha, Qatar,* Reza Sadr, *Texas A&M University at Qatar, Collage Station, United States*

Improvement of Physical-Mechanical Properties of the Composite Materials in Aircraft Structure using Carbon Nanomaterial Based on Phenolic Binder and Fiberglass
Technical Publication. ICNMM2013-73143
Khaled Alhussan, *King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia*

TRACK 6 Electrokinetic Flow

Track Organizer: **Dominik P.J. Barz,** *Queen's University, Kingston, Canada*
Track Co-Organizers: **Hirofumi Daiguji,** *The University of Tokyo, Kashiwa, Japan,* **Carolyn Ren,** *University of Waterloo, Waterloo, ON, Canada*

6-2 Electrokinetic Flow II

Room D **4:40pm–5:30pm**

Streaming Potential Revisited: Why it is Important to Measure In-Situ Liquid Conductivities
Technical Presentation Only. ICNMM2013-73062
Rakesh Saini, Abhinandan Garg, Vishvek Babbar, Jasleen Arora, Dominik P.J. Barz, *Queen's University, Kingston, ON, Canada*

Proton Transport in Mesoporous Silica SBA-16 Thin Films with Three-Dimensional Cubic Structures
Technical Publication. ICNMM2013-73112
Junho Hwang, Hirofumi Daiguji, *The University of Tokyo, Kashiwa, Chiba, Japan*

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TRACK 1: SINGLE PHASE GAS FLOW

Track Organizer: **Stéphane Colin**
Co-Organizer: **Chungpyo Hong,** *Kagoshima University, Japan*

TRACK 2: SINGLE PHASE LIQUID FLOW

Track Organizer: **Tatiana Gambaryan-Roisman,** *Technische Universitat Darmstadt, Germany*
Co-Organizers: **Diana-andr Borca-Tasciuc, Heinz Herwig,** *TU Hamburg-Harburg, Germany*

TRACK 3: TWO-PHASE FLOW

Track Organizer: **Masahiro Kawaji,** *University of Toronto, Canada*
Co-Organizers: **Niro Nagai,** *University of Fukui, Japan,* **Gherhardt Ribatski,** *University of São Paulo - São Carlos, Brazil,* **Vijayaraghavan Chakravarthy,** *Praxair, Inc., United States*

TRACK 4: BOILING AND CONDENSATION

Track Organizer: **Peter Stephan,** *Technische Universität Darmstadt, Germany*
Co-Organizers: **Ichiro Ueno,** *Tokyo University of Science, Japan,* **Theodorian Borca-Tasciuc, Saeed Moghaddam,** *University of Florida, United States*

TRACK 5: ELECTRONICS COOLING

Track Organizer: **Tomoyuki Hatakeyama,** *Toyama Prefectural University, Japan*
Co-Organizers: **Mark Steinke,** *International Business Machines Corp., United States,* **Ali Kosar,** *Sabanci University, Turkey,* **Shirish Mulay**

TRACK 6: ELECTROKINETIC FLOW

Track Organizer: **Dominik P.J. Barz,** *Queen's University, Canada*
Co-Organizers: **Hirofumi Daiguji,** *University of Tokyo, Japan,* **Carolyn Ren,** *University of Waterloo, Canada*

TRACK 7: FUEL CELLS

Track Organizer: **Debjyoti Banerjee,** *Texas A&M University, United States*
Co-Organizer: **IShohji Tsushima,** *Tokyo Institute of Technology, Japan*

TRACK 8: THIN FILM, INTERFACIAL PHENOMENA, AND SURFACE TENSION DRIVEN FLOWS

Track Organizer: **Daniel Attinger,** *Iowa State University, United States*
Co-Organizers: **Koji Takahashi,** *Kyushu University, Japan,* **Kripa Varanasi**

TRACK 9: NANO AND MICRO-STRUCTURES FOR HEAT TRANSFER ENHANCEMENT

Track Organizer: **Evelyn Wang,** *MIT, United States*
Co-Organizer: **Masahiko Shibahara,** *Osaka University, Japan*

TRACK 10: BIOMEDICAL AND LAB-ON-A-CHIP

Track Organizer: **Michael King**
Co-Organizer: **Koji Miyazaki,** *Kyushu Institute of Technology, Japan*

TRACK 11: MEASUREMENTS AND INSTRUMENTATION

Track Organizer: **Masahiro Motosuke,** *Tokyo University of Science, Japan*
Co-Organizers: **David Sinton, David Nobes,** *Univeristy of Alberta, Canada*

TRACK 12: MODELING AND SIMULATION

Track Organizer: **Ali Beskok**
Co-Organizers: Jun-Ichiro Shiomi, *University of Tokyo, Japan,* **Adam Donaldson,** *Dalhousie University, Canada*

TRACK 13: NUCLEAR APPLICATION

Track Organizer: **Yasuo Koizumi,** *Shimshu University, Japan*
Co-Organizer: **Moo Hwan Kim**

TRACK 14: MIXING AND CHEMICAL REACTIONS

Track Organizer: **Norbert Kockmann,** *TU Dortmund University, Germany*
Co-Organizer: **Chun Yang,** *Nanyang Technological University, Singapore*

TRACK 15: GENERAL PAPERS

Track Organizer: **Masamichi Kohno,** *Kyushu University, Japan*
Co-Organizer: **Sushanta Mitra**

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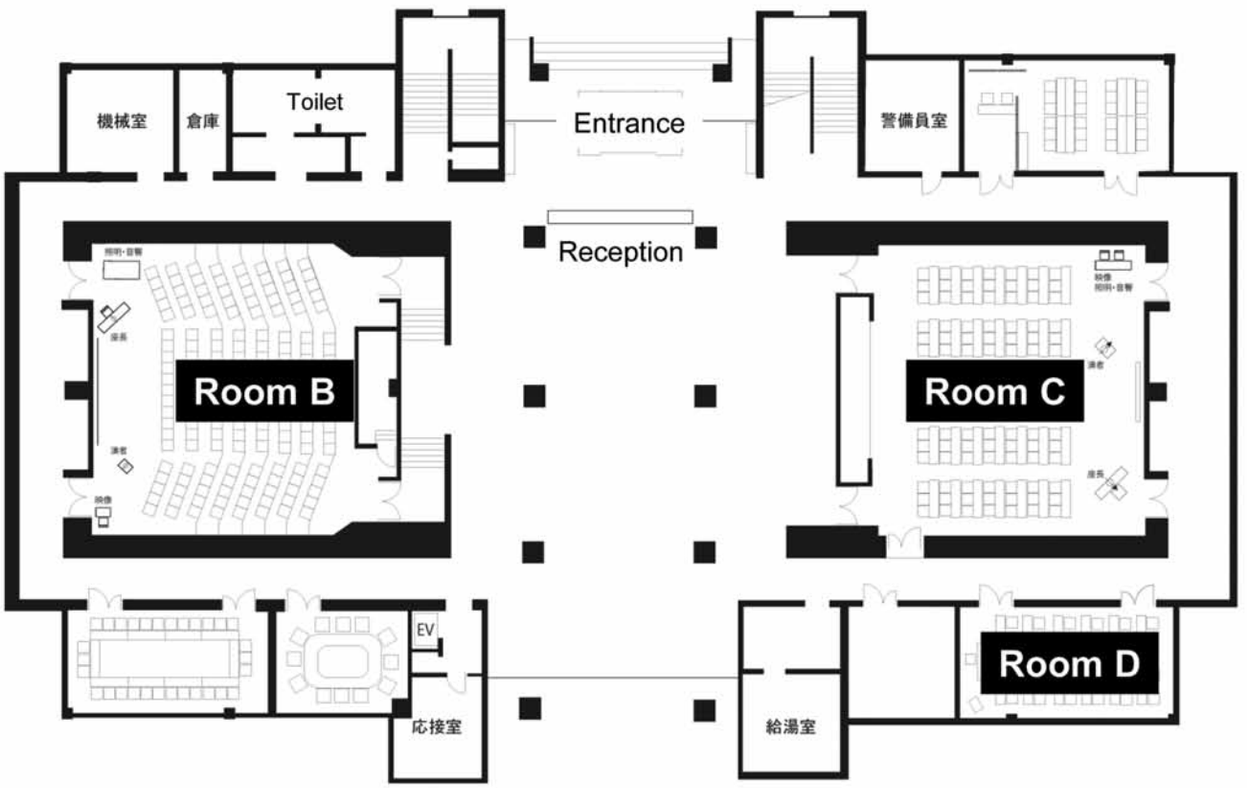

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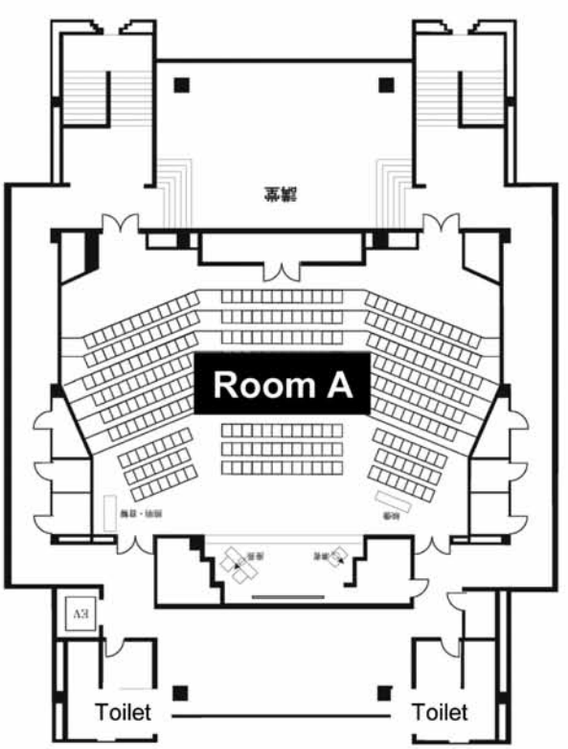

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