ANNALS OF THE NEW YORK ACADEMY OF SCIENCES

Volume 974 October 2002

MICROGRAVITY TRANSPORT PROCESSES IN FLUID, THERMAL, BIOLOGICAL, AND MATERIALS SCIENCES

Editor S. S. Sadhal

Associate Editors VIJAY K. DHIR, HARUHIKO OHTA, REGINALD W. SMITH, AND JOHANNES STRAUB

This volume is the result of a conference entitled Microgravity Transport Processes in Fluid, Thermal, Biological, and Materials Sciences, held September 30-October 5, 2001 in Banff, Alberta, Canada.

CONTENTS	
Preface. By Satwindar Singh Sadhal, Vijay K. Dhir, Haruhiko Ohta, Reginald W. Smith, and Johannes Straub	хi
Part I. Space Systems: Electrostatic, Electromagnetic, Fluid, and Thermal Phenomena	
Use of an Electric Field in an Electrostatic Liquid Film Radiator. By S.G. Bankoff, E.M. Griffing, and R.A. Schluter	1
Large-Scale Geophysical Flows on a Table Top. By John Hegseth AND KAMEL AMARA	10
Transport from Higher Order g-Jitter Effects. By Robert J. Naumann	29
The Use of Pulsatile Flow to Separate Species. By AARON M. THOMAS AND R. NARAYANAN	42
Part II. Materials Processing and Crystal Growth	
The Influence of Gravity on the Precise Measurement of Solute Diffusion	

Coefficients in Dilute Liquid Metals and Metalloids.

By REGINALD W. SMITH, XIAOHE ZHU, MARK C. TUNNICLIFFE,

Structures of Solid and Liquid during Melting and Solidification of Indium. By G. Costanza, F. Gauzzi, and R. Montanari	68
Unidirectional Solidification of Magnetostrictive Materials Using a Magnetic Field in Microgravity. By HIDEKI MINAGAWA, KEIJI KAMADA, HIDEAKI NAGAI, YOSHINORI NAKATA, AND TAKESHI OKUTANI	79
Dielectric in Situ Monitoring of Microgravity Polymerizations. By ALVIN P. KENNEDY AND SOLOMON TADESSE	87
The Influence of Gravity on Composition Uniformity and Microstructure in Immiscible Al-In Alloys. By J. Barry Andrews and Letitia J. Hayes	102
The Influence of Marangoni Flows on Crack Growth in Cast Metals. By B.J. YANG, R.W. SMITH, M. SAHO, AND M. SADAYAPPAN	110
Thermal Diffusivity Coefficient of Glycerin Determined on an Acoustically Levitated Drop. By K. Ohsaka, A. Rednikov, and S.S. Sadhal	124
Thermophysical Property Measurements by Electromagnetic Levitation Melting Technique under Microgravity. By SAYAVUR I. BAKHTIYAROV AND RUEL A. OVERFELT	132
Mass and Thermal Diffusivity Algorithms: Reduced Algorithms for Mass and Thermal Diffusivity Determinations. By R. MICHAEL BANISH, LYLE B.J. ALBERT, TIMOTHEE L. POURPOINT, J. IWAN D. ALEXANDER, AND ROBERT F. SEKERKA	146
ATEN: A New High Temperature Materials Processing Facility for the International Space Station. By Wayne N.O. Turnbull, Donald L. Misener, Timothy J.N. Smith, Guy R.J. Oram, and Reginald W. Smith.	157
Microgravity Effects on Thermodynamic and Kinetic Properties of Colloidal Dispersions. By Tsuneo Okubo and Akira Tsuchida	164
Gravity-Induced Anomalies in Interphase Spacing Reported for Binary Eutectics. By REGINALD W. SMITH	176
Part III. Interfacial Phenomena and Two-Phase Flows	_,_
Optical Measurement of Concentration Gradient Near Miscible Interfaces. By N. RASHIDNIA AND R. BALASUBRAMANIAM	193
Coupled Mean Flow-Amplitude Equations for Nearly Inviscid Parametrically Driven Surface Waves. By EDGAR KNOBLOCH, CARLOS MARTEL, AND JOSÉ M. VEGA	
Thermocapillary Convection Around Gas Bubbles: An Important Natural Effect for the Enhancement of Heat Transfer in Liquids Under Microgravity. By J. Betz and J. Straub	201
Experimental Investigation of the Liquid Interface Reorientation upon Step Reduction in Gravity. By Mark Michaels, Michael E. Dreyer, AND HANS J. RATH.	
Microscale Heat Transfer to Subcooled Water: 200-6,000 psia, 0-3,500 W/cm ² . By ROBERT H. LEYSE	246261

Condensate Removal Mechanisms in a Constrained Vapor Bubble Heat Exchanger. By Ling Zheng, Yingxin Wang, Peter C. Wayner, Jr., and Joel L. Plawsky	
Numerical Simulations of Bubble Motion in a Vibrated Cell Under Microgravity Using Level Set and VOF Algorithms. By Timothy J. Friesen, Hiroyuki Takahira, Lisa Allegro, Yoshitaka Yasuda, and Masahiro Kawaji.	
Annular Flow Film Characteristics in Variable Gravity. By Ryan M. MacGillivray and Kamiel S. Gabriel	
A Study of Gas—Liquid Two-Phase Flow in a Horizontal Tube Under Microgravity. Ву Винонд Сної, Текизніде Гилі, Нітозні Asano, and Катѕимі Sugiмото	316
Part IV. Boiling Phenomena	210
Vapor Bubbles in Flow and Acoustic Fields. By Andrea Prosperetti	
AND YUE HAO	328
Observations and Conclusions from Experiments Performed at Microgravity. By JOHANNES STRAUB	348
High Heat Flux Cooling by Microbubble Emission Boiling. By Koichi Suzuki, Hiroshi Saitoh, and Kazuaki Matsumoto	364
Dynamics of Single and Multiple Bubbles and Associated Heat Transfer in Nucleate Boiling Under Low Gravity Conditions. By D. QIU, G. SON, V.K. DHIR, D. CHAO, AND K. LOGSDON	378
Rapidly Expanding Viscous Drop from a Submerged Orifice at Finite Reynolds Numbers. By Nivedita R. Gupta, R. Balasubramaniam, AND KATHLEEN J. STEBE	398
Review of Existing Research on Microgravity Boiling and Two-Phase Flow: Future Experiments on the International Space Station. By HARUHIKO OHTA, ATSUSHI BABA, AND KAMIEL GABRIEL	
Pool Film Boiling Experiments on a Wire in Low Gravity: Preliminary Results.	410
By P. DI MARCO, W. GRASSI, AND F. TRENTAVIZI	428
By Ho Sung Lee	447
By Haruhiko Ohta	463
Criteria for Approximating Certain Microgravity Flow Boiling Characteristics in Earth Gravity. By Herman Merte, Jr., JAESEOK PARK, WILLIAM W. SHULTZ, AND ROBERT B. KELLER	481
Part V. Biotransport Processes and Protein Crystal Growth	
Microgravity Studies of Cells and Tissues. By GORDANA VUNJAK-NOVAKOVIC, NANCY SEARBY, JAVIER DE LUIS, AND LISA E. FREED	504
Flow Field Measurements in the Cell Culture Unit. By STEPHEN WALKER,	

Mike Wilder, Arsenio Dimanlig, Justin Jagger, and Nancy Searby $\,$.

518

Compact Optical Sensor for Real-Time Monitoring of Bacterial Growth for Space Applications. By R.C. van Benthem, D. van den Assem, and J. Krooneman	541
Bioactive, Degradable Composite Microspheres: Effect of Filler Material on Surface Reactivity. By QING-QING QIU, PAUL DUCHEYNE, AND PORTONOVO S. AYYASWAMY	556
Vapor Transport Growth of Organic Solids in Microgravity and Unit Gravity: Some Comparisons and Results to Date. By Maria Ittu Zugrav, William E. Carswell, Glen B. Haulenbeek, Mohan Sanghadasa, Sue K. O'Brien, Bogdan C. Ghita, and William E. Gathings	565
Sliding-Cavity Fluid Contactors in Low-Gravity Fluids, Materials, and Biotechnology Research. By Paul Todd, John C. Vellinger, Shramik Sengupta, Michael G. Sportiello, Alan R. Greenberg, and William B. Krantz	581
Microgravity Protein Crystallization: Are We Reaping the Full Benefit of Outer Space? By NAOMI E. CHAYEN AND JOHN R. HELLIWELL	591
Space-Grown Protein Crystals Are More Useful for Structure Determination. By JOSEPH D. NG	598
Mathematical Model for Diffusion of a Protein and a Precipitant about a Growing Protein Crystal in Microgravity. By Onofrio Annunziata AND JOHN G. ALBRIGHT	610
Index of Contributors	625

Financial assistance was received from:

- NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
- NATIONAL SCIENCE FOUNDATION
- United Engineering Foundation, Inc.

The New York Academy of Sciences believes it has a responsibility to provide an open forum for discussion of scientific questions. The positions taken by the participants in the reported conferences are their own and not necessarily those of the Academy. The Academy has no intent to influence legislation by providing such forums.