

10th AIAA/ASME Joint Thermodynamics and Heat Transfer Conference 2010

**Chicago, Illinois, USA
28 June – 1 July 2010**

Volume 1 of 2

ISBN: 978-1-61738-924-5

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 1801 Alexander Bell Drive, Reston, VA 20191, USA.

TABLE OF CONTENTS

VOLUME 1

2010-4313 Development of a Tool to Recreate the Mars Science Laboratory Aerothermal Environment	1
<i>A. Beerman, M. Lewis, J. Santos, T. White</i>	
2010-4314 An RSM/EVM Flow/Heat Transfer Model Applied to Pre-Transitional and Turbulent Boundary Layers	19
<i>J. Moore, J. Moore</i>	
2010-4315 Numerical Analysis of Heated Channel Flows by a Space-Marching Finite-Volume Technique	31
<i>A. Urbano, F. Nasuti</i>	
2010-4316 Efficient Radiative Transfer Equation Solver Using the Discontinuous Galerkin Method and the GPU	47
<i>X. He, R. Jain, R. Munipalli, L. Pilon, A. Karagozian</i>	
2010-4318 Heat Transfer LES Simulations in Application to Wire-Wrapped Fuel Pins	56
<i>Y. Peet, P. Fischer</i>	
2010-4319 Simulation of Gas-Surface Interactions Using ReaxFF Molecular Dynamics: Oxygen Adsorption on Platinum	66
<i>P. Valentini, T. Schwartzentruber, I. Cozmuta</i>	
2010-4320 Modeling Air-SiO² Surface Catalysis Under Hypersonic Conditions with ReaxFF Molecular Dynamics	82
<i>P. Norman, T. Schwartzentruber, I. Cozmuta</i>	
2010-4321 Development of a Catalytic Coating for a Shuttle Flight Experiment	97
<i>D. Stewart, M. Rezin, T. Gokcen, S. Sepka, D. Leiser</i>	
2010-4322 Development of a 30kW Inductively Coupled Plasma Torch Facility for Aerospace Material Testing	112
<i>W. Owens, J. Uhl, M. Dougherty, A. Lutz, D. Fletcher, J. Meyers</i>	
2010-4323 Monte Carol Simulation of Atomic Oxygen Undercutting on Polymer Film	127
<i>Y. Liu, G. Li, L. Jiang</i>	
2010-4324 Modeling Distribution of Atomic Oxygen Flux and Fluence on Spacecraft Surface in LEO Space Environment	137
<i>X. Li, G. Li, X. Liu, Y. Liu</i>	
2010-4325 Computations of Heat Transfer in Transitional Turbine Flows	143
<i>L. Kingery, Y. Suzen, F. Ames</i>	
2010-4328 Improved Temperature Extrapolation Methods for Powerplant Systems	154
<i>F. Uriz, B. Remy, A. Degiovanni, O. Verseux</i>	
2010-4329 Modeling of Rocket Combustion Devices	163
<i>M. Frey, T. Aichner, J. Görden, B. Ivancic, B. Kniesner, O. Knab</i>	
2010-4330 TeraHertz Rayleigh Scattering of Particles in Rocket Exhaust Plumes	175
<i>A. O'Shea, A. Ketsdever, T. Mulcahy, H. Song</i>	
2010-4331 Numerical Simulation of Hypersonic Blunt Body and Nozzle Flows Using Master Equation	187
<i>P. Vedula, E. Josyula</i>	
2010-4332 A Multi-Group Maximum Entropy Model for Thermo-Chemical Non-Equilibrium	202
<i>Y. Liu, M. Vinokur, M. Panesi, T. Magin</i>	
2010-4334 On the Kinetic Formulation of Vibrationally Coupled Diatomic Dissociation and Monatomic Recombination	221
<i>R. Yano, K. Suzuki</i>	
2010-4335 Vibrational State to State Kinetics in Expanding and Compressing Nitrogen Flows	234
<i>A. Munafò, M. Panesi, R. Jaffe, Andrea Lani, T. Magin</i>	
2010-4336 Rovibrational Internal Energy Excitation and Dissociation of Molecular Nitrogen in Hypersonic Flows	258
<i>T. Magin, M. Panesi, A. Bourdon, R. Jaffe, D. Schwenke</i>	
2010-4499 Assessment of Reaction-Rate Predictions of a Collision-Energy Approach for Chemical Reactions in Atmospheric Flows	275
<i>M. Gallis, R. Bond, J. Torczynski</i>	
2010-4500 Spray Cooling Droplet Impingement Model	294
<i>P. Kreitzer, J. Kuhlman</i>	
2010-4501 Distributional Direct Simulation Monte Carlo Methods	309
<i>C. Schrock, A. Wood</i>	

2010-4502 A Smoothed Accept-Reject Algorithm for Collisional Modeling in DSMC	321
<i>R. Greendyke, S. Summers</i>	
2010-4503 Particle-in-Cell Method for Solving the Boltzmann Equation	337
<i>E. Malkov, M. Ivanov</i>	
2010-4504 DSMC Study of an H₂/O₂ Detonation Wave Structure	347
<i>Y. Bondar, M. Ivanov</i>	
2010-4505 Verification of an Electron-Carbon Interaction Model for DSMC Schemes	355
<i>D. Petkow, F. Bozsak, G. Herdrich, M. Auweter-Kurtz</i>	
2010-4508 Absolute Radiation Measurement in Venus and Mars Entry Conditions	366
<i>B. Cruden, D. Prabhu, R. Martinez, H. Le, J. Grinstead, D. Bose</i>	
2010-4510 Analysis of Air Radiation Measurements Obtained in the EAST and X2 Shocktube Facilities	381
<i>A. Brandis, B. Cruden, D. Prabhu, D. Bose, M. McGilvray, R. Morgan</i>	
2010-4511 Ablative Material Testing at VKI Plasmatron Facility	404
<i>B. Erzincanli, C. Asma, O. Chazot</i>	
2010-4512 A Study on Ablation Behavior of Spherical Ice Piece in Hypersonic Flow	417
<i>O. Imamura, T. Okumuki, K. Suzuki</i>	
2010-4513 Experimental and Numerical Studies of Hypersonic Flows in the Rarefied Wind Tunnel	426
<i>T. Ozawa, T. Suzuki, K. Fujita</i>	
2010-4514 Energy Transfer Kinetics of Vibrationally Excited Molecules	441
<i>E. Ivanov, M. Nishihara, I. Adamovich, J. Rich</i>	
2010-4515 Nonequilibrium Flow Characterization in a Mach 5 Wind Tunnel	461
<i>M. Nishihara, K. Takashima, N. Jiang, W. Lempert, I. Adamovich, J. Rich</i>	
2010-4516 Analysis of Multi-Vane Radiometers in High-Altitude Propulsion	486
<i>B. Cornella, S. Gimelshein, N. Gimelshein, A. Ketsdever</i>	
2010-4517 Vibration-Rotation Excitation and Dissociation in N₂-N₂ Collisions from Accurate Theoretical Calculations	497
<i>R. Jaffe, D. Schwenke, G. Chaban</i>	
2010-4518 Improvement and Extension of the Loosely Coupled Navier-Stokes Code SINA to Different Gases	510
<i>U. Bauder, A. Majid, M. Fertig, M. Auweter-Kurtz</i>	
2010-4520 Nonequilibrium Chemistry and Radiation for Neptune Entry	518
<i>C. Park</i>	
2010-4521 Coupled Radiation-Gasdynamic Model for STARDUST Aerothermodynamic Data	527
<i>S. Surzhikov, J. Shang</i>	
2010-4522 Emission Spectroscopic Measurements in the Plenum Region of the NASA IHF Arc Jet Facility	558
<i>M. Winter, D. Prabhu, J. Taunk, I. Terrazas-Salinas</i>	
2010-4525 Study of Radiation in Electric Arc Shock Tubes	569
<i>E. McCorkle, H. Hassan</i>	
2010-4526 Details of Modeling Titan Entry Nonequilibrium Radiation with a Multi-Quantum Vibration State CR Model	607
<i>A. Brandis, T. Magin, C. Laux</i>	
2010-4527 Spectral Emissivity of Shock Waves in Martian and Titan Atmospheres	619
<i>S. Surzhikov</i>	
2010-4528 Experimental Investigation of Radiation Flux Behind Strong Shock Waves in CH₄/N₂ Mixture	651
<i>I. Kosarev, M. Nudnova, V. Khorunzhenko, P. Sagulenko</i>	
2010-4642 Quantification of Uncertainty in Aerodynamic Heating of a Reentry Vehicle due to Uncertain Wall and Freestream Conditions	660
<i>B. Bettis, S. Hosder</i>	
2010-4643 Analysis of Instabilities in Non-Axisymmetric Hypersonic Boundary Layers over Cones	678
<i>F. Li, M. Choudhari, C. Chang, J. White</i>	
2010-4644 Computational Analysis of Arc-Jet Wedge Tests Including Ablation and Shape Change	702
<i>T. Gokcen, Y. Chen, K. Skokova, F. Milos</i>	
2010-4645 Validation of a Three-Dimensional Ablation and Thermal Response Simulation Code	723
<i>Y. Chen, F. Milos, T. Gokcen</i>	
2010-4646 EXOMARS Capsule Aerodynamic Analysis	737
<i>J. Verant, M. Spel, B. Bonnal</i>	
2010-4647 Three-Dimensional Aerodynamics Study for Mars Aeroshell in Nonequilibrium Flow	755
<i>M. Furudate, H. Takayanagi, T. Suzuki, K. Fujita</i>	

2010-4648 Thermal Performance of a Wire Mesh/Hollow Glass Sphere Composite Structure	764
<i>S. McKenna, D. Kim, E. Marotta, L. Fletcher</i>	
2010-4650 Stagnating Radiator Thermal Model Design and Verification	792
<i>E. Bannon, C. Iacomini, C. Bower, C. Linrud</i>	
2010-4651 Experimental Study of Natural Convection on the Wall of Infrared Balloon	806
<i>R. Bruce, P. Reulet, P. Millan, G. Parot, G. Letrenne</i>	
2010-4653 Local Heat Transfer Measurements inside a Compact Heat Exchanger	816
<i>H. Webber, N. Taylor</i>	
2010-4654 Experimental Determination of the Key Heat Transfer Mechanisms in Pharmaceutical Freeze Drying	829
<i>A. Ganguly, A. Alexeenko, S. Nail</i>	
2010-4655 Pyrolysis Mechanism of PICA	847
<i>J. Scoggins, H. Hassan</i>	

VOLUME 2

2010-4656 Assessment of Carbon-Phenolic-in-Air Chemistry Models for Atmospheric Re-entry	863
<i>A. Martin, I. Boyd</i>	
2010-4657 Post-Test Sample Analysis of Fiber Reinforced Plastic Using Arcjet	878
<i>T. Sakai, M. Tomita, T. Suzuki, K. Fujita, K. Hirai</i>	
2010-4658 Parametric Studies with an Arc Electrode Mass Loss Model	889
<i>J. Sheeley</i>	
2010-4659 Experimental Study of Natural Frost Formation on a Horizontal Cylinder	908
<i>M. Yaghoubi, H. Khoshnazar</i>	
2010-4660 Combined Heat Transfer in High-Porosity High-Temperature Fibrous Insulations: Theory and Experimental Validation	942
<i>K. Daryabeigi, G. Cunningham, S. Miller, J. Knutson</i>	
2010-4661 Development of a High-Temperature Optical Coating for Thermal Management on Solar Probe Plus	957
<i>E. Congdon, D. Mehoke, M. Buchta, D. Nagle, D. Zhang</i>	
2010-4662 Atomistic Modeling of the Decomposition of Charring Ablators	966
<i>B. Venkatachari, G. Cheng, I. Cozmuta</i>	
2010-4663 Ablation, Thermal Response, and Chemistry Program for Analysis of Thermal Protection Systems	983
<i>F. Milos, Y. Chen</i>	
2010-4664 Multidimensional Testing of Thermal Protection Materials in the Arcjet Test Facility	1005
<i>P. Agrawal, D. Ellerby, M. Switzer, T. Squire</i>	
2010-4665 Radiation Testing of PICA at the Solar Power Tower	1021
<i>S. White</i>	
2010-4766 Heat Conduction Inside of an Irregularly Shaped Non-Convex Body Immersed in a Turbulent Hypersonic Flow Field	1037
<i>G. Risher Jr.</i>	
2010-4767 Effect of Axial Heat Conduction and Internal Heat Generation on the Effectiveness of Counter Flow Microchannel Heat Exchangers	1045
<i>B. Mathew, H. Hegab</i>	
2010-4768 Modeling a Phase Change Thermal Storage Device	1058
<i>Robert Rhodes, Trevor Moeller</i>	
2010-4769 Heat Transfer Past Multiple Tube Banks: A Numerical Investigation	1072
<i>M. Galal, E. Khalil, A. Abdel-Raouf</i>	
2010-4770 Numerical Investigation of Jet-Obstructions to Aid in Enhancing Surface Heat Transfer from an Impinging 2D Hot-Air Jet	1083
<i>M. Khan, F. Saeed, A. Al-Garni</i>	
2010-4771 Performance Evaluation of Atrium Smoke Exhaust System by Two Fire Models	1098
<i>W. Chow, J. Li, N. Fong</i>	
2010-4774 Contribution of Vacuum-Ultraviolet (VUV) Transitions of Molecular Nitrogen to Radiation During Atmospheric Reentry	1103
<i>H. Liebhart, H. Röser, M. Fertig, G. Herdrich</i>	
2010-4778 Modeling Hierarchical Thermal Transport in Electronic Systems	1118
<i>A. Shah, R. Shih, C. Bash, N. Kumari,</i>	
2010-4780 Micro Channel Heat Sink with Embedded Pin-Fin Structures	1128
<i>T. John, B. Mathew, H. Hegab</i>	

2010-4781 Characteristic Study on the Optimization of Micro Pin-Fin Heat Sink with Staggered Arrangement	1138
<i>T. John, B. Mathew, H. Hegab</i>	
2010-4784 Design of Embedded Temperature-Sensor Heat Flux Gauges for Bodies with Initial Linear Temperature Gradients	1149
<i>D. Maqbool, C. Cadou</i>	
2010-4785 Volumetric Heat Flux Characterization Experiments in the Interaction Heating Facility at NASA Ames	1158
<i>J. Santos, A. Nawaz, E. Martinez, I. Terrazas-Salinas</i>	
2010-4786 Test Flow Conditions for the Expansion Tube Experiment	1172
<i>Y. Nagata, K. Wasai, H. Makino, K. Yamada, T. Abe</i>	
2010-4787 Evaluation of Prediction Accuracy of Thermal Response of Ablator Under Arcjet Flow Conditions	1188
<i>T. Suzuki, K. Fujita, T. Sakai, K. Okuyama, S. Kato, S. Nishio</i>	
2010-4788 Experimental and Numerical Investigation of an Unsteady Conjugate Heat Transfer Case	1202
<i>V. Galoul, P. Reulet, E. Laroche, P. Millan</i>	
2010-4888 Interactions of Single-Nozzle Sonic Propulsive Deceleration Jets on Mars Entry Aeroshells	1216
<i>H. Alkandry, I. Boyd, E. Reed, J. Codoni, J. McDaniel</i>	
2010-4889 Assessment of Turbulent CFD against STS-128 Hypersonic Flight Data	1229
<i>W. Wood, W. Kleb, A. Hyatt</i>	
2010-4892 A Unified Numerical Approach for the Aerothermal-Man-Machine-Environmental System	1241
<i>S. Zhang, Y. Zhu</i>	
2010-4893 Parallel Flow Microchannel Heat Exchangers Subjected to Axial Heat Conduction and Internal Heat Generation	1257
<i>B. Mathew, H. Hegab</i>	
2010-4894 Porous Media Combustion for Heating Process	1268
<i>R. Amano, K. Guntur</i>	
2010-4895 Chemically Reacting and Particle-Laden Multiphase Flow in an Molten Salt Vessel	1273
<i>G. Marin, Z. Wang, G. Naterer, K. Gabriel</i>	
2010-4896 Modeling and Simulation of Heat Transfer on Functionally Graded Materials for Hot Structures in Scramjet Engines	1283
<i>C. Messe, D. Kliche, T. Wallmersperger, B. Kroplin, C. Mundt</i>	
2010-4898 A USM Two-Phase Subgrid Stress Model for Swirling Gas-Particle Flows	1293
<i>Y. Liu, G. Li, X. Liu</i>	
2010-4900 Determining the Thermal Conductivity of W/B₄C Multilayer Structures Using Photothermal Deflection Spectroscopy	1302
<i>M. Moorhead, C. Avedisian, A. Kazimirov</i>	
2010-4902 Numerical Analysis of Convection Heat Transfer over Multiple Vaulted Roof Buildings	1315
<i>M. Yaghoubi, P. Haghi</i>	
2010-4903 Ice Slurry Thermal Energy Storage System	1340
<i>L. Lin, L. Elston, R. Harris, J. Hartman, R. Carr</i>	
2010-4904 Radiation Heat-Transfer Model for the Ablation Zone of Low-Density Carbon-Resin Composites	1350
<i>T. Van Eekelen, J. Lachaud</i>	
2010-4905 Assessing Calorimeter Evaluation Methods in Convective and Radiative Heat Flux Environment	1361
<i>A. Nawaz, J. Santos</i>	
2010-4907 Uncertainty and Local Sensitivity Analysis of View Factors for Steady-State Conjugate Heat Transfer Problems	1376
<i>C. Rauch, R. Almbauer</i>	
2010-5046 Development of Supersonic Retro-Propulsion for Future Mars Entry, Descent, and Landing Systems	1387
<i>K. Edquist, A. Korzun, J. Studak, A. Dyakonov, J. Shidner, M. Tigges, D. Kipp, R. Prakash, K. Trumble, I. Dupzyk</i>	
2010-5047 An Initial Assessment of Navier-Stokes Codes Applied to Supersonic Retro-Propulsion	1409
<i>K. Trumble, D. Schauerhamer, W. Kleb, J. Carlson, P. Buning, K. Edquist, M. Barnhardt</i>	
2010-5048 Comparison of Inviscid and Viscous Aerodynamic Predictions of Supersonic Retropropulsion Flowfields	1434
<i>A. Korzun, C. Cordell Jr., R. Braun</i>	
2010-5049 Development of Thermal Protection Materials for Future Mars EDL Systems	1454
<i>A. Cassell, R. Beck, J. Arnold, M. Wright, H. Hwang, C. Szalai, M. Blosser, C. Poteet</i>	

2010-5050 Validation Testing of Dual Heat Pulse, Dual Layer Thermal Protection System Applicable to Human Mars Entry, Descent, and Landing	1477
<i>J. Arnold, S. Sepka, P. Agrawal, E. Venkatapathy, Y. Chen</i>	
2010-5051 Direct Coupling of the NEQAIR Radiation and DPLR CFD Codes	1486
<i>G. Palmer, T. White, A. Pace</i>	
2010-5052 Co-Optimization of Mid Lift to Drag Vehicle Concepts for Mars Atmospheric Entry	1502
<i>J. Garcia, J. Brown, D. Kinney, J. Bowles, X. Jiang, I. Dupzyk, E. Lau, L. Huynh</i>	
2010-5053 Comparison of Heat Transfer Measurement Devices in Arc Jet Flows with Shear	1525
<i>I. Terrazas-Salinas, J. Carballo, D. Driver, J. Balboni</i>	
2010-5054 Numerical Simulations of Knudsen Forces in Microsystems	1549
<i>J. Nabeth, S. Chigullapalli, A. Alexeenko</i>	
2010-5055 Experimental Study of Droplet Motion and Thermocapillary Heat Transfer in a Closed Microchannel	1561
<i>A. Odukoya, G. Naterer</i>	
2010-5056 Dynamics of Fluid Flow in a Heated Zig-Zag Square Microchannel	1570
<i>B. Mathew, H. Hegab, T. John</i>	
2010-5058 DPD Simulation of Electroosmotic Flow in Nanochannels and the Evaluation of Effective Parameters	1583
<i>M. Darbandi, R. Zakeri, G. Schneider</i>	
2010-5059 Assessing the Potential for Condensation in Supersonic MicroNozzle Flows	1594
<i>W. Louisos, D. Hitt</i>	
2010-5060 Development of a MEMS Based Integrated Hot-Film Flow Sensor	1617
<i>G. Johnson, M. Hucker, D. Gough, C. Warsop, D. Baker</i>	
2010-5061 Importance Sampling Based Direct Simulation Monte Carlo Method	1628
<i>P. Vedula, D. Otten</i>	
2010-5062 Mesh Tailoring for Strongly Coupled Computation of Ablative Material in Nonequilibrium Hypersonic Flow	1641
<i>A. Martin, I. Boyd</i>	
2010-5063 Modeling Gun Bore Heat Transfer & Degradation	1657
<i>S. Sopok</i>	
2010-5064 Thermal Model Correlations: Benefits, Limitations, and Best Practices	1667
<i>A. Whelan, J. Evans, D. Anderson</i>	
2010-5066 The Effect of End Conditions on Laminar and Turbulent Natural Convective Flow in a High Aspect Ratio Enclosure	1685
<i>P. Oosthuizen, J. Paul</i>	
2010-5067 Convective and Radiative Heat Flux Estimation on a Reentry Capsule	1694
<i>M. Di Clemente, D. Ferrarella</i>	
2010-5068 Effect of Velocity-Ratio on the Mixing of Non-Isothermal Counter-Flowing Jets in Channel	1707
<i>S. Khan, N. Hasan</i>	
2010-5069 Flow and Heat Transfer Characteristics Downstream of A Porous Sudden Expansion	1722
<i>K. Alammari</i>	
Author Index	