CURRICULUM VITAE: MICHAEL A. HOMEL

CONTACT INFORMATION:

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ACADEMIC BACKGROUND

Currently a Ph.D. candidate in the Mechanical Engineering Computational Solid Mechanics group at the University of Utah with 3.9/4.0 GPA. (Advisor: Dr. Rebecca Brannon)

- Passed Ph.D. qualifier exam (Nov. 2011) with topic exams on Finite Element Method, Adv. Strengths of Materials, and Fluid Dynamics. (As part of the PhD path, a coursework MS in Mechanical Engineering, is anticipated to be conferred at the end of the Spring 2012 semester.)
- Coursework in advanced finite element methodology, statistical thermodynamics, advanced mechanics of materials, vibrations analysis, continuum mechanics, object-oriented programming, elasticity, and computational constitutive modeling.
- Recipient of the 2011 Washakie Renewable Energy Scholarship for Mechanical Engineering, in recognition of academic excellence and accomplishments in the field of energy research
- As a graduate student, developed a finite element model to investigate structural instability of a geodesic truss support for a solar thermal concentrator, and developed a ray-trace algorithm to compute the reflective properties the deformed faceted structure. The analysis involved advanced use of ANSYS integrated with Matlab.

Received a Bachelor's of Mechanical Engineering from the University of Utah in 2006, with advanced coursework in finite element analysis, computational fluid dynamics, advanced composites, physical chemistry and quantum mechanics.

- As an undergraduate, won an EPA grant to initiate a wind energy research program as a senior design project to develop advanced composite turbine blades with tailored aero-elastic properties and developed a finite element software tool to facilitate this research and for educational purposes.
- While engaged in independent research related to undergraduate coursework, formulated an improved analytical model to predict the transverse modulus of UD composite laminates, and also discovered a new approach towards improving airfoil design for horizontal axis wind turbine blades.
- Recipient of the undergraduate Kennecott Engineering Scholarship in recognition of academic achievement

RESEARCH AND DESIGN EXPERIENCE

Research Assistant, University of Utah Computational Solid Mechanics (June 2010-present), with a focus on constitutive theory of porous fluid-saturated materials for use in high-rate, large deformation, material point method finite element simulations. This work has included:

- Mesoscale simulation of porous materials using the Uintah material point method (MPM) code, with convective particle domain interpolation (CPDI) to simulation pore collapse and expansion of porous idealized geometries and material microstructures.
- Formulation of an analytical model describing the elastic, elastic-plastic, and fully plastic response of an idealized porous material with a fluid-saturated pore-space. The development and visualization and verification of this model involved in-depth use of Mathematica.
- Adaptation of an analytical result for deformation mechanics of an idealized material model to form a structure for a semi-empirical formulation; parameterization of the modified expression using experimental data.
- Implementation of effective stress models and improved algorithms for damage into the Kayenta geomechanics model, requiring extensive use of Fortran, and associated development tools.

Research Engineer, Materials and Systems Research, Inc. (Aug. 2000– Aug. 2010) designing, fabricating and testing a variety of high temperature electrochemical devices and systems, such as fuel cells, electrolyzers, batteries, sensors, and separation membrane, and developing expertise in analytical and finite element modeling of these devices. This work has included:

- Development of thin film oxidation resistant protective coatings for metallic SOFC interconnects for a DOE sponsored project which included optimization of electro-vapor deposition (EVD), physical vapor deposition (PVD), anhydrous electroplating, solution and sol-gel processes as well as XRD, SEM, and surface characterization of thin films.
- Creation of a finite element code to predict flow characteristics in planar SOFC stack that led to improved design of flow manifolds allowing for increased stack efficiencies.
- Design and analysis of novel heat management methods for SOFC power modules under a project funded by the California Energy Commission which included extensive modeling of thermodynamic and heat transfer effects and led to a demonstration of a thermally integrated prototype system to evaluate the effectiveness of a radiative air preheater.
- Design of high power density planar SOFC stack geometries for DARPA funded palm power project, and design of a thermally integrated, portable SOFC power generator that was the first such device to be successfully operated.
- Design of compact tubular SOFC bundle for an ONR-funded high power density battery charger.
- Design and analysis of a 5kW system for cogeneration of hydrogen and electricity from distributed natural gas and bio-fuels.
- Design and fabrication of a 1kW reactor for devolatilization and gasification of carbonaceous fuels
- Design of a 1kW tubular SOFC power module for enhanced stability and performance at high temperatures on dry CO-based fuels
- Design and Modeling of a compact SOFC module for operation on logistics fuels and a chemical oxygen source with application to unmanned underwater vehicles.

- Modeling and experimental analysis of a novel 2-phase molten carbonate membrane for high temperature CO_2 separation from flue-gas streams.
- Optimization of compression systems for sealing and maintaining electrical contact in stacks of planar electrochemical devices.
- Design of high-temperature battery systems including Na-metal chloride cells, and Na-S cells.
- Design of advanced concepts for manufacturing in planar solid oxide fuel cells including single-fired stacks, single-piece stamped interconnects, novel flow-field configurations for reduced stack mass and improved flow uniformity, robust geometries for with low-thermal mass for rapid heating.
- Development of advanced concepts for integration of fuel reforming with selective high-temperature gas membranes for improved efficiency and yield in chemical processes.
- Design of a high-temperature multistage electrochemical compressor using a planar cell geometry and capable of achieving high pressure product stream with ceramic membranes.

TEACHING

Course Instructor, University of Utah, "*Introduction to Finite Element Methods*", (ME EN 5510/6510, Summer 2011)

- The course covered analytical solutions, direct stiffness approach, and Galerkin method developments for 1D linear systems, generalized boundary conditions, 2D scalar field problems, material and geometric non-linearity, verification and validation, and an overview of advanced topics with an emphasis on design applications.
- Designed and conducted a computational laboratory portion of the class that covered an introduction to ANSYS including projects on structural and thermal problems with non-linearity, contact, vibrations, buckling, plasticity, and exercises in verification and validation.
- The course was conducted at a dual level, with 17 undergraduates and 6 graduate students. Course reviews rated the instructor well above the department and university averages, with exceptional marks given for being knowledgeable about the subject matter.

Invited Guest Lecturer, University of Utah:

- PhD-level special topics course in computational constitutive modeling. "*Porous and granular media: stable and unstable behaviors. Carroll-Holt and Gurson models. Lode angle dependence. Stable pore crushing model, experimental evidence of nonlocal deformation. Introduction to principles of material stability*." (ME EN 7960-017, Fall 2011)
- Chemical engineering survey course on alternative energy technology, "*Electrochemical processes, fuel cells and electrolysis systems*." (CH EN 1001, Fall 2006)

PROJECT MANAGEMENT EXPERIENCE

Served as the Principal Investigator for the following research and development projects, each of which was funded by a grant won through a proposal I had authored. Completed for each, the technical, budget, labor and scheduling oversight, as well as preparation of progress reports and presentations to the contract administrators.

- Design and Construction of a 300W prototype tubular SOFC generator fueled by a CPOX reformate of logistics fuels and integrated into a compact tactical power generator. Phase I and Phase II efforts funded by the Office of Naval Research.
- Design Study of a hybrid thermoelectric-solid oxide fuel cell device for portable power generation from logistics fuels. Phase I SBIR effort funded by the Office of Naval Research.
- Design and fabrication of a 1kW prototype for conversion of carbonaceous fuels to electricity at high temperature using a Boudouard gasifier coupled to a solid oxide fuel cell. An effort funded under subcontract to Direct Carbon Technologies, Ltd. With support from the US Department of Energy.

PATENTS/INVENTION DISCLOSURES

Inventor or co-inventor in the following invention disclosures and/or patent applications:

- Michael A. Homel, Michael Gardiner, Jared Rich "Assemblies of Hollow Electrode Electrochemical Devices" USPTO application #2010/0086824 (Pub. April 2010).
- "Hi-temp multi-stage planar solid oxide electrochemical hydrogen compressor." (IDS, MSRI 2010)
- "Anhydrous electrophoretic deposition of alumina on stainless steel." (IDS, MSRI 2010)
- "Membrane-Assisted WGS with high temp dual-phase CO_2 separation membrane." (IDS, MSRI 2009)
- "Novel Planar Stack Design for Improved Thermal Management and Flow Distribution in High-Temperature, Planar Electrochemical Devices." Prov. Pat. App. (MSRI, 2007)
- "Hybrid Planar Electrochemical Device for Cogen. of H_2 and Electricity," Prov. Pat. App. (MSRI, 2007)
- "Tet-Manifold Geometry for Improved Flow Distribution in SOFC Stacks" (IDS MSRI, 2006)
- "High Temperature Dual-Phase Membrane for CO2 Separation" Prov. Pat. App. (MSRI, 2006)
- "All-Ceramic High Temperature Compression Hardware for Planar SOFC Stack" (IDS MSRI, 2005)
- "Anhydrous Electroplating of Thin Film Mn_2CrO_4 Spinel for SOFC Interconnects." (IDS MSRI, 2002).

WORKSHOPS AND CONFERENCES

- Invited Presentation at the International Symposium on Plasticity and Its Current Applications, San Juan, PR, Jan 2012. , "Semi-Empirical Effective Stress Model for Quasi-static Deformation of Fluid-Saturated Porous Materials"
- Invited Presentation at the March 2010 Office of Naval Research Energy and Propulsion Workshop in Santa Rosa, CA. Presented an overview of research conducted for MSRI entitled "Solid Oxide Fuel Cells for Air-Independent Unmanned Underwater Vehicles."
- Invited Attendee to the SECA fuel cell modeling seminar at Pacific Northwest National Labs, 2001-02

TECHNICAL WRITING AND PUBLICATIONS

Co-Authored the following peer-reviewed publications, has also contributed significant portions of technical writing to more than 10 successfully funded research grant proposals and numerous technical reports and presentations.

- Michael A. Homel, Rebecca M. Brannon, “Semi-Empirical Effective Stress Model for Quasi-static Deformation of Fluid-Saturated Porous Materials”, Proceeding of the Int. Symposium on Plasticity and Its Current Applications, (Submitted Jan. 2012).
- Kristen M. Homel, Michael A. Homel, Robert E. Gresswell, “Interpolating continuous movement paths from sparse telemetry data in a linear system”, Ecology, (Submitted Dec. 2011)
- Michael A. Homel, Turgut M. Gür, Joon Ho Koh, Anil V. Virkar, “Carbon monoxide-fueled solid oxide fuel cell,” Journal of Power Sources, Volume 195, Issue 19, 1 October 2010, p6367-6372.
- Anil V. Virkar, Fred F. Lange, Michael A. Homel, “A simple analysis of current collection in tubular solid oxide fuel cells,” Journal of Power Sources, Volume 195, Issue 15, 1 August 2010, p4816-4825.
- Turgut M. Gür, Michael A. Homel, Anil V. Virkar, “High performance solid oxide fuel cell operating on dry gasified coal” Journal of Power Sources, Volume 195, Issue 4, 15 February 2010, p1085-1090.
- Tad J. Armstrong, Michael A. Homel, Anil V. Virkar, "Evaluation of metallic interconnects for use in intermediate temperature SOFC," Proceedings of the Electrochemical Society (2003-07).

SOFTWARE PROFICIENCIES

General computing proficiency in Linux and Windows environments including word processing, LaTeX document generation, digital graphics, audio and video editing and presentation graphics.

Programming:

- Extensive experience with Fortran 77, with development using basic Linux tools, as well as static code analysis using Understand to maintain and develop new features for the Sandia-Kayenta material model.
- Extensive experience with Matlab, for programming of finite element, and finite difference solutions for solid mechanics, heat transfer, fluid mechanics, process simulation, and optimization, as well as user interface development and interface/scripting for use with Excel, ANSYS, Pro/Engineer, and rapid prototyping machinery.
- Extensive experience with Mathematica: development of a multi-purpose material model and material element driver, custom finite element codes, numerous analytical and numerical solutions, statistical analysis, algorithm/theory development and data visualization.
- Additional limited experience with C++ (MS Visual Studio), Python, NI LabView, and Excel

Engineering Analysis:

- Extensive use of Uintah for material point method (MPM) with convective particle domain analysis (CPDI) for mesoscale simulation and verification/validation of continuum material model results.
- Extensive use of ANSYS for h-method finite element simulation FEM, Pro/Mechanica for p-method finite element analysis

- Extensive use of Pro/Engineer Wildfire, for 3D modeling and analysis of structural and thermal systems and generation of engineering drawings.
- Extensive use of Fluent for finite difference computational fluid dynamics (CFD)
- Familiar with AutoCAD, Solid Works, and Working Model

EXTRACURRICULAR ACTIVITIES

Other projects that were outside the realm of work or school:

- Developed a method for analysis of sparse telemetry data for tracking the migration patterns of freshwater fish that extends the solution for advection diffusion in a 1D system with analysis for X-t space to ecological systems.
- Developed a prototype device to scramble an egg inside its shell, without piercing the shell, with application for the production of pre-scrambled fresh eggs.
- Designed and constructed a 30m² parabolic solar concentrator using geodesic construction for demonstration of a low-cost and portable solar thermal concept.
- Provided consultation and design services for a residential solar thermal installation
- Organized and hosted a live music open mic event and has taught musical technique and performed live music (piano, guitar and vocals) at numerous venues throughout the state.
- Developed a software simulation tool for site-specific tailoring of wind turbine blade geometries and rotor dynamics for eventual commercial distribution to industrial and academic clients.

CURRENT ACTIVITIES

- Pursuing a PhD in mechanical engineering at the University of Utah; currently enrolled in coursework in object-oriented programming, elasticity, and computational nonlinear constitutive modeling at large and small deformations, with emphasis on verification and validation, as well as exposure to aleatory uncertainty, scale effects, and nonlocal regularization required for mesh-independent predictions.
- Research assistantship for the Computational Solid Mechanics group at the University of Utah mechanical engineering department under Dr. Rebecca Brannon. Research is funded by Schlumberger Technology Corp., to (i) develop improved continuum models for fluid-saturated porous media under high rate deformation, (ii) implement these models as Fortran code in Kayenta, (iii) conduct verification and validation of the constitutive theory via mesoscale simulation using material point method (MPM) with convective particle domain interpolation (CPDI) integration.

REFERENCES

Rebecca M. Brannon: Graduate Advisor, University of Utah (2 yrs.)
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