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② B
The Sciences and
Engineering

Volume 63

Number 11

May 2003

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DISSERTATION ABSTRACTS INTERNATIONAL



B

The Sciences and
Engineering

UMI[®]

Volume 63

Number 11

May 2003

Dissertation Abstracts International Section B (ISSN 0419-4217) is published monthly by ProQuest Information and Learning, 300 North Zeeb Road, Ann Arbor, Michigan 48106-1346 U.S.A. Telephone: 734-761-4700. No part of this publication may be reproduced by any means (printed, electronic, or any other) without prior written permission of the publisher.

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INTRODUCTION

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Dissertation Abstracts International (DAI) is published monthly by ProQuest Information and Learning and includes abstracts of doctoral dissertations submitted to UMI by 550 participating institutions in North America and throughout the world.

Each author-prepared abstract, up to 350 words in length, describes in detail the original research project on which the dissertation is based. Most of the approximately 45,000 dissertations published by UMI each year are abstracted in *DAI* and may be purchased in microform or as paper copies.

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III — Health and Environmental Sciences

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Section C—*Worldwide* (formerly *European Abstracts*) is published quarterly and includes abstracts of dissertations in all disciplines accepted for doctoral and post-doctoral degrees at institutions throughout the world. Most of these dissertations are not available from UMI; those which are for sale are also listed in Section A or B. Beginning with Volume 50 (Spring 1989), *DAI—C* was expanded to include institutions worldwide.

Arrangement of Entries

Entries in *Dissertation Abstracts International* are grouped by author-selected subject. The subject categories are listed elsewhere in these introductory pages. Not every subject category will appear in every issue of *DAI*. Within each

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All bibliographic data relating to a dissertation appear at the head of an entry. The abstract then follows. Each entry contains the following essential information:

- Title
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- Degree and date earned
- Institution granting the degree
- Number of pages in the original dissertation
- Reference to location of abstract in *DAI*
- Dissertation adviser
- UMI order number

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Each issue of *DAI* includes two indexes, both of which follow the main abstract text:

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Author Index. Each entry in the Author Index includes a *DAI* page and section reference. A *Cumulative Author Index* of Sections A and B combined is published annually at the end of the volume year (July-June).

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Academic institutions join UMI's publishing program on an ongoing basis. Some schools publish all of their dissertations, while others choose to publish only current ones. Dissertations accepted by British institutions are made available through UMI in association with The British Library. A comprehensive list of participating institutions is located elsewhere in this introductory section.

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UMI's dissertation database is a computerized file containing bibliographic citations to over 1.5 million North American doctoral dissertations dating back to 1861. In addition, citations to over 70,000 masters theses are included. More than 45,000 dissertation citations and 12,000 masters thesis citations are added to UMI's dissertation database each year. New citations are entered into the database each month.

There are a number of ways to search the dissertation database for citations. Following is a brief outline of UMI's Search Services.

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Dissertations Direct is a computerized search specifically designed for collection development. By working with UMI's editorial and database experts, libraries and research centers can identify areas of special interest and create a customized collection.

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With access to BRS, Data-Star, Dialog®, OCLC EPIC, and STN® online information search services, researchers can conduct a direct and immediate search of UMI's dissertation database. Researchers can order dissertation copies directly through their terminal by using the DIALOG Dialorder service or BRS ORDER or the OCLC ILL subsystem.

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The landmark 37-volume *CDI 1861-1972* lists more than 417,000 dissertations under keyword headings and within a separate author index. The *CDI Ten-Year Cumulation 1973-1982* cites nearly 351,000 dissertations in a 38-volume single-source reference and the *CDI Five-Year Cumulation 1983-1987* includes over 162,000 citations in 22 volumes. Together, these powerful bibliographic tools allow access to approximately 930,000 dissertations spanning more than 125 years with just *three* separate searches. *CDI* supplements are published annually in both library-bound volumes and on microfiche.

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American Doctoral Dissertations, published annually on an academic-year basis, is arranged by subject category, institution, and author. It is compiled for The Association of Research Libraries.

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Library Science
Mass Communications
Music
Speech Communication
Theater

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Administration
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Agricultural
Art
Bilingual and Multicultural
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Elementary
Finance
Guidance and Counseling
Health
Higher
History of
Home Economics
Industrial
Language and Literature
Mathematics
Music
Philosophy of
Physical
Reading
Religious
Sciences
Secondary
Social Sciences
Sociology of
Special
Teacher Training
Technology

Tests and Measurements

Vocational

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Language
General
Ancient
Linguistics
Modern
Rhetoric and Composition
Literature
General
Classical
Comparative
Medieval
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American
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Philosophy of
Theology

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Canadian
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United States
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Public Administration
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Social Work
Sociology
General
Criminology and Penology
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 Forestry and Wildlife
 Plant Culture
 Plant Pathology
 Plant Physiology
 Range Management
 Soil Science
 Wood Technology

Biology

General
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 Animal Physiology
 Biostatistics
 Botany
 Cell
 Ecology
 Entomology
 Genetics
 Limnology
 Microbiology
 Molecular
 Neuroscience
 Oceanography
 Veterinary Science
 Zoology
 Biophysics
 General
 Medical

Earth and Environmental Sciences

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 Environmental Sciences
 Geochemistry
 Geodesy
 Geology
 Geophysics
 Hydrology
 Mineralogy
 Paleobotany
 Paleoecology
 Paleontology
 Paleozoology
 Palynology
 Physical Geography

Physical Oceanography

Health Sciences

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 General
 Audiology
 Dentistry
 Education
 Health Care Management
 Human Development
 Immunology
 Medicine and Surgery
 Mental Health
 Nursing
 Nutrition
 Obstetrics and Gynecology
 Occupational Health and Safety
 Oncology
 Ophthalmology
 Pathology
 Pharmacology
 Pharmacy
 Public Health
 Radiology
 Recreation
 Rehabilitation and Therapy
 Speech Pathology
 Toxicology
 Home Economics

Physical Sciences

Pure Sciences
 Chemistry
 General
 Agricultural
 Analytical
 Biochemistry
 Inorganic
 Nuclear
 Organic
 Pharmaceutical
 Physical
 Polymer
 Radiation
 Mathematics
 Physics
 General
 Acoustics
 Astronomy and Astrophysics
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 Atomic
 Condensed Matter

Electricity and Magnetism

Elementary Particles and High Energy
 Fluid and Plasma
 Molecular
 Nuclear
 Optics
 Radiation
 Statistics

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 Engineering
 General
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 Agricultural
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AGRICULTURE, AGRONOMY

Characterization of the mechanism of resistance of a johnsongrass (*Sorghum halepense*) biotype to selected graminicides in Virginia and response of mugwort (*Artemisia vulgaris*) to specific herbicidal and cultural control strategies. Bradley, Kevin Wayne, Ph.D., *Virginia Polytechnic Institute and State University*, 2000. 104pp. ISBN: 0-493-93000-0. Chair: E. Scott Hagood
Order Number DA3073091

Johnsongrass [*Sorghum halepense* (L.) Pers.] and mugwort (*Artemisia vulgaris* L.) are both rhizomatous perennial weeds that are capable of rapidly colonizing a variety of different environments. Separate experiments were conducted throughout Virginia from 1996 to 1999 to determine more effective methods for reducing infestations of these perennial weeds in the future. Field and greenhouse experiments conducted on a resistant johnsongrass population discovered in New Kent County, Virginia revealed that this biotype exhibits low levels of resistance to the aryloxyphenoxypropionate (APP) herbicides quizalofop-P and fluazifop-P and the cyclohexanedione (CHD) herbicide sethoxydim. Additional laboratory experiments revealed that resistance is not due to differential absorption, translocation, or metabolism of the APP and CHD herbicides in the resistant vs. the susceptible biotype. However, acetyl-coenzyme A carboxylase (ACCase) assays revealed that resistance to the APP and CHD herbicides is conferred by an overproduction of the ACCase enzyme in the resistant compared to the susceptible johnsongrass biotype. In field experiments conducted on mugwort infestations discovered in several counties throughout Virginia, 100% mugwort control was achieved with standard application rates of picloram at 4 months after treatment (MAT), and also greater than 70% mugwort control was achieved with the higher application rates of clopyralid, glyphosate, and dicamba at 4 MAT. However, all other herbicides evaluated in these experiments provided less than 65% mugwort control at 4 MAT, even at exceptionally high use rates. Additionally, the results from these trials revealed that sequential herbicide applications and sequential mowings prior to herbicide application are both effective mugwort control strategies.

Characterization and economic analysis of perennial weed populations in Kentucky no-till fields. Brommer, Chad Leslie, Ph.D., *University of Kentucky*, 2002. 93pp. ISBN: 0-493-90599-5. Director: William W. Witt
Order Number DA3070658

Perennial weeds are a continuing problem of no-till fields in North America. This study sought to characterize these weeds in Kentucky no-till fields. Weeds included in the study were hemp dogbane, trumpetcreeper, honeyvine milkweed, and Canada thistle. Ph and organic matter were good individual predictors of weed presence of trumpetcreeper, honeyvine milkweed, and hemp dogbane at the Shelby Co site. Buffered pH was influential for trumpetcreeper presence at the Calloway Co. site. Hemp dogbane populations tested with individual soil and hydrology attributes had significant odds ratios for pH ($P \leq 0.01$), Zn ($P \leq 0.05$), OM ($P \leq 0.001$), and CTI

($P \leq 0.1$) at Shelby Co. Multiple regression analysis had a goodness of fit value of $Pr > \chi^2 = 0.999$. The combination of all perennial weed species, across both Calloway and Shelby Co. sites produced a multiple logistic regression prediction model with a goodness of fit $Pr > \chi^2 = 0.738$. Location of perennial weeds in Kentucky no-till fields has correlations to soil and terrain attributes with pH being correlated with perennial weeds more than any other attribute in this study.

Crop yield reductions from the presence of perennial weeds are a central issue for producers. Three trumpetcreeper plants per square meter, soybean yield loss was in the 10-15% range for the Shelby Co. but, between no loss and 6% reduction for the Calloway site. Across locations in Calloway and Shelby Co., trumpetcreeper did not reduce yield unless three plants per square meter were present. Canada thistle reduced yield of corn and soybean with one plant per square meter. One or two hemp dogbane plants per square meter did not measurably reduce soybean yield. Corn yield reduction from hemp dogbane was monitored at Shelby, Calloway, and Woodford Co. One or two honeyvine milkweed plant per square meter reduced corn yield 16 percent and 24 percent, respectively. Corn yield reductions from field bindweed were not high enough to be measured at either one or two plants per square meter. There is not a strong economic basis for using herbicides to control these perennial weeds, post harvest, at densities up to 3 plants per square meter.

Introgression of wheat D-genome chromosomes into 'Presto' triticale and genetic and environmental effects on agronomic and end-use quality characteristics of diverse winter wheat genotypes. Budak, Hikmet, Ph.D., *The University of Nebraska - Lincoln*, 2002. 55pp. ISBN: 0-493-89761-5. Supervisor: P. Stephen Baenziger
Order Number DA3070123

Hexaploid triticale (*X Triticosecale* Wittmack) ($2n = 6x = 42$, AABBRR) and wheat (*Triticum aestivum* L.) ($2n = 6x = 42$, AABBDD) differ in their R and D genomes. An unanswered question is whether introgressions of the D-genome chromatin could improve triticale. Our objective was to determine optimal chromosomal make-up (the best A, B, D or R composition) for agronomic performance and end-use quality characteristics of 'Presto'. We evaluated the effects of D-genome chromosome substitutions on agronomic performance and end-use quality of 16 substitution genotypes, their twelve controls for the substitutions, and five check cultivars at Lincoln, in 1996, 1997 and 1998 and at Mead in 1998. Most of the D-genome chromosomes in Presto reduced or had little effect on Presto's performance. As expected, chromosomes 1D and 6D introgressions improved end-use quality characteristics of Presto.

Wheat (*Triticum aestivum* L.) genotypes with short mixing times usually have low mixing tolerance values, which make them more sensitive to over-mixing in commercial bread production. We evaluated the genotypic and environmental effects on agronomic performance and end-use quality of 27 genotypes which were identified in an initial screen as having short mixing times and good mixing tolerances to: (1) determine if genotypes identified in a preliminary end-use quality screen as lines with usually long tolerances but short mixing times were due to their genotype (G), the environment

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and the numerical model. The modified dynamic model is shown to be successful in simulations of turbulent channel flow.

The physical models proposed herein provide accounting of the numerical method's implicit filtering characteristics as well as discounting of the numerical method's dissipative nature.

Impact response of a laminated beam on an elastic foundation. Tudela, Mark Allen, Ph.D., *Georgia Institute of Technology*, 2002. 488pp. ISBN: 0-493-92387-X. Director: Jianmin Qu
Order Number DA3072364

An experimental and numerical investigation of the impact response of laminated composites on an elastic foundation is performed. The impact configuration uses a modification to the split-hopkinson bar setup and laser vibrometers are used to measure the displacements during the test. The histories of contact force, front face and back face displacement are recorded. This allows the indentation to be recorded during the impact event. The damage state is also recorded after each test is complete.

Numerical simulations of the impact event are conducted with the LS-DYNA commercial finite element software. Information obtained from the impact tests is used along with the finite element results to predict the displacement and indentation response along with the damage state.

The experimental results show that damage can be detected via the force-time response, FFT analysis of the force-time response and the indentation-time response. The indentation is found to be the most sensitive means to detect real-time damage. Results from the damage study show that the foundation has a marked effect on the damage state. Analysis of the stresses beneath the contact point along with the experimental results suggest that the elastic foundation can alter the damage evolution due to the redistribution of stresses. A mechanistic explanation of failure is provided based on the overall results from both the experimental and analytical work.

Laser-assisted micromachining for subsurface silicon-embedded structures. Vakanas, George Petrou, Ph.D., *Arizona State University*, 2002. 128pp. ISBN: 0-493-89629-5. Adviser: Ampere A. Tseng
Order Number DA3069864

The Semiconductor Industry Association (SIA) in their 2001 Roadmap identifies micro-electromechanical systems (MEMS) as the emerging technology of Performance-on-Chip (PoC) systems. Unlike logic/memory semiconductors, the diversity of MEMS structures and functionalities renders high-volume manufacturing (HVM) infeasible. In light of the above constraint, this dissertation focuses on developing low-volume and low-cost laser-assisted capabilities for fabrication, repair and restructuring of packaging and components of mesoscale (10–100µm) MEMS simultaneously. Such capabilities stand as competitive alternatives to current MEMS encapsulation techniques.

The proposed Laser-Assisted Micromachining for Subsurface Silicon-Embedded Structures (LAMSES) is a synthesis of transmission laser heating/bonding (TLH/B), laser-assisted chemical etching (LACE) and buried silicon micromachining (BSµM) concepts. LAMSES is capable of micromachining silicon structures embedded between silicon substrates and silicon oxide (SiO₂) transparent films. The process generates only local-heating on the micromachined surface of active devices (e.g. flip-chips) and is thus compatible with the Complimentary Metal-Oxide Semiconductor (CMOS) industry standard. The feasibility of LAMSES is demonstrated by fabricating the basic cell of arrayed mesoscale fluidic structures, which comprises two trenches in silicon, connected with a subsurface microchannel, embedded between silicon and overhanging silicon-oxide. LAMSES demonstrated fabrication of subsurface microchannels up to 500µm long with an aspect ratio of 100:10:1. Trench sidewall angles within 10 degrees of the vertical were achieved, thus exceeding the capabilities of both Q-switched laser silicon processing and dicing-saw wafer grooving.

LAMSES also demonstrated nearly mirror-like ($\lambda/10$) floor roughness, comparable to anodic bonding. The achieved aspect ratio, sidewall angle and floor roughness of the silicon structural cell meet the requirements for mesoscale fluidic MEMS applications, such as microheatpipe arrays for electronic cooling, photonic switching platforms and biochemical analysis MEMS structures, whose fabrication schedules are presented.

Control of the process was achieved with a one-dimensional opto-thermal model, stoichiometry and first-order chemical kinetics. The model predicts the material removal rate of silicon in a chlorine atmosphere to within 10% of experiments. Supplementary Q-switched Nd:YAG experiments demonstrated an auxiliary drilling and grooving capability with LabVIEW-based

control. The dissertation finally explores extending LAMSES to new materials, smaller scales and less-costly solutions and addresses remaining challenges such as non-destructive metrology of the achieved subsurface microstructures.

A study on the suitability of geopolymers for structural steel fire protection. Varela, Benjamin, Ph.D., *New Mexico State University*, 2002. 100pp. ISBN: 0-493-91863-9. Chair: A. Burl Donaldson
Order Number DA3072029

Geopolymers are a novel family of inorganic polymeric materials with promising engineering applications. In this study two geopolymers of the Na-PSS and Na-PSDS types were synthesized using commercially available materials and cured at 65°C. Analytical techniques such as solid state nuclear magnetic resonance, X-Ray diffraction analysis, energy dispersive analysis and scanning electron microscopy were used in order to characterize the material and for comparison with previously published information. The resultant products are amorphous to semi-crystalline three dimensional structures with polymeric S-O-Al bonds that exhibit good bonding to a steel substrate.

Experimental and analytical techniques used to measure the thermal stability, density, thermal conductivity, thermal diffusivity, heat capacity and reaction kinetics indicate that geopolymers of the Na-PSDS type are suitable for the protection of steel structures due to a combination of low thermal conductivity, foaming capacity, high thermal stability and integrity after flame exposure.

Analysis of the residual stresses in silicon wafers using shadow moiré technique. Vrinceanu, Isabela Diana, Ph.D., *Georgia Institute of Technology*, 2002. 154pp. ISBN: 0-493-92434-5. Director: S. Danyluk
Order Number DA3072368

Many problems of defective device in silicon integrated circuits can be traced ultimately to stresses that develop in various stages of processing. This thesis considers the plate theory assumption that the behavior of a plate when transversal loaded at its center is different when the plate is initially in-plane stressed than when it is free of stress (an example is a drumhead, which gains lateral stiffness as it is tightened).

This thesis concerns extracting residual stress from the analysis of the out-of-plane deformation of plates loaded at the center. Material anisotropy is also considered by this thesis. In a first order approximation, it can be shown that for thin circular anisotropic plates the generalized Hooke's law simplifies to an isotropic-like Hooke's law for which equivalent material properties can be defined. The full anisotropic material properties are considered in the plate theory. The thesis seeks determination of the relationship between the initial in-plane tensions and the characteristic strain fields using linear plate theory (small deflections approach) and non-linear plate theory (large deflections approach). Shadow moiré is used to measure the deformed surface shape of the silicon wafers. A full field phase information is used to obtain the deflection displacement of the plate due to a central transversal load. A self-balanced residual stress is calculated using the displacement as an input in the von Kármán elastic plate theory.

Thin-film adhesion measurement by laser-induced stress waves. Wang, Junlan, Ph.D., *University of Illinois at Urbana-Champaign*, 2002. 154pp. ISBN: 0-493-90272-4. Advisers: Nancy R. Sottos; Richard L. Weaver
Order Number DA3070468

Thin films are crucial components in a wide range of multilayer micro-electronic and optical devices. The size scales and dissimilar nature of the constituents present great challenges regarding thermomechanical integrity and reliability. Interfacial adhesion is a critical parameter governing the mechanical behavior and reliability of a thin film on a substrate. Laser spallation techniques have been developed to investigate the intrinsic strength of planar interfaces using laser generated stress waves. In all of the laser spallation experiments reported in the literature, only normal pressure pulses were applied to the films. Consequently, the interfaces were subjected to only tensile (mode I) loading. In most commercial applications, however, thin film interfaces fail under mixed-mode conditions. The goal of this research is to develop the use of laser generated stress waves to characterize intrinsic interfacial strength of thin films under mixed-mode conditions.

A rigorous theoretical analysis of stress wave generation, propagation and attenuation is carried out followed by a systematic experimental study of tensile spallation. Theoretical analysis provides meaningful insight into the nature of the wave propagation, while the experimental study reveals important design variables for interface strength. Boeing Ex. 1049, pp. 21 of 24

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developing the mixed-mode loading experiments. Of particular importance is that fused silica substrates, with their negative nonlinear elasticity, cause the compressive stress wave generated by the pulsing laser to evolve a decompression shock, which is critical for generation of fast fall times needed for significant loading of thin film interfaces.

Based on the theoretical and experimental parametric study results, the planar tensile sample geometry is modified to a triangular prism so that a high strain rate shear wave is generated and then allowed to impinge upon the test film. By allowing the initial longitudinal wave to mode convert to a shear wave and a secondary longitudinal wave at the oblique surface, mixed-mode loading of the thin film interface is realized. Film failure under mixed-mode conditions is observed and the mixed-mode interfacial strength is measured and compared with the tensile case.

Set mapping in the method of imprecision. Wang, Xiaou, Ph.D., *California Institute of Technology*, 2003. 128pp. ISBN: 0-493-89104-8. Adviser: Erik K. Antonsson
Order Number DA3069429

The *Method of Imprecision*, or M_oI , is a set-based approach which uses mathematics of fuzzy sets to aid the designer making decisions with imprecise information in the preliminary design stage.

The M_oI uses preference to represent the imprecision in engineering design. The preferences are specified both in the design variable space (DVS) and the performance variable space (PVS). To reach the overall preference, the mapping between the DVS and the PVS should be explored. In the preliminary stage, the specifications are imprecise and resources are limited. An interpolation model is introduced to the M_oI to construct metamodels for the actual mapping function. Due to the nature of engineering design, multistage metamodels are needed. Experimental design is used to choose design points for the first metamodel. Several sampling criteria are discussed and tested on two specific examples.

The metamodels can be used to induce preferences in the DVS or the PVS according to the extension principle. The Level Interval Algorithm (LIA) is a discrete approximate implementation of the extension principle. The resulting preference by the LIA is presented as α -cuts. There are some limitations of the LIA, especially for multidimensional DVS and PVS. A new extension of the LIA is proposed to compute α -cuts with more accuracy and less limitations. The designers have more control over the trade-off between the computational cost and accuracy.

The results of the M_oI should be sets in the DVS and in the PVS at a certain preference level. The information about preferences in the DVS and the PVS is needed to transfer back and forth. Usually the mapping from the PVS to the DVS is unavailable, while it is needed to induce preference in the DVS from the PVS. A new method is constructed to compute the α -cuts in both spaces.

Finally, a new measure is proposed to find the most cost-effective sampling region of new design points for a metamodel. Then the M_oI is applied to the structure design of a passenger vehicle.

Numerical study of pulverized coal-litter biomass blend combustion and pollutant emissions in a swirl burner. Wei, Gengsheng, Ph.D., *Texas A&M University*, 2002. 286pp. ISBN: 0-493-92279-2. Chair: Kalyan Annamalai
Order Number DA3072553

Combustion of pulverized coal-biomass blend is one of the most attractive new technologies to the electric power industry to reduce fuel cost and pollutant emissions. In this work the biomass considered is broiler litter called litter biomass or LB. Two tasks were performed: (1) formulation study of a mixture fraction PDF method for pulverized fuel combustion modeling and its simplification for three mixture fraction problems, (2) numerical study of pulverized coal-LB blend combustion and pollutant emissions in a swirl burner.

In the study of the mixture fraction PDF method, a system of arbitrary number mixture fractions is considered. General equations and procedures to solve turbulence mean chemical properties based on fast chemistry assumption are obtained. In the numerical study which is the major part of this work, the PCGC2 model for pulverized fuel combustion is modified by incorporating a moisture vaporization model, considering more char reactions, implementing adiabatic boundary condition, and including PO_2 and P_4O_{10} calculations. The generalized mixture fraction PDF method is reduced to three mixture fractions which track primary air, fuel mixture offgas, and vaporized moisture, respectively. The PCGC2 program is significantly modified.

Numerical predictions are conducted and a fairly good agreement with experimental data is achieved for the TAMU 100,000 BTU/hr (30 kW)

boiler burner facility. The major features of moisture vaporization and its effects on flame structure and species emissions are successfully captured. The reaction $2C + O_2 \rightarrow 2CO$ is generally the only important char reaction whereas the steam-char reaction is found important at some near-burner locations where water vapor concentration is high and O_2 concentration is low. At furnace exit most phosphorous emissions are in the form of PO_2 at a few hundred ppm while emission of P_4O_{10} is very low (a few ppm).

Parametric study is carried out numerically to determine effects of key parameters on combustion behavior and pollutant emissions. It is found that increasing the moisture level in fuel blend delays combustion causing longer flame length, lower burnout, more CO, more P_4O_{10} , less PO_2 , and less NO emissions. Changing the moisture level in biomass only has negligible influence on combustion and pollutant emissions if the co-firing ratio is low. Increasing the swirl number leads to stronger recirculation flow near the burner, higher burnout, lower CO, slightly lower P_4O_{10} , slightly higher PO_2 , and higher NO emissions. Increasing excess air level causes stronger recirculation flow, stronger fuel-air mixing, a shorter flame length, higher burnout, lower CO, higher P_4O_{10} , lower PO_2 , and higher NO emissions.

A study of buoyancy and shear driven turbulence within a closed water channel. Wilson, Peter Nixon, Ph.D., *Texas A&M University*, 2002. 227pp. ISBN: 0-493-92281-4. Chair: Malcolm J. Andrews
Order Number DA3072555

We examine experimentally and describe theoretically the properties of turbulence developing from buoyancy-driven and shear-driven instabilities that can occur at the interface between two fluids. In particular, we examine those circumstances found in our experimental and numerical investigations that depart from spectral equilibrium. To calculate the stochastic behavior of turbulence, it is necessary to model the equations governing the correlations of turbulent fluctuations, which interact with pressure gradients and/or mean-flow shear. To evaluate the suitability of a model for representing the physics of a very complex flow, it is necessary to have experimental data for comparison with calculated results. Turbulence is comprised of many scales, or spectra, of correlated motion; the dominant, or large scales receive most of their energy from the mean-flow kinetic and/or potential energy. Quantifying the rate of energy transference from large scales to small-scale motion is one of the problems that all models have to address. Most models (e.g., the K- ϵ model) assume self-similarity for the turbulent spectra, and that the rates of cascade in these spectra are governed solely by the dominant scales—an assumption which can be violated in a variety of circumstances. The principal source of violation that we investigate occurs when there is a combination of shear and buoyancy-driven turbulence.

Large eddy simulations of particle dispersion and deposition in a turbulent square duct flow. Winkler, Chad Michael, Ph.D., *University of Illinois at Urbana-Champaign*, 2002. 175pp. ISBN: 0-493-90103-5. Adviser: S. P. Vanka
Order Number DA3070061

In the current dissertation work, the preferential concentration and deposition of heavy solid particles in a downward, fully developed turbulent square duct flow are studied using large eddy simulations. A second-order accurate, finite-volume based fractional step scheme, based on an unstructured Cartesian mesh, is used to integrate the unsteady, incompressible, three-dimensional Navier-Stokes equations. An algebraic multigrid solver is used to solve the Poisson equation resulting from the fractional step method. The subgrid stresses are modeled with a dynamic subgrid kinetic energy model. The particle equation of motion includes drag, lift and gravity forces and is integrated using the fourth-order accurate Runge-Kutta method. The Reynolds number for the square duct is 360, based on average friction velocity and duct width. The grid used is $80 \times 80 \times 128$ in the two wall-normal and streamwise directions, respectively.

The preferential concentration of particles is studied assuming that the particles do not modify the turbulence and that particle-particle collisions are insignificant. The continuous and the dispersed phases are treated using Eulerian and Lagrangian approaches, respectively. Four cross-sectional locations representative of the time-mean secondary flow patterns and six particle response times were chosen to study the effect of location and particle inertia on preferential concentration. Variation of vorticity magnitude, swirling strength, strain-rate, and $\nabla u : \nabla u$, and their probability distribution functions (PDF), with particle response time and location is shown to demonstrate preferential concentration. Particles are seen to accumulate in regions of high $\nabla u : \nabla u$ and strain-rate and in regions of low swirling strength. In general, particles accumulate in regions of low vorticity magnitude. However, near the wall, large particles accumulate in regions of

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