

## ICCE/3 KEYNOTE LECTURES

"Sol-Gel Route to 2D or 3D Functional Ceramic Matrix Composites with Tailored Fibre-Matrix Interphase and Interface" Philippe COLOMBAN (ONERA, France).....	7
"Textile, Toughness and Delocalization of Damage" Brian COX (Rockwell Int., CA).....	9
"Some Topics on Metal Matrix Composites" Mikio MORITA (Toyama Prefectural U., president Japan Society of Composite Material).....	17
"On the Micromechanical Failure Modes in a Class of Ideal Brittle Matrix Composites" Nick PAGANO (Wright Lab, OH).....	21
"Bolted Patch Repair of Composite Structures" Cheung POON, Y. Xiong (Nat. Res Council, Canada), M. Lucking (CAE, Alberta, Canada).....	29
"Bridging the Science-Engineering Breach: New Durability and Damage Tolerance Concepts and Methodologies" Ken REIFSNIDER (Virginia Tech.).....	31
"Development, Applications, and Challenges of Composite Materials in the Offshore Industry" Mamdouh M. SALAMA (Conoco Inc., OK)	
"Thermoplastics as Engineering Materials: the Mechanics, Materials, Design, Processing Link" Vijay STOKES (General Electric, NY).....	33
"Evaluating Advanced Composites for Applications in Transportation Structures" Mohsen SULTAN (CALTRAN, CA) THURSDAY EVENING BANQUET KEYNOTE	
"Composite Materials for the Transportation Industry: Status of Research and Application in Germany" Peter J. WINKLER (Daimler-Benz, Germany).....	35
"Overview of Size Effects in Composite Materials" Carl ZWEBEN (Lockheed Martin Astro Space, PA).....	37

## ICCE/3 DISTINGUISHED LECTURERS

Hanz BAUER (Audi Automobile, Germany).....	1
Deborah CHUNG (SUNY-Buffalo, NY).....	3
Lawrence T. DRZAL (Michigan St.U.).....	11
Vistasp KARBHARI (UC San Diego, CA).....	13
Koichi NIIHARA (Osaka U., Japan).....	19
Michael R. PIGGOTT (U. Toronto, Canada).....	25

## ICCE/3 ACCEPTED PAPERS FOR ORAL PRESENTATIONS

### AGING, DURABILITY AND FLAMMABILITY

"Creep and Stress Relaxation in Thick-Walled Composite Cylinders" Jerome TZENG (US Army Res Lab, MD).....	867
"Axial Creep-Rupture Lifetime of Boron Fiber Reinforced Aluminum Matrix Composites" Koichi GODA (Yamaguchi U.), Jun-ichi Hamada (Nippon Steel, Japan).....	309
"Viscoelasticity of Fibrous Polymeric Composites: A Theoretical Approach" Andrzej P. WILCZYNSKI (Warsaw U. Tech, Poland).....	927
"Creep Performance of Natural Based Composites" Benjamin Tobias, Vinh T. LIENG (Victoria U. Tech., Australia).....	517
"Aging Behavior of Squeeze Cast SiCw/AZ91 Magnesium Alloy Composite" Kun WU, Mingyi Zheng, Min Zhao, Congkai Yao (Harbin, China), Jihong Li (Shengyang, China).....	939
"Influence of the Casting Shape on the Creep Properties of Single Crystal Nickel Base Superalloy CMSX-6" Abdel-Fatah M. HASHEM (Minia U., Egypt).....	349
"The Qualification of Advanced Composite Pipe for Use in Fire Water Deluge Systems on Open Type Offshore Oil Platforms" Michael A. Stubblefield, Chihdar YANG, Su-Seng Pang (LSU, LA), V. Trent Montgomery (Southern U., LA) Richard H. Lea (Specialty Plastics, LA).....	945
"Fire Hard Composites for Marine Applications" Aram MEKJIAN (BP Chemicals, NJ).....	575
"Structural Performance of Composites at Elevated Temperatures due to Shipboard Fires" Usman SORATHIA, T. Dapp (Naval Surf. War. Cen., MD).....	783
"Analysis of Strain Wave Propagation in Polymeric Materials" Eric N. HARSTAD (Los Alamos N.L., NM), J.C. Foster Jr., L.L. Wilson (Wright Lab, FL), P.J. Maudlin (Los Alamos), H.L. Schreyer (U. New Mexico).....	345
"The Use of Impact Techniques in the Characterization of the High Rate Mechanical Behavior and Ignition Threshold of High Explosive Composites" Joseph C. FOSTER (Wright Lab, FL), Leonard L. Wilson (SAIC/Eglin, FL).....	281
"Fire Resistant Fiberglass Pipe Technology Advances" Joie L. FOLKERS (Ameron Fiberglass Pipe Div., TX).....	279
"American Bureau of Shipping (ABS) Rules for Marine Construction" William J. LIND, Derek S. Novak (ABS, New Orleans).....	993
"Developing a Plan for a Fire Research, Test and Training Facility at the Naval Air Warfare Center Weapons Division, China Lake" Gill CORNELL (Naval Air Warfare Cen, CA).....	193
"Fire Effects on Molecular Composites: Liquid Crystal Polymers" John J. RUSEK (Naval Air Warfare Cen., CA).....	523

## BIO-COMPOSITES

Chairs: Dr. Kunio WAKASA (Hiroshima U., Japan)  
Dr. Shisei KUBO (Nagasaki U., Japan)

- "Resin-Enamel Adhesive Strength: Effects of Location and Tested Surface Area"** Yasuo SHONO, M. Terashita, P. Brewer, David H. Pashley (Medical Coll. Georgia)..... 761
- "PRIMM(TM) Technology Augmentation of Dental Composite Resins"**  
Daniel C.N.CHAN, R.G. Ritsco, M.B. Lyles, Kevin D. Rathbun  
(U.Texas-San Antonio)..... 141
- "Application of the PRIMM(TM) Technology to Bone Cements"**  
Kevin RATHBUN, Mark B. Lyles, Ron G. Ritsco, Joe W. Tippett (Mat. Evolution  
Dev, TX) ..... 699
- "Fiber Composites in Prosthetic Dentistry: Impregnation of Glass Fibers with Dental  
PMMA Resin"** Pekka K. VALLITTU, A. Yli-Urpo (U. Turku, Finland) ..... 877
- "Changes on Dentine Morphology Molecular Composition and Collagen  
Conformation Induced by Acidic Conditioners"** G. Eliades, Georgios  
PALAGHIAS, G. Vougiouklakis (EKEVYL, Greece) ..... 659
- "Neural Network Application on Fracture Mechanics Analysis of an Orthotropic Elastic  
Media with Three Cracks under Biaxial Loading"** M. Sayeed Hasan (Indiana St.U.),  
Abdullah FARAQUE (Missis. Valley St.U.)..... 263
- "Measurement of Microhardness on the Resin-Dentin Bonded Area of Human Dentin by  
Nano-Indentation"** Naotake AKIMOTO, Yusuko Momoi, Atsushi Kohno, (Tsurumi  
U., Japan), Shiro Suzuki, Charles F. Cox (U. Alabama-Birmingham) ..... 55
- "Fracture Analysis of Cracked Macadamia Nutshells"** Rong LIU (Deakin U., Australia),  
Chun H. Wang (DSTO, Australia), R.G. Bathgate (Deakin U.)..... 531
- "The Study of the Eye Lens Elastic Behavior"** Michaela BARITZ, Mircea Gh. Munteanu (T.U.  
Brasov, Romania) ..... 97
- "A Modified Biphasic Formulation for the Steady State Swelling Response of the Intact  
Cornea"** Michael R. BRYANT, Peter J. McDonell (U. Southern Calif.) ..... 133
- "Development of Antibacterial Dental Composite Containing Immobilized Bactericide"**  
Satoshi IMAZATO (Osaka U., Japan) ..... 383
- "Wear Characteristics of Dental Composites: Two-Body vs Three-Body Test"** Shisei  
Kubo, Hiroaki YOKOTA, Yoshihiko Hayashi (Nagasaki U., Japan)..... 961
- "Microleakage of Cervical Composite Resin Restorations"** Shisei KUBO, Hiroaki Yokota,  
Tahek Watanabe, Yukiko Konishi, Masahiro Ohsawa, Yoshihiko Hayashi (Nagasaki U.,  
Japan)..... 473
- "Function of the Resin-Impregnated Zone as a Stress-Absorbing Layer in Resin-Dentin  
Bonding"** Shigeru UNO (Hokkaido U., Japan), Werner J. Finger (RWTH  
Aachen, Germany)..... 871
- "Analytical Model of Fracture at the Dentine/Resin Composite Interface"** Kunio  
WAKASA, Y. Yoshida, M. Yamaki (U. Hiroshima, Japan)..... 893
- "Resin-Dentin Interface Revealed by Argon Ion Etching"** Shigehisa INOKOSHI (Tokyo  
Medical Dental U., Japan) ..... 385
- "Effect of Particle Size and Shape Variations on in Vitro Wear of Dental Composites"** S.  
Suzuki, Daniel A. GIVAN (U. Alabama-Birmingham) ..... 307

- "Hydrolytic Degradation of Dental Composites"** Nikhil Sarkar, X. Xu (Louisiana St.U.) L. Li  
(U. New Orleans), Fred SHIH (US Dept. Agriculture, LA)..... 753
- "Metal-Matrix Interface Bonding in Reinforced Glass Ionomers"** Nikhil SARKAR, L.F.  
Wallace, P.E. Schneider (Louisiana St.U., N. Orleans) ..... 660
- "Wear of Composite Luting Cement"** Masayuki OTSUKI (Tokyo Med. Dental U., Japan), S.  
Suzuki, S.H. Suzuki (U. Alabama-Birmingham), J. Tagami (Tokyo), C.F. Cox  
(U. Alabama-Birm.)..... 651

## BUCKLING and STRUCTURAL OPTIMIZATION

chairs: Alex BOGDANOVICH (AdTech, OH), Su-Seng PANG (Louisiana St.U.)

- "Analytical Solution to Anti-Symmetric Plates with Non-Navier and non-Levy Type  
Boundary Conditions"** H.R.H. KABIR (Kuwait U.) ..... 425
- "Stacking Sequence Optimization by using GA with Repair Method"** Akira TODOROKI  
(Tokyo I.T., Japan), Raphael T. Haftka (U. Florida)..... 847
- "Genetic Algorithms in Optimization Problems of Composite Thin Walled Structures-the  
Influence of Transverse Shear Deformations"** Aleksander MUC (Cracow  
U.T., Poland) ..... 607
- "Multiobjective Optimization of Laminated Cylindrical Shells for Maximum Buckling  
Loads"** Mark WALKER, Talmon Reiss (Tech. Natal, S. Africa) ..... 895
- "Infinite Angle-Ply Laminates on Elastic Foundation with a Transverse Load"** Chun-Fu  
CHEN, J.S. Liou (Chung-Hua Poly Ins., Taiwan)..... 151
- "Thermal and Mechanical Buckling Analysis of Hat-Stiffened Panels with Varying Face  
Sheet Geometry and Fiber Orientations"** William L. KO (NASA-Dryden, CA) .... 451
- "Design of Composite Cylindrical Shells for Minimum Buckling Sensitivity"**  
Sarp ADALI, A. Richter, V.E. Verijenko, M. Walker (U. Natal, S. Africa)..... 45
- "Whirl Speeds of Rotating Composite Shafts under Axial Loads"**  
Lien-Wen CHEN, W.K. Peng (Nat Cheng-Kung U., Taiwan)..... 157
- "Bearing-Induced Buckling of Composite Laminates"**  
Steve C. LIPP, Paul D. Herrington (U. New Orleans) ..... 527
- "Large Deflections of Thin FRP Panels under Extreme Pressure"**  
Howard G. Allen, Zheng-Nong FENG (U. Southampton, UK) ..... 271
- "Buckling Loads of Thin Composite Shells with Arbitrary End Conditions"**  
Chandra B. SHARMA, M. Darvizeh, A. Darvizeh (UMIST, UK) ..... 747
- "Use of Foam Insulation to Resist Buckling of Deep Water Pipelines"**  
Mendel NOCK (Kvaerner-R.J. Brown, TX)..... 633

## CERAMICS

chair: Allen YU (U. Tennessee)

- "Problems of the Fibre-Matrix Bonding in a Ceramic Matrix Composite"** B. Wielage, Uta  
ZESCH, U. Jungnickel (T.U. Chemnitz-Zwickau, Germany)..... 975

"Research and Development of Si <sub>3</sub> N <sub>4</sub> Ceramic Valves for a AUDI 4 Cyl.-5 Valve-Motor" Hanz BAUER, H.G. Haldenwanger (Audi Automobile, Germany) DISTINGUISHED LECTURER .....	1
"Progressive Damage in Cross-Ply Ceramic Matrix Composites" N. Allen YU (U. Tennessee) .....	926
"Crack Bridging of CMCs with Elongated Reinforcements" Hongxiang ZHAI (Northern Jiaotong U., China), Young Huang, Changan Wang (Tsinghua U., China), Xin Wu (U. Michigan) .....	977
"Some New Perspectives on the Strength and Fracture of Nicalon Fibers" Seth T. TAYLOR, Yuntian Zhu, D.P. Butt, Michael G. Stout, W.R. Blumenthal, Terry C. Lowe (Los Alamos Nat L., NM) .....	837
"SiC Whisker Reinforced Si <sub>3</sub> N <sub>4</sub> Ceramics Fabricated by Slip-Casting and Pressureless Sintering Method" Takehiko HIRATA, M. Miyachi, A. Akiyama, H. Yamamoto (Mitsubishi Heavy Ind, Japan) .....	361

## CHEMICAL BEHAVIOR AND COATINGS

chairs: Charles PITTMAN (Mississippi St.U.)  
Lawrence T. DRZAL (Michigan St.U.)

"Surface Chemistry of Carbon Fibers after Electrochemical and Plasma Oxidation" Charles U. PITTMAN Jr., Guoren He, Wenbo Jiang, Steven D. Gardner (Mississippi St.U.) .....	681
"The Effect of Degassing Treatment and Extrusion Ratio on Tensile Properties of SiCp/2024 AL Composites Fabricated by Powder Extrusion" Byong-Kwon SUH, Yong-Tak Cho, Chi-Hwan Lee (Inha U., Korea) .....	805
"A Study on the Heat Treatment of Plasma Sprayed Chromium Oxide Coatings" Han-Sam KIM (Inha Tec. Col, Korea), Ik-Hyun Oh, Soo-Sik Kim (Inha U., Korea) .....	447
"Some Co-ordination Polymers Prepared from BIS-(B-Diketones)" A. HACHEMI, A. Addala (U. Ferhat Abbes, Algeria), M. Gross (Strasbourg, France) .....	331
"The Interaction between Porous Graphite Substrate and Copper Alloys Containing Active Elements" Natalia SOBCZAK (Cracow, Poland), P. Rohatgi (U. Wisconsin-Milw.), J. Sobczak, M. Ksiazek, W. Radziwill (Cracow, Poland) .....	777
"Role of a TiB <sub>2</sub> /TiB-Coating System in SiC Fibre Reinforced Titanium Alloys" Andreas WERNER, P. Mogilevsky, H.J. Dudek (Koln, Germany) .....	923
"The Role of Chemical Bonding at the Fiber-Matrix Interface on Adhesion in Carbon Fiber/Thermoset Matrix Composites" Lawrence T. DRZAL (Michigan St.U.), Naoki Sugiura (Mitsubishi, Japan), Daniel Hook (Michigan St.U.) DISTINGUISHED LECTURER .....	11
"Wetting and Interfacial Chemistry in the CuTi/BN System" Natalia Sobczak, Ewa BENKO (Cracow, Poland), Sudipta Seal, Terry Barr (U. Wisconsin-Milw.) .....	111
"Composite Phospho-Nitrided Layers on Ferrous Alloys" Jerzy NOWACKI (T.U. Lodz, Poland) .....	639
"Carbon Fiber Surface Oxidation: Synergism of Nitric Acid and Oxygen Plasma Treatments" Steve D. GARDNER, Eric D. Perakslis, Charles U. Pittman Jr. (Mississippi St.U.) .....	293

"Non-uniform Displacements in Copper-Carbon Solid Solutions" David Fuks (Ben-Gurion U., Israel), Simon DORFMAN (Technion, Israel) .....	225
"The Role of Chemical Kinetics in the Modeling of Chemical Vapour Infiltration of Ceramic Matrix Composites" A. Baldi, Andrea LAZZERI, Donato Aquaro (U. Pisa, Italy) .....	493
"Thermo Physical Characterization of Barium Titanate-Cobalt Ferrite Composite Ceramics" A. Hanumaiah, T. Bhimasankaram, S.V. Suryanarayana, G.S. KUMAR (Osmania U., India) .....	477
"Environmental Coating Protection for High Temperature Composites: Choice, Design and Production" Louis F. POCHET, P. Howard (Chromalloy Gas Turbine, NY), S. Safaie (SUNY-Rockland, NY) .....	683
"Studies of the Twin-Wire Electric Arc Spraying of Zinc/Aluminum Composite Coatings" Dominic J. VARACALLE Jr, C. Shelton-Davis, R. Mizia, L. Torres (Idaho N. Eng Lab, ID), V. Zanchuck, E. Sampson (Tafa Inc., NH) .....	879
"Stabilization of the Fiber/Matrix Interface in SiC-Titanium Alloy Composites" Pavel MOGILEVSKY, A. Werner, H.J. Dudek (DLR, Koln, Germany) .....	595

## COMPUTATIONAL MECHANICS

chairs: Donald J. DAWE (U. Birmingham, UK)  
Rakesh KAPANIA (Virginia Tech.)

"Mechanical Cell for Modeling Composite Materials" Andrei A. GUSEV (ETH, Switzerland) .....	327
"Non-Linear Deformations of a Quasi-Isotropic Laminate using Finite Element Plate- Membrane Coupling Model" Pramod CHAPHALKAR, Ajit D. Kelkar, J. Sankar (N. Carolina A&T) .....	149
"Geometrically Exact Structural Analysis: a Total-Lagrangian Finite-Element Approach" P. Frank PAI, Mark J. Schulz, A.S. Abdelnaser (N. Carolina A&T) .....	655
"Finite Element Modeling of Composite Spur Gears" Eng-Teik NG, Chu-Ho Lu, H.H. Lin (U. Memphis, TN) .....	625
"Large Deflection Analysis of Poroelastic Beams" LePing LI, K. Shulgasser, G. Cederbaum (Ben-Gurion U., Israel) .....	513
"A Refined Linear Analysis of Laminated Plates using Finite Element Method" Dorde VUKSANOVIC, Zivota Perisic, N. Lazarevic (U. Belgrade, Yugoslavia) .....	891
"A 3-D Partial Hybrid Laminated Element for Analysis of Thick Composites" Wei FENG, S.V. Hoa (Concordia U., Canada) .....	269
"FE Modelling the Mechanical Behavior of Two-Phase Materials up to Large Deformations" Thorsten STEINKOPFF (Siemens AG, Germany), M. Sautter (Audi AG, Germany), E. Soppa (U. Stuttgart, Germany) .....	795
"Stress Analysis of Bimodulus Laminates Using Hybrid Stress Plate Element" Yi-Ping TSENG, Yu-Ching Jiang (Tamkang U., Taiwan) .....	863
"Finite Element Implementation of a Dilative Bond Model for Uni-Directional Reinforced Materials" Leonard Herrmann, Joseph D. MELLO (UC Davis, CA) .....	579
"A Numerical Procedure for Calculating the Large Deflections of Composite Rings" Chun- To LUNG, Ping-Cheung Tse, Tai-Cheung Lai (Hong Kong Polytech. U.) .....	541



"Numerical Analysis of the Transverse Mechanical Properties of Polymeric Composites" Alberto TALIERCIO (Politec Milano, Italy) .....	825
"Buckling of Composite Shell Structures using the Spline Finite Strip Method" S. Wang, Donald J. DAWE (U. Birmingham, UK) .....	209
"Identification of Anisotropic Parameters for Laminated Composites by using FEM Eigenvalue Analysis" Kinya MATSUMOTO (Mie U., Japan), Masaru Zako, Kohei Suzuki, Masami Furuno (Tokyo Metro U., Japan) .....	567
"Evaluation of a Full Scale 3-D Armored Multilayered Hull-Turret Assembly using Computational Modal Analysis" Aaron D. GUPTA (Army Res Lab, MD) .....	325
"Recent Results on the Analysis of the Performance of Turbo-Codes" Sabah BADRI (U. Paderborn, Germany) .....	87

## DAMAGE AND INTERFACIAL FAILURE OF COMPOSITES

chairs: George VOYIADJIS (Louisiana St. U.)  
Miroslav CERNY (Czech Tech. U.)

"Angle Ply Laminates-Fact and Fantasy" Michael R. PIGGOTT, Marziyeh Khatibzadeh (U. Toronto, Canada) DISTINGUISHED LECTURER .....	25
"Composite Interfaces Studies by Electromechanical Pull-Out Testing" Deborah D.L. CHUNG, Xuli Fu (SUNY-Buffalo, NY) DISTINGUISHED LECTURE .....	3
"The Role of Interface Reaction on the Mechanical Behavior of Al/SiCp Composites" Metin YILMAZ, Sabri Altintas (Bogazici U., Turkey) .....	955
"Study on Stress State near the Ply Interface in the Interior Region of Composite Laminates" Wei Feng (Concordia U., Canada), James Q.S. YANG (Hong Kong U. Sci Tech.) .....	947
"The Effect of Matrix/Particle Interface Characteristics on the Assessment of Service Life in Steels for High Temperature Service" E.R. SCHIAPPARELLI, J.J. Tiebas, R. Castillo, G.R. Montero, J. Garibaldi (Argentina) .....	735
"Analysis of Interfacial Shear Strength and Micro-Failure Mechanism of SiC Fiber Reinforced Aluminum Composites using Single Fiber Composites (SFC) and Acoustic Emission Technique" Joung-Man PARK (Gyeongsang Nat U., Korea), Bong-Jin Son, Joon-Hyun Lee (Pusan Nat U., Korea) .....	663
"Measurement of Interfacial Properties using Fiber Push-Out in a Scanning Electron Microscope" Russell STACKPOLE II (Touchstone Res Lab, WV) .....	789
"In-Situ Modeling of Aluminium Based Matrix in Metal-Matrix Composites Subjected to Cyclic Loading" Ganesh THIAGARAJAN, George Voyiadjis (Louisiana St. U.) .....	843
"An Analytical Model to Calculate the Response of the Cylindrical Composite Shells subjected to External Compressive Loadings" Ioan Goia (TU Brasov, Romania), Horatiu TEODORESCU (Bucharest, Romania) .....	839
"A Continuum Damage Mechanics Model for Matrix Failure in Laminates" Juha ISOMETSA, S.G. Sjolind (U. Oulu, Finland) .....	397
"Damage Development in Disordered Composites" Didier FOKWA (U. Douala, Cameroon), Lazare Kamdem (Cachen, France) .....	277
"Three-Dimensional Friction Contact Behavior and Damage of Composites" C.C. CHAO, Y.H. Lai, C.Y. Shih (N. Tsing-Hua U., Taiwan) .....	147
"Local Damage using the Generalized Cells Model in MMCs" George Z. VOYIADJIS, Babur Deliktas (Louisiana St. U.) .....	889

"Interfacial Damage in Metal Matrix Composites" Taehyo PARK, George Voyiadjis (Louisiana St. U.) .....	665
"Numerical Analysis of Damage in Composites" Miroslav CERNY (Czech Tech. U.) .....	137
"Damage Propagation Simulation Based on 2-D FEM for Composite Laminates" Yoshinobu SHIMAMURA, Akira Todoroki, Hideo Kobayashi, Haruo Nakamura (Tokyo I.T., Japan) .....	755
"Passive Damage Control in Fiber Glass/Epoxy Plates using Variable Fiber Architecture" Erick C. MILLER, Gary C. Lickfield (Clemson U., SC) .....	589
"Influence of Curvature Radius and Thickness in the Failure of Stiffened Panels" J. Travassos, Manuel J.M. de FREITAS (Lisboa, Portugal) .....	215
"Empirical Determination of a Failure Criteria for C/C-SiC" Werner GEIWIZ, A. Theuer, F.J. Arendts (U. Stuttgart, Germany) .....	297
"Failure Mode Analysis of Parallel Cutting AFRP under Various Tool Rank Angle" Jing-Dae HUANG (N. Yun-Lin I.T., Taiwan), Meng-Kao Yeh (N. Tsing Hua U., Taiwan) .....	377
"Progressive Failure of Symmetric Laminates under In-Plane Loads" Ashwini KUMAR, S.B. Singh (IIT-Kanpur, India) .....	475
"An Investigation into the Failure Modes of the Filament-Wound Composite Pressure Vessels" Badr S. AZZAM (Cairo, Egypt) .....	85
"Strength Reduction of Composites with a Circular Hole subject to Tension and Bending" Yi ZHAO, Su-Seng Pang (Louisiana St. U.) .....	985
"Residual Compressive Strength of Hand Lay-Up Fiber Reinforced Plastic Laminates due to Low Velocity Impact" Ivan VOLPOET, Chihdar Yang, Su-Seng Pang (Louisiana St. U.) .....	887
"Contact Analysis and Experiment of Delaminated Cantilever Composite Beam" Lian-Bin Fang, Meng-Kao YEH (N. Tsing Hua U., Taiwan) .....	951
"Delamination in Multidirectional Carbon/Epoxy Laminates" Michael Gilchrist (U. College Dublin), Niklas SVENSSON (Swedish Inst. Fibre & Polymers) .....	813
"Load Buckling in Local Delaminated Composites" Roberta SBURLATI (U. Genova, Italy) .....	733
"Analysis for Delamination Crack in a Laminated Composite Strip under Generalized Plane Deformation" Seyoung Im, Insu JEON (Korea Adv Ins. Sc. Tec.) .....	403
"Delamination Instability of Curved Composite Panels under Axial Compression" Seyoung Im, Yujun KIM (Korea Adv. Ins. Sci. Tech.) .....	449
"Topographic Variations due to Delamination in Laminated Composites" Shankar Krishnakumar, Murat TAHTALI (U. New South Wales, Australia) .....	819
"Investigating Delamination Buckling and Growth: an Approach Based on Structural Analysis and Testing" Ronald KRUGER, M. Konig, C. Hansel (U. Stuttgart, Germany) .....	469
"Non-Uniqueness and Dynamics of Delamination Growth" Stefan ESSEBIER, S. Rinderknecht, B. Kroplin (U. Stuttgart, Germany) .....	257
"Computation of the Delamination Force in Multilayered Composite Plates" Florence ROUDOLFF, Yves Ousset (ONERA, France) .....	717



## EXPERIMENTAL TECHNIQUES AND WAVE PROPAGATION

chair: Rathi BHATACHARYA (Bradley U., IL)

"Behavior of Glass Fiber Reinforced Composites in Uniaxial and Biaxial Tensile Tests" Nicolae CONSTANTIN, A.Hadar, G. Jiga, N. Sandulescu(Bucharest, Romania) .....	189
"The Effect of Fiber Orientation upon the Elastic Constants and Failure of Fiber Reinforced Composites" G. JIGA, Nicolae Constantin, A. Hadar, N. Sandulescu (Bucharest, Romania) .....	409
"Study of Interlaminar Stresses and Delaminations Effect on Carrying Load Capacity of Laminates" A. HADAR, Nicolae Constantin, N. Sandulescu(Bucharest, Romania) .....	333
"Effects of Fixture Geometry on Nonlinearities in Homogeneous, Symmetrically Delaminated Single Leg Bending Tests" Andrea PIERACCI (U.Pisa, Italy), Barry D. Davidson, V. Sundararaman (Syracuse U., NY) .....	677
"A Photoelastic Study of Interface Crack in Dissimilar Isotropic Media" Anand Asundi, Wei DENG (U.Hong Kong) .....	221
"Use of Coupled Thermal and X-ray Imagery on Mechanical Structures in Composite Materials" G. Grasso, Guido LaRosa, A. RISITANO (U.Catania, Italy) .....	705
"An Experimental Method for Studying some Dynamic Parameters of the Rigid Body" Ileana ROSCA, Gheorghe N. Radu (Transilvania U., Romania) .....	715
"The Behavior of the Rotating Disks with Radial Slits in Axial-Symmetrical Thermic State" Gheorghe N. RADU, Ileana Rosca (TU Brasov, Romania) .....	695
"On the Measurement of Viscoelastic Properties in Polymers using Microindentation" Douglas SHINOZAKI, Y. Lu (U. Western Ontario, Canada) .....	759
"Shearography Technique for Non-Destructive Impact Damage Detection in Composite Materials" M.A.P. Vaz, J.A. CHOUSAL, J.F. Silva Gomes (U. Porto, Portugal) .....	183
"Experimental Study of the Microstructure Influence on the Mechanical Properties in RTM" Juan Valor, Francisco CHINESTA (U. Valencia, Spain) .....	175
"Optimization of Stressing Techniques for Holographic Nondestructive Testing of Composites" Dan N. BORZA (Inst. Nat. Sci. App. Rouen, France) .....	127
"Experimental Optical Techniques for Identification of Macroscopic Behavior of Anisotropic Composite Structures" Gerard MAUVOISIN (IUT Rennes, France), Dan Borza (INSA Rouen, France) .....	569
"Gauge Theory of Elastic-Plastic Waves in Composites" N.V. CHERTOVA, V.L. Popov (Siberian, Russia) .....	169
"Genetic Algorithms for Ultrasonic Characterization of High Temperature Composite Material Properties" Navin S. Rao, Krishnan BALASUBRAMANIAM (Mississippi St. U.) .....	89
"Diffraction Tomography and Seismic Inversion" Vladimir N. TROYAN (St. Petersburg U., Russia) .....	855
"Study of Deformation Process in Carbon Fiber Reinforced Plastics by Acoustic Emission Method" A. Leksovskij (St. Petersburg, Russia), Szymon PILECKI (Warsaw, Poland), G.N. Gubanov (Russia) .....	679
"The Cross Ambiguity Function: a tool for Nondestructive Evaluation of FRP Composites" Renato S. Olivito, P. Stumpo, L. SURACE (U. Calabria, Italy) .....	809
"Propagation of Axisymmetric Transverse Waves in Composite Pipes" Jose M. CIRNE (U. Coimbra, Portugal), Francisco J.Q. Melo, Jose L. Leal, M. Vaz, J.F. Silva Gomes (U. Porto, Portugal) .....	187
"Computation of Transient Wave Transmission in a Layered Composite"	

Cetin Cetinkaya (Wolfram Res Ins, IL), Alexander F. VAKAKIS (U. Ill.-Urbana) .....	875
"Surface Waves in Pre-Stressed Fibre-Reinforced Composites" Graham A. ROGERSON (U. Salford, UK) .....	713
"Waves in Pre-Stressed, Incompressible Composites" Kevin J. SANDIFORD (U. Salford, UK) .....	725
"Detection of Crack Initiation and Crack Presence in Fatiguing Tubular T-Joints using Modal Analysis" Shumin CHENG, A.S.J. Swamidas (Memorial U. Newfoundland, Canada) .....	165
"Vibroacoustics of a Submerged Cantilever Plate for Fatigue Crack Identification" Yulan LI (York U., Canada), J.Y. Guigne, A.S.J. Swamidas (Memorial U. Newfoundland, Canada) .....	515
"Damage Characterization of Fatigue Loaded Quasi-Isotropic Carbon Epoxy Laminates, using Acoustic Emission and other Nondestructive Techniques" Dimos TSAMTSAKIS, M. Wevers, P. DeMeester, C. Santulli (Cath. U. Leuven, Belgium) .....	859
"The Use of X-ray Transmission Microscopy in the Evaluation of Particle Distribution in Metal Ceramic Composites" Frank R. JURETZKO, B.K. Dhindaw (U. Alabama), S. Sen (USRA-Huntsville, AL), D.M. Stefanescu (U. Alabama) .....	421

## FATIGUE OF COMPOSITES

chairs: Rathi BHATACHARYA (Bradley U., IL), George Voyiadjus (Louisiana St. U.)

"The Acoustic Fatigue of Composite Structures in Severe Aircraft Environments" R.G. WHITE (U. Southampton, UK) .....	925
"Interface Shear Effects on the Hysteresis and Fatigue Behavior of Ceramic Matrix Composites- an Analytical Study" David D. ROBERTSON (AFIT, OH), J.P. Solti (Air Force Academy, CO), S. Mall (Air Force I.T., OH) .....	711
"The Fatigue Response of a Hail-Damaged Graphite/Epoxy Laminate" Richard SKORDAHL, Mohammad Mahinfalah (N. Dakota St. U.) .....	769
"The Fatigue Performance of Carbon Fiber Reinforced PEEK" David H. ISAAC, K.S. Saib, W.J. Evans (U. Wales Swansea, UK) .....	393
"A Micro-Mechanical Fatigue Damage Approach for Metal Matrix Composites" Rainer ECHLE, George Voyiadjus (Louisiana St. U.) .....	245
"Composite Fatigue Design Methodology a Simplified Approach" Tonny NYMAN (Saab Aircraft, Sweden) .....	641
"The Visual Discernment of Failure Regions Caused by Fatigue Load" Kiyoshi TANIUCHI (Meiji U.), Jun Onodera, Ziro Onoue (Kayaba Ind., Japan) .....	829
"Modification of the Damage Mechanisms in the Fatigue Process" Constantin GHEORGHIES (U. Dunarea de Jos, Romania) .....	303
"A Study of Fatigue Life of Composite Joints with Titanium Countersunk Fasteners" Alan R. Trodus (McDonnell Douglas, MO), Swami KARUNAMOORTHY (St. Louis U., IL) .....	431
"Residual Stress Effects on Fatigue and Fracture of Metal Matrix Composites" Alex M. KORSUNSKY, Philip Withers (U. Cambridge, UK) .....	459

## FIBER PROPERTIES

- "Rheometry of Molten Short Fibers Composites" Frederic Meslin, Arnaud POITOU(Ecole N.Sup Cachan,France)..... 685
- "Structure-Property-Relations and Fiber Strength of CVD-Coated Fibers" Klaus NESTLER, S.Stoeckel, D. Dietrich, G. Marx, U.Jungnickel, B.Wielage (TU Chemnitz-Zwickau, Germany)..... 621
- "Z-Fibers Reinforced Cored Composites Structures" Constance MAGEE, Tom Fusco, Glenn Freitas(Aztex Inc.,MA), John Harris(Foster-Miller Inc.)..... 336
- "Microfibrillar Composites from Incompatible Polymer Blends" M. EVSTATIEV(Sofia U.,Bulgaria), J.M. Schultz(U.Delaware), Slava G. Petrovich, S. Fakirov (Sofia U.,Bulgaria)..... 259
- "Interfacial Zone of Fiber Reinforced Cement and Gypsum Based Composites"Gypsum Composites" Pablo A. Jorillo, Goro SHIMIZU, Tadahiko Suzuki (Tech U.Philippines)757
- "Numerical Generation of Stress-Strain Properties of Coir Fiber Reinforced Composites" Pablo JORILLO, Goro Shimizu, Ben Verdejo, Reynaldo Baarde (T.U. Philippines) ... 423
- "Centrifugated Fiber Concrete: Cement-Based Precast Formwork" Pablo Jorillo(TU Philippines), Tadahiko SUZUKI (Shimizu Corp,Japan), Yoshitaka Shiobara(Teihyu Corp,Japan)..... 811

## FRACTURE MECHANICS

chairs: Richard DONOVAN(U.Evansville, IL), Lawrence SCHOVANEC (Texas Tech U.)

- "Modelling the Influence of Thermal Strains, Mixed Mode Loading State and Friction on the Single-Fibre-Pull-out Test" Wieland BECKERT, B. Lauke (Dresden, Germany)..... 107
- "Effect of Fibre Length and Fibre Orientation Distributions on the Tensile Strength and Work of Fracture of Short Fibre Reinforced Polymers" Bernd LAUKE, S.Y. Fu (Dresden, Germany)..... 491
- "Micromechanics, Piezoelectricity, Mixture Theory, and Advanced Composites Structural Analysis" Richard P. DONOVAN (U.Evansville, IL)..... 223
- "Crack-Microcrack Interaction and Stress Intensity Factor Evaluation of an Orthotropic Composite Material under Mixed-Mode Loading" M. Sayeed HASAN(Indiana St.U.), Rathi Bhattacharya (Bradley U., IL)..... 347
- "Mode-I Fracture of Bonded Wood/Phenolic FRP Interface" Julio F. Davalos, Prabhu MADABHUSI-RAMAN, Pizhong Qiao (W.Virginia U.)..... 551
- "Energy Release Rate Calculations for Fracture in Nonhomogeneous and Nonlinear Material" Lawrence SCHOVANEC (Texas Tech U.)..... 741
- "On the Fracture of the Unidirectional Composites in Compression" S.D. AKBAROV, T. Sisman, N. Yahnioğlu (Yildiz T.U., Turkey)..... 53
- "Cracked Stage in the Reinforced Beam subjected to Bending" Mieczysław JARONIEK (T.U. Lodz, Poland)..... 401
- "G<sub>Ic</sub> as a Function of Starter Film Thickness, Residual Stresses and Layup" Paul Robinson, Steve FOSTER, John M. Hodgkinson (Imperial Coll., UK)..... 283

## "Microfracture Behavior of Ni-NiO in-situ Composites"

- Hitoshi TAKAGI (U.Tokushima, Japan)..... 821
- "Estimation of n(eI) of DCB Test Specimen and G(Ic) Determination by the Work Factor Approach" Kyong Y. RHEE (Won-Kwang U., Korea)..... 703
- "Determination of Energy Release Rate and Mode Mix in Three-Dimensional Layered Structures using Classical Plate Theory" Hurang HU, Barry Davidson (Syracuse U.,NY)..... 375
- "A Displacement-Based Fracture Criterion for Failure Analysis of Unidirectional Composite Materials" Jung-Ho CHENG, Ze-Yuen Chang (N.Taiwan U.)..... 163
- "A Theoretical Study of the DCB and ENF Test Specimens" Joakim Schon, Borje ANDERSSON (Aero Res Inst, Sweden)..... 65
- "Fracture Mechanical Properties of the DCB and ENF Specimen, an Experimental and Numerical Investigation" Joakim SCHON, Anders Blom (Aero Res Inst,Sweden) Hans Ansell, Tonny Nyman (Saab Aircraft, Sweden)..... 739
- "Strength and Fracture of Three-Layer Construction Elements" Jonas BAREISIS (Panevezys Polytech KTU, Lithuania)..... 95
- "A Hybrid Experimental and Numerical Method to Determine Dynamic Interlaminar Fracture Toughness" Prashant KUMAR, S.K.Verma, N.N.Kishor(IIT-Kanpur,India)..... 479

## FUNCTIONALLY GRADED MATERIALS

Chair: Seiichi NOMURA (U.Texas-Arlington)

- "Graded Composite Coatings for Optimizing Wear and Adhesion" Nima MERK (Lausanne, Switzerland)..... 585
- "Functional Grading of Mechanical Properties by Means of Multi-Stage Spot Heat Treatment" Shuji TADA, Toshio Takahashi, Toshihiko Abe (Tohoku Nat.Ind.Res.Inst, Japan)..... 815
- "Galerkin Function Approach to Thermomechanical Analysis of Functionally Graded Materials" Seiichi NOMURA, Donna Sheahan (U.Texas-Arlington)..... 635
- "Contact and Fracture in FGMs under Thermally Induced Stresses" R. Babaei, S.A. LUKASIEWICZ (U.Calgary, Canada)..... 537
- "Optimal Material Distribution for Thermoelastic Graded Plates" Joseph C. NADEAU, Mauro Ferrari (UC Berkeley, CA)..... 615
- "Characteristics of Fatigue Crack Growth in an Al-Al<sub>3</sub>Ni Functionally Graded Material" Yasuyoshi FUKUI (Kogoshima U.,Japan),Masayuki Shimojou(Tokyo IT),Paul Bowen (U.Birmingham, UK)..... 285
- "Mechanical Response of Functionally Graded MMC Tubes with Fiber Damage to Torsional Loading" Sarah C. BAXTER, Marek Pindera (U. Virginia)..... 105



## HIGH TEMPERATURE MATERIALS AND INTERFACES: Analysis, Processing and Characterization

chairs: Nick PAGANO (Wright Lab, OH), Theodore MATIKAS (WPAFB, OH),  
P. KARPUR (U. Dayton, OH)

"Self-Monitoring of Strain and Damage by Carbon-Carbon Composites" Shoukai WANG, Deborah D.L. Chung (SUNY-Buffalo, NY).....	903
"High Temperature Strength and Creep Behavior of Ceramic Based Nanocomposites-Roles of Intergranular Nano-Sized Particulates" Koichi NIIHARA, Tatsuki Ohji, Tohru Sekino (Osaka U., Japan) DISTINGUISHED LECTURE.....	19
"Ultra-High Temperature Resistant Ceramics Derived by Polymers" Wolfgang DREBLER, L.M. Ruwisch, R. Riedel (Darmstadt, Germany).....	231
"Hypersonic Air Intake Ramp Made of C/SiC Ceramic Matrix Composite" A. MUHLRATZER, H. Koberle, D. Sygulla (MAN Tech. AG, Germany).....	609
"Strain Energy Release Rate Application Limits and Errors" Richard B. HALL, Nick J. Pagano (Wright Lab, OH).....	337
"Control of Carbon Fiber-Polymer Interphases by an Electrochemical Process" Jude O. IROH, Greg A. Wood (U. Cincinnati, OH).....	391
"Processing of Laminated Hybrid Ceramic Composites" Mala SHARMA, Maurice F. Amateau (Pennsylvania St.U.).....	751
"Microstructure Strengthening Mechanism in AL203/NIAL Composites" Kang XU, R.J. Arsenault (U. Maryland).....	943
"New Light Metals and Metal Matrix Composites for Elevated Temperature Applications" Yann BARBAUX, A. Rapoport (Aerospatiale, France).....	93
"Simulation of Ceramic Matrix Composites Behavior by Progressive Substructuring" Chris Chamis, Pappu L.N. Murthy (NASA Lewis, OH), Subodh K. MITAL (U. Toledo, OH).....	593
"Ultrasonics and their Model for Composite Materials Characterization" Jean F. deBELLEVAL, C. Potel, T.J. Chotard, M.L. Benzeggagh (U.T. Compiègne, France).....	211
"An Approach to the Characterization of Bi-Material Interfaces by Acoustic Microscopy" Eva DRESCHER-KRASICKA (NIST, MD), D.J. Rowcliffe (Royal I. Tech, Sweden), Rollie Dutton (NIST, MD).....	233
"Shear Strength and Toughness of NiAl/Mo Laminates" Amit K. GHOSH, Sion M. Pickard (U. Michigan).....	305
"On the Theory of the Thermoviscoelastic Solid" Y.M. HADDAD (U. Ottawa, Canada).....	306
"Fiber-Matrix Strength Measurement in Natural Fiber Reinforced Composites" A. Valadez-Gonzalez, M. Cervantes-Uc, Pedro J. HERRERA-FRANCO (Yucatan, Mexico).....	355
"Thermal Aging of Industrial PMR15 Composites: Influence of Basic Component" Bruno HILAIRE, Nathalie Regnier, Christophe Conreur (DGA/CREA, France).....	357
"The Mechanics of High Temperature Design with Composites" Fred A. LECKIE (UC Santa Barbara, CA).....	495
"Effects of the Interface on the Longitudinal Deformation and Load Sharing Behavior in Titanium Matrix Composites" Bhaskar S. MAJUMDAR (UES, Dayton, OH), Theodore Matikas (Wright Lab, OH), Prasanna Karpur (U. Dayton, OH).....	557
"Effects of Crack Roughness on Mixed-Mode Interface Crack Tip Plasticity"	

Daniel A. MENDELSON (Ohio St.U.), L.J. Young (Chung-Hua Poly, Taiwan), T.S. Gross (U. New Hampshire).....	581
"High Rate Direct Deposition of Structural Intermetallics using PVD" Sion M. PICKARD, Amit K. Ghosh (U. Michigan).....	675
"Photothermal Microanalysis on Composite Materials" J.J. SERRA, E. Milcent P.F. Louvigne (DGA DRET, France).....	745
"Determination of the Tangential Shear Strength of Interfaces and their Impact on Transverse Properties of SiC/Ti-6AL-4V Composites" Sunil G. WARRIER, Bhaskar S. Majumdar (UES, Dayton, OH), Daniel B. Miracle (Wright Lab, OH).....	909
"Effect of Residual Stress on Fatigue of a Titanium Matrix Composite" P. Kennard WRIGHT (GE Aircraft, OH), P. Rangaswamy, M.A. Bourke (Los Alamos N.L., NM).....	935

## HIGHER-ORDER LAMINATION THEORY

chair: C.C. CHAO (N. Tsing Hua U., Taiwan)

"A Discrete Layer Theory for Modeling Plate Delamination" Todd O. WILLIAMS, Frank L. Addessio (Los Alamos N.L., NM).....	929
"Shear Bending and Torsion Modelling for Multilayered Beams of Rectangular Cross-Section" M. Ganapath, Olivier Polit, Maurice TOURATIER (U.P. et M., France).....	853
"Geometrically Nonlinear Analysis of Composite Shells using Higher-Order Transverse Shear Deformation Theories and a co-Rotational Formulation" Lei JIANG (Martec Ltd, Canada).....	407
"Eigenvalue Analysis of Multilayered Composite Structures using Higher Order Discrete Models" V. Franco CORREIA, C.M. Mota Soares and C.A. Mota Soares (Portugal).....	195
"Eigenfrequency Analysis of Higher Order Multilaminated Free-Free Rectangular Plates by Ritz Technique and Symbolic Computation" J.V. Santos, A.L. Araujo, C.M. MOTA SOARES (IDMEC, Portugal).....	601

## IMPACT DYNAMICS

chairs: Ray WOODWARD (DSTO, Australia)  
Arnold MAYER (WPAFB, OH)

"A Numerical Model for the Impact and Penetration of Thermoplastic Woven Fabric Composites" David VINCKIER (CONDAT, Germany).....	885
"Composites under Impact: Shock Wave Simulation" A.M. da Costa Junior, Clelio THAUMATURGO (I. Militar Engenharia, Brasil).....	841
"3D Damage Analysis of Low-Energy Impact on Composite Laminates" Olivier ALLIX, Didier Romand (ENS Cachan, France).....	59

<b>"Target Thickness Scaling Laws for Impact and Penetration of Composite Plates"</b> Arnold MAYER (Wright Lab, OH), Jianyong Sun, David Hui (U.New Orleans).....	571
<b>"Analytical Modelling of the Performance of Unbonded Metallic Laminates"</b> Ray L. WOODWARD (Embassy Australia,DC), S.J.Cimpoeru (DSTO,Australia)....	933
<b>"Measurements of Characteristics of a Visco-Elastic Medium at Dynamic Loading"</b> Michael SPEKTOR (Oregon Ins.Tech.), Vadim Baladinsky (Kiev,Ukraine).....	787
<b>"Laminated Composite Plate subjected to Transverse Line Loading as a result of Low Speed Impact"</b> Gunay ANLAS, N.Unal Elbeyli (Bogazici U.,Turkey).....	71
<b>"Fracture Toughness and Impact Properties of Laminated Metal Composites"</b> Donald R. LESUER, R.A. Riddle, R.P. Gogolewski, C.K. Syn, B.J. Cunningham(Lawrence Livermore N.L., CA) .....	509
<b>"The Effect of Thermal Exposure on the Impact Performance of Phenolic Composites"</b> Stephen G. KUZAK (Tech U.Nova Scotia, Canada) .....	487
<b>"Estimation of the V50 using Semi-Empirical (1-point) Procedures"</b> Greg CZARNECKI (Wright Lab, OH).....	199
<b>"Ballistic Impact Behavior of Composite Armour"</b> Hermann SENF (Ernst-Mach Inst, Germany) .....	743
<b>"The Effect of Strain-Rate on Strain-Induced M-Transformation and Stress-Strain Analysis of the Dual Phase in a SUS 301 Sheet under Tension"</b> Akio TAKIMOTO (Yamaguchi U., Japan) .....	823
<b>"Composite Impact Damage Issues Relevant to Space Vehicles"</b> Alan T. NETTLES (NASA Marshall, AL).....	623
<b>"Axial Fatigue Behavior of the Carbon/Epoxy Composites under Impact and Pretorsional Effects"</b> Ming-Chuen YIP, Yih-Ling Lee (N.Tsing-Hua U.,Taiwan).....	959
<b>"Impact Response Prediction of Beams and Plates subjected to Non-Uniform Projectiles"</b> Tom J.G. STOUMBOS, Rakesh Kapania (Virginia Tech) .....	797
<b>"Impact Resistance of Polymeric Composite Materials"</b> I. Sidney CHOCRON-BENLOULO, V. Sanchez-Galvez (Madrid, Spain) .....	177
<b>"Impact Properties of Kevlar 49/Epoxy Composites"</b> Zdenek KORINEK (Czech Tech U.).....	457
<b>"Impact Behaviour of Multilaminar Steel Reinforced Composite at Low Temperatures"</b> Alfonso J. VAZQUEZ-VAAMONDE (CENIM, Spain) .....	881
<b>"Dynamic Impact Response of Ceramic/GRP Composite Targets"</b> Elmar STRABBURGER, Hermann Senf (Ernst Mach Inst,Germany) William A. Gooch,Matthew Burkins (Army Res. Lab, MD) .....	799
<b>"Three-Dimensional Oblique Impact Contact of Laminates with Anisotropic Friction"</b> C.Y. TU, C.C.Chao (N.Tsing-Hua U.,Taiwan) .....	865
<b>"Taylor Tests of an Unconventional Material"</b> L.L. Wilson, J.C. Foster Jr. (Wright Lab,FL), Stanley E. JONES (U.Alabama), P.P. Gillis (U.Kentucky) .....	417
<b>"Observations from the Penetration of A Glass-Fabric-Reinforced Plastic"</b> Nevin L. RUPERT (Army Res Lab, MD) .....	721

## INDUSTRIAL APPLICATIONS (NON-CIVIL ENGINEERING)

chair: Matt FENSKE (NASA Goddard, MD)

<b>"On the Mechanical Properties of Glass Fibre/Epoxy Filament Wound Pipes"</b> X.P. ZHANG, G.G. Corbett, A.R. Akisanya (U.Aberdeen, UK).....	983
<b>"The Manufacturing and Testing of Injection Molded Sandwich Construction"</b> Hung-Sying JING (N.Cheng Kung U.,Taiwan) .....	411
<b>"The Application of Graphite Composites for a Large Spacecraft Adapter Structure"</b> Joseph EDER (Lockheed Martin,CA) .....	247
<b>"Composite Applications for Launch Vehicle Structures"</b> Shane F. CUDA(McDonnell Douglas,CA) .....	194
<b>"Composite Plastic and Steel Structural Pilings, Camels and Lumber"</b> Andrew BARMAKIAN (Plastic Pilings Inc.,CA).....	99
<b>"Debonds and Buckling of an Ablative Nozzle Skirt"</b> Jeff K. CHI, Wayne Goodman,S.R. Lin (Aerospace Corp,CA).....	173
<b>"Commercial and Aerospace Applications of Composite Materials"</b> Carl Zweben, Richard FENTON (Lockheed Martin Missiles Space,PA).....	273
<b>"US Evaluation of C/C-SiC Tensile Loaded Specimens"</b> R.M. AOKI, P. Schanz (German Aero.Res.Est.).....	75
<b>"Application of Composite Materials to Orthopaedic and Reconstructive Bone Replacement"</b> Paul J. BIERMANN (Johns Hopkins U.,MD).....	115
<b>"Application of Composites to Consumer Products-a Rapid Usage"</b> Chris CHAMIS (NASA Lewis, OH) .....	114
<b>"Improvement of Fibrous Composites Proofing"</b> Vladimir KOMINAR (Kinarot Ltd, Israel), V. Kinevsky (Ben-Gurion), O. Figovsky (Polyadd, Israel).....	455
<b>"Investigation of Aluminum Composite Sliding Bearings"</b> Mihaly KOZMA (T.U.Budapest, Hungary) .....	465
<b>"Affordable Polymer Composites for Aerospace Applications"</b> Gary C. KRUMWEIDE (Composite Optics, CA).....	471
<b>"The Effect of Intercalation in Graphite Epoxy Composites on the Shielding of High Energy Radiation"</b> James R. GAIER (NASA Lewis, OH),Wendie C. Hardeback, Dwight B. Berry (Manchester College, IN) .....	289
<b>"The Hydroelastic Behavior of Composite Propeller"</b> H.J. LIN, Y.J. Lee, J.J. Lin (Nat. Taiwan U.).....	519
<b>"The Analysis of the Forces considered in the Study of Feeding Transport and Proportioning Systems used by Automatic Dimensional Control"</b> Luciana CRISTEA (U.Transilvania, Romania).....	197

## INFRASTRUCTURE COMPOSITES

chairs: Ayman MOSALLAM (Calif St.U. Fullerton)

V. KHABARI (UC San Diego)

<b>"Using Aluminium Composite Sandwich Structures for Prestige Buildings"</b> Paul M. BURLING (TWI, Cambridge,UK) .....	135
<b>"Cracking of Concrete Slabs Reinforced with Advanced Composite Materials"</b>	



Hany ABDALLA, Mamdouh El-Badry (Concordia U.,Canada), Sami Rizkalla(U.Manitoba,Canada) .....	43
<b>"Strengthening of Concrete Members using Externally Prestressed Composite Cables"</b> Raafat El-Hacha, Mamdouh EL-BADRY, Hany Abdalla (Concordia U.,Canada).....	249
<b>"Retrofitting of Prestressed Concrete Crossties using Composite Fabrics"</b> Raafat EL-HACHA, Mamdouh El-Badry, Zenon Zielinski, Hany Abdalla(Concordia U., Canada) .....	251
<b>"Parametric Sensitivity Study of Nonlinear Buckling of Reinforced Concrete Panels by Finite Element Method"</b> Sankar C. Das (Tulane U.,LA), Xianghui Zhang (Waldemar S. Nelson Co.,LA).....	203
<b>"Optimum Design of FRP Wrap for Construction"</b> Hwai-Chung WU (U. Michigan) .....	937
<b>"Fibre Reinforced Composite Materials for Renewal of Infrastructure in the 21st Century"</b> Vistasp KARBHARI (UC San Diego, CA) DISTINGUISHED LECTURER.....	13
<b>"Fracture Properties of High Performance Concrete Reinforced with Synthetic Fibers"</b> Ashish DUBEY, Nemkumar Banthia (U. Br.Columbia,Canada).....	235
<b>"Tensile Properties of Sisal and Compression Behaviour of Cement Mortar Sisal Composites"</b> Romildo D.T.Filho, Khosrow GHAVAMI (PUC-Rio,Brazil) .....	301
<b>"Effective Length Factors in the Design of Pultruded FRP Columns"</b> Zouheir HASHEM (U.Nevada-Las Vegas).....	351
<b>"Flexural Testing of Externally Reinforced Natural Stone"</b> Kimberly E. KURTIS, C.K.H. Dharan (UC Berkeley) .....	485
<b>"Investigation of Dynamic Pressure Behavior during the Pultrusion of Composites"</b> Deep SHARMA, Tyrus A. McCarty, Jeffrey A. Roux, James G. Vaughan (U.Mississippi).....	749
<b>"Vibration Analysis of Simply Supported Pultruded Fiber-Reinforced Plastic Composite Box Beams under Dynamic Loads"</b> Robert L. YUAN, Sittichai Seangatith (U.Texas-Arlington) .....	965
<b>"Interfacial Damage Modeling for Fiber-Reinforced Cementitious Materials"</b> Y. Philip GENG (UC San Diego, CA), Chris K.Y. Leung (MIT, MA).....	299
<b>"An Integral Composite Bridge Superstructure"</b> Amjad AREF, I. Dennis Parsons (U.Illinois-Urbana) .....	79
<b>"Study of Concrete Slab Reinforcement with Carbon Fiber sheet"</b> S. Matsui (Osaka U.),N.Mori(Nagoya Hwy), K. Kobayashi, M. UEMURA (Tonen Corp, Japan) .....	869
<b>"Braided Reinforcements Provide Versatile, Cost Effective Options in Molded Composite Products"</b> Jeff MARTIN (Atkins-Pearce Tech.,OH).....	563
<b>"Infrastructure Repair by Polymer Encapsulation"</b> Glen NICKELSEN, Frank Apicella, Frank Wang (Master Builders Inc, OH) .....	631
<b>"Mixed Damage-Flow-Fracture Process in Cement Based Composite Material-a Combined Approach"</b> Miodrag PAVISIC (Inst Kirilo Saivc, Yugoslavia) .....	669
<b>"Lockheed Martin's Demonstration Composite Highway Bridge: a Low-Cost Modular Design"</b> Chris DUMLAO, A. Abrahamson, L. Fisher, B. Hurlbut, M. Jacoby,K. Lauraitis, A. Miller (Lockheed Martin, CA) .....	239
<b>"Improving Hardened Hydraulic Cement with Supercritical CO2"</b> Roger H. JONES Jr.(Materials Tech Ltd., Nevada) .....	415
<b>"The Dynamic Properties of Polyolefin Fiber Reinforced Concrete Composites"</b> Linfa Yan, Richard L. PENDLETON (S.Dakota Sch.Mines Tech) .....	671
<b>"Shear Lag in Wide-Flange FRP Composite Shapes"</b> Julio F. DAVALOS, Hani A. Salim, Pizhong Qiao (W.Virginia U.).....	205

<b>"Multiobjective Optimization of Fiber-Architecture for FRP I-Beam"</b> Pizhong QIAO, Julio F. Davalos (W.Virginia U.) .....	691
<b>"Stress Concentration caused by Holes in PFRP Members"</b> Magdi A. KHALIFA (United Arab Emirates U.), Osama A. Hodhod (Cairo,Egypt) .....	439

## JOINTS, ADHESION AND REPAIR

chairs: Paul HERRINGTON (U.New Orleans)  
Chihdar YANG (Louisiana St. U.)

<b>"Heat Distribution in the Curing of Prepreg Fabric for Composite Pipe Joint"</b> Michael A. STUBBLEFIELD, Chihdar Yang, Su-Seng Pang (Louisiana St. U.),V. Trent Montgomery (Southern U.,LA), Richard H.Lea (Specialty Plastics,LA) .....	803
<b>"A Novel Method for the Measurement of Adhesion of Polymer Films"</b> Olga GOUSSEV, Karel Zemen, Ulrich W. Suter (EMPA, Switzerland).....	315
<b>"Three-Dimensional Analysis of Bonded Double Lap Composite to Metal Plates"</b> Alex E. BOGDANOVICH, Indrajith Kizhakkethara (AdTech, OH) .....	121
<b>"Design of Experiments for Controlling Bondline Thickness and Porosity"</b> Brett C. BONNET, Paul Mehrkam (Naval Air War.Cen,MD) .....	125
<b>"On the Stress Analysis of Wood Finger Joints"</b> Mircea Gh MUNTEANU, Gheorghe N. Radu (T.U.Brasov,Romania) .....	613
<b>"Load Transfer in Bonded Flexible Composite Joints"</b> Chris Jenkins, R. Skalleberg, Shengmin WEN (S.Dakota Sch. Mines.).....	921
<b>"Buckling Analysis of an Adhesive-Bonded Taper-Taper Joint between Two Composite Plates"</b> Jack E. HELMS (Albemarle Corp,LA), Chihdar Yang, Su-Seng Pang (Louisiana St. U.) .....	353
<b>"Innovative Joining Techniques for Pultruded Composites"</b> S.J. Smith, I. Dennis PARSONS, K.D. Hjelmstad (U.Illinois-Urbana) .....	667
<b>"Continuum Damage Mechanics of Adhesively Bonded Joints under Large Strains"</b> Jean-Francois GANGHOFFER, J. Schultz (Delft U.Tech.,Netherlands).....	291
<b>"Self-Reinforcing Polymer Composites"</b> W.L. CHEUNG, X.D. Lin (U. Hong Kong) .....	171
<b>"Lamellar Structure of POM Spherulites Imaged by a Two-Stage RU04 Staining Technique"</b> J.X. LI, W.L. Cheung (U. Hong Kong).....	511
<b>"Composites to Hold Up Structures"</b> Edward R. Fyfe, Scott F. ARNOLD, Duane J. Gee (Hexcel Fyfe, CA).....	64
<b>"Analysis and Characterization of Local Stresses in Adhesive Joints"</b> Wan-Lee YIN (Georgia Tech.).....	957
<b>"Generic Conductive Cooled Module Solder Joint Durability Evaluation"</b> T. Eric WONG, D.T. Winslow, S.H. Lee (Hughes Aircraft Co., CA) .....	931
<b>"The Behaviour of the Bi-Metallic Joints made with Adhesives in Variable Loading"</b> Liviu PALAGHIAN, Iulian G. Birsan (U.Galati, Romania) .....	657
<b>"Stiffness Behaviour of Composite-to-Metal Single Lap Shear Joints Bonded with Flexible and Rigid Adhesives"</b> James F. OWENS, Pearl Lee-Sullivan (U.New Brunswick, Canada) .....	653

"Damage Tolerance Analysis of Scarf Joints" Chun H. WANG (DSTO, Australia).....	897
"Progress in Composite Repair Inspection Technology" Donald HAGEMAIER (McDonnell Douglas, CA).....	335
"Adhesive Bonded Composites Patch Repair" Anand ASUNDI (U.Hong Kong), S.W. Ricky Lee (Hong Kong U.Sci Tech), Alta Y.N. Choi (U. Hong Kong).....	81
"Boron/Epoxy Composite Patch Repair" Siew-Lok TOH (Nat.U. Singapore), Chiang-Jeng Er (Singapore Air Force) Tong-Earn Tay, Fook-Siong Chau (N.U.Singapore).....	849

## MATHEMATICAL MODELING

chairs: Lars-Erik PERSSON (Lulea U.Tech.,Sweden)  
Harn C. CHEN (Northrop Grumman, CA)

"Correlation Analysis and Reliability of Laminated Composites" Sergei P. YUSHANOV (U. Akron, OH) Alex E. Bogdanovich (AdTech, OH).....	969
"Probabilistic Design of Ceramic Matrix Composite Components"Paolo Conti (U. Perugia, Italy), Donato AQUARO (U.Pisa, Italy).....	77
"Stress Analysis on Multi-Layers Bellows" Yimin ZHU (Hong Kong Baptist U.).....	989
"Bounds and Estimates on the Effective Conductivity Tensor" Annette Meidell (Hueck Aluminum,Narvik), Dag LUKKASSEN (Narvik I.T.,Norway).....	539
"Asymptotic Analysis of the Maxwell Equations" Niklas WELLANDER (U. Gavle-Sandviken,Sweden).....	917
"Moment Distributions Around Elliptical Cutouts in Finite Laminated CompositePlates" Harn C. CHEN (Northrop Grumman, CA).....	153
"Lattice Boltzmann Methods for Modeling Microscale Flow in Fibrous PorousMedia" Michael A. SPAID, Fred Phelan Jr. (NIST, MD).....	785
"Homogenization of Elastic-Plastic Composite Beams" Christoph ADAM, Franz Ziegler (TU Wien, Austria).....	47
"Perturbation Analysis of Laminated Anisotropic Cylindrical Shells" Dipo ONIPEDE Jr. (U.Pittsburgh, PA).....	645
"A New Distribution of Extremes and its Applications to Stochastic Crack Growth" Boris KUNIN (U.Alabama-Huntsville).....	483
"Interaction Between Circular Dislocation Loops and Cylindrical Inhomogeneity" Ismail DEMIR (King Saud U.,Saudi Arabia).....	219
"On the Homogenization Method as a Useful Tool for Solving Problems in Composites Engineering" Lars-Erik PERSSON, Peter Wall (Lulea U.T.,Sweden).....	673
"Scaling and Topology of Failure in Composites due to the Nonlinear Kineticsof Damage Accumulation" Oleg NAIMARK (Perm, Russia).....	617
"Generalization of Stress Intensity Factor for the Complex Topology of Crack Trace in Composites" Marina DAVYDOVA (Perm, Russia).....	207
"Structural Simulation of Damage Accumulation in Highly Filled Random GranularComposites" O.C. GARISHIN, V.V. Moshev (Perm, Russia).....	295
"Micromechanical Modelling of Nonlinear Deformation and Damage Processes in Disordered Composites" A.N. ANOSHKIN, Yu V. Sokolkin, A.A. Tashkinov(Perm, Russia).....	73

"Determination of Structural Characteristics of Materials using theDiagrams of Continuous Indentation" Valetin P. ALEKHIN, Anatoly D. Shliapin, Sergey I. Bulychev, Valery I. Koshkin (Moscow Motor Car Construc.).....	57
---	----

## METAL MATRIX COMPOSITES

"Thermomechanical Cycling of Continuous SiC/Ti Metal Matrix Composites" Qi Fang,Paulette SIDKY, M.G. Hocking (Imperial Col.,UK).....	763
"Threshold Stress in Superplastic Aluminum Composites" B.Q. HAN, K.C. Chan (Hong Kong Poly U.).....	341
"Analysis on the Load Transfer Efficiency of Whiskers in Metal Matrix Composites" Soon H. Hong, Kyung H. CHUNG (Korea Adv.Inst.Sci.Tec.).....	185
"The Residual Strength of Spliced Fiber Metal Laminates" Anand Asundi, Alta Y.N. CHOI (U. Hong Kong).....	179
"Superplastic Behavior in Metal Matrix Composites" Mamoru MABUCHI (Nat Ind Res Inst, Nagoya, Japan), Hajime Iwasaki (Himeji I.T.,Japan),Kenji Higashi (Osaka Pref.U.,Japan).....	547
"Effect of Composite Fabrication on the Strength of Single Crystal AL203 Fibers in Two Fe-Base Alloy Composites" Susan L. DRAPER, B.J.M. Aikin (NASA Lewis, OH).....	229
"Microstructure and Wear Resistance of an Al-Al3Ti Composites Manufacturedby Centrifugal Method" Yoshimi WATANABE(Shinshu U.,Japan),Noboru Yamanaka(Miyakonojo Nat Col,Japan) Y. Fukui (Kagoshima U., Japan).....	911
"Modelling of Damage-Plasticity Coupling in Metal-Composite Laminates" M. MAHE (Aerospatiale, France).....	553

## MOISTURE and THERMAL EFFECTS

chair: Terry VANDIVER (US Army Missile Com,Redstone,AL)

"A Darcy Law for Quasi-Periodic Porous Media and Optimal Design of CompositeMaterials" Anders HOLMBOM (Lulea U.T.,Sweden).....	363
"Effect of Hot Water Immersion on Fracture Strength of Unidirectional AFRP" Satoshi SOMIYA, M. Maruyama (Keio U., Japan).....	781
"Hot-Wet Cold-Dry Thermal Cycle Effects on Composites Pressure Vessels" Terry VANDIVER (Army Missile Com, Redstone,AL).....	874
"The Effect of Hygrothermal Cycling on the Properties of Advanced EpoxyResins and their Carbon Fibre Reinforced Composites"James A. HOUGH, Frank Jones (U.Sheffield, UK).....	367



"Relaxations Analysis of a Carbon Fibre-reinforced-Plastic High Dimensional Stability Structure due to Moisture Diffusion" V. Giaretto, G. Kaniadakis, Elio MIRALDI (Politec Torino, Italy) .....	591
"Influence of Residual Thermal Stresses on the Boundary Layer Stress Field of Composite Laminates" Waldir G. GONCALVES (Embraer, Brazil).....	311
"Microcracking of Low Coefficient of Thermal Expansion Low Moisture Absorption Organic Matrix Resin/Pitch 75 Graphite Composites due to Thermal Cycling" Jerry ZAKRZEWSKI (Lockheed Martin, CA) .....	973

## NANO-COMPOSITES and ELECTRONIC MATERIALS

chairs: Evan MA (Louisiana St.U.)  
Yuntian ZHU (Los Alamos N.Lab, NM)

"An Investigation of Thermal and Mechanical Properties of ALN/Polyimide Nanocomposite" Xiaohe CHEN, K.E. Gonsalves (U.Connecticut), W.R. Schmidt(United Technologies,CT) .....	161
"Nitride and Boride Nano-Composites and Multilayered Films" R.A. ANDRIEVSKI (Moscow, Russia) .....	69
"Nano-Composites Prepared by Mechanical Milling and Their Magnetic Properties" Jinke TANG, Wei Zhao (U. New Orleans) .....	827
"High-Energy and Reactive Milled Ceramic-Metal Powders for Nano-Composites" R. TOMASI, E.M.J.A. Pallone, D.E. Hannai, W.J. Botta (U.Fed Sao Carlos, Brazil) .....	851
"On the Strain Gradient Plasticity of the Crystalline Materials in the Submicrometre Range" Jiri NOVAK, Dana Lauerova (Prague, Czech Rep.) .....	637
"Preparation of SiC Ceramic Fiber Mixed with Nano Particle" Jun WANG, Chunxiang Feng, Yongeai Song (Changsha, China) .....	899
"Cu-Fe Nano-Composites formed by Cryogenic Ball Milling and Hot Pressing" Evan MA, L. He (Louisiana St.U.) .....	545
"Borohydride Reduction: A Technique to Synthesize Nanosize Transition Metals, Reduced Transition Metal Oxides and Nanocomposites" Yuntian ZHU (Los Alamos) A. Manthiram, S. Guggila (U.Texas-Austin), Terry C. Lowe, Michael G. Stout (Los Alamos, NM) .....	987
"Applications of Thermally Conductive Polymeric Composites to Electronic Packaging" David POWELL, Gary C. Krumweide, Gary Tremblay (Composites Optics Inc., CA) .....	687
"Whisker-Reinforced Glass-Ceramic Composites for Microelectronic Substrates" Robert F. COOK (IBM, NY) .....	191
"Design Techniques for Sizing the Walls of Advanced Composites Electronic Enclosures for Dynamic Loads" Jack C. ROBERTS (Johns Hopkins U., MD) .....	709

## PARTICULATE COMPOSITES

"Structure of Particulate Metal Matrix Composites Produced by Liquid Metal Infiltration" M.A. TAHA, M.H. Abdel-Latif, N.A. El-Mahallawy, Hala A. El-HAKIM (Ain Shams U., Egypt).....	817
"Initial Damage and Crack in Particulate Composites" Young W. KWON, J.H. Lee (Nav. Postgrad. Sch, CA), C.T. Liu (Phillips Lab, CA).....	489
"Influence of Specimen Thickness and Loading Rate on Opening and Growth of Crack in a Particulate Composite Material" C.T. LIU (Phillips Lab, CA).....	529
"Investigating the Local Behaviors Near Crack Tip of a Particulate Composite Containing a Circular Hole" S.C. Max YEN (Southern Illinois U.), C.T. Liu (Phillips Lab, CA) ...	953

## PROCESSING OF COMPOSITES

chairs: Jason LO (Canmet, Canada)  
M. FATHI (U. Dortmund, Germany)

"Improved Processing Concepts for and Nondestructive Evaluation/Characterization of Carbon/Carbon Composites" U.K. VAIDYA, H. Gajiwala, S. Sodah, H. Mahfuz, S. Jeelani (Tuskegee U., AL) .....	873
"Quantitative Prediction of Stresses During Thermoset Cure" Douglas ADOLF, Bob Chambers, Steve Burchett (Sandia N.L., NM) .....	991
"The Direct Electrochemical Synthesis of Polychelate Complexes of Copper II and Thermal Stability" Abderrezak ADDALA, A. Hachemi, Z.M. Kotkowska (U. Farhat Abbas, Algeria).....	51
"Characterization and Processing of Hollow Carbon Fiber from Polyethylene Precursor" Dong ZHANG, Qin Sun, Larry Wadsworth (U. Tennessee).....	979
"Corrosion Protection of Particulate Aluminum-Matrix Composites by Anodization" Jiangyuan HOU, Deborah D.L. Chung (SUNY-Buffalo, NY).....	365
"Mechanical Properties of Titanium Matrix Composite Produced by Combustion Synthesis" Hsiao-Tsung TSANG, C.G. Chao (N. Chiao-Tung U., Taiwan), C.Y. Ma, C.M. Chen, C.Y. Wang, C.C. Yang (Mat Res Dev Cen, CSIST, Taiwan).....	861
"Monitoring Autoclave Cure in Commercial Carbon Fibre/Epoxy Composites" George M. MAISTROS, Ivana K. Partridge (Cranfield U., UK).....	555
"Processing of Long Fibre Reinforced Metal Strip by Twin Roller Caster" B. Wielage, A. DORNER (Tech. U. Chemnitz, Germany) .....	227
"On the Fabrication of a Hybrid Metal Composite Laminate" John F. MALLUCK, Ayo Abatan, Kevin McNair (Clark Atlanta U., GA) .....	561
"The Studies of Dynamic Mechanical Properties of AS4/3501-6 Composites with Different Curing Conditions" Jian-Yin CHEN (NRC, Quebec), S.V. Hoa (Concordia U., Canada), C.K. Jen, D. Levesque, J.P. Monchalain (NRC, Quebec) .....	155
"Effect of Titanium on Structure and Properties of the Squeeze Cast Aluminum Matrix Composites Reinforced with Continuous Carbon Fibers" Natalia Sobczak, Jerzy SOBCZAK, Antoni Karamara, S. Dybczak (Cracow, Poland) .....	775

<b>"On-Line Process Monitoring of Composite Cure Utilizing Near-IR Spectroscopy"</b> John R. SCHLUP, Lisheng Xu, Zong-Wei Shen (Kansas St.U.) .....	737
<b>"Optimization of Material Processing Profiles"</b> Robert S. SALZAR, Steve M Arnold (NASA Lewis, OH) .....	723
<b>"Relationships between Differential Scanning Calorimetry and Dynamic Mechanical Analysis of Undercured Composites"</b> Abdelatif Atarsia, Rachid BOUKHILI, Eric Blaise (Ecole Poly Montreal, Canada) .....	129
<b>"The Effect of Grain Size on the Tensile Properties of Hot Extruded SiCp/AZ91 MG Composites"</b> Doo-Myun Lee, Bong-Gil Kim, Chi-Hwan LEE (Inha U., Korea) .....	497
<b>"Strength of Alumina-Wire Reinforced Stainless Steel Composite by Controlled Fracture Forming"</b> Kiyohiko TATSUZAWA, T. Aizawa, J. Kihara (U. Tokyo, Japan) .....	835
<b>"One-Step Tape Casting of Composites via Slurry on Fiber"</b> Henry C. deGROH III (NASA Lewis, OH) .....	217
<b>"Modeling of the Shape of Solidification Front in the Composite in Situ Casting"</b> E. Frasz, Wojciech KAPTURKIEWICZ, E. Guzik (Krakow, Poland), H.F. Lopez (U. Wisconsin-Milwaukee), A.A. Burbielko (Krakow, Poland) .....	429
<b>"The Manufacture of Ti/SiC Fibre Metal Matrix Composites by a New Spray/Wind Process"</b> Patrick S. GRANT, Z. Fan, B. Cantor (U. Oxford, UK) .....	321
<b>"The Microstructure and Mechanical Properties of Al-TiC MMCs Fabricated by a Modified Stir-Casting Technique"</b> Andrew KENNEDY (U. Nottingham, UK), S.A. Lockyer (U. Oxford, UK) .....	437
<b>"Modeling of Thermographic Testing in Bonded Stratified Composites Evaluation"</b> Alexandrina MIHAI, C. Mihai (Bucharest, Romania) .....	587
<b>"Technological Problems in Producing Metal-Particle Composites with High Wear Resistance"</b> FI. STEFANESCU, G. Neagu (Bucharest, Romania) .....	793
<b>"High Frequency (27.12 MHz) Curing and Physical Characterization of Epoxy-Graphite Powder Composites"</b> Saida Abdessameud (Alger, Algeria), P. Alazard (France), Nadir Beldjoudi (Algeria), Albert GOURDENNE (Toulouse, France) .....	313
<b>"Titanium Matrix Composites for High-Temperature Applications: Processing, Microstructure and Mechanical Properties"</b> H.J. DUDEK, R. Leucht, W.A. Kaysser (German Aerospace Res. Est.) .....	237
<b>"Minimizing Warpage of Injection Molded Part"</b> Shijun NI (Lexmark Int. Inc., KY) .....	629
<b>"Resin Transfer Moulding (RTM) Technology Development in India: Concept to Commercialization- a Case Study"</b> S. SUNDARAM, B.J.C. Babu, P.S. Shembekar (Glass Fibre T.C., Hyderabad, India) .....	807
<b>"Structure Property Characterization of Injection Molded Short Fiber Reinforced Syndiotactic Polystyrene"</b> Xiurong Zhang, Chang-Meng HSIUNG (U. Southwestern Louisiana) .....	371
<b>"Molecular Dynamics Simulation of the Bending Process of Composite Interfaces"</b> Xuan LUO (Harbin I.T., China), Gefei Qian, Yuming Wang (China) .....	543
<b>"New Composite Rolls for High Speed Rolling"</b> Jia-Lin Ji, Jin-Xiang Yao (Xian Jiaotong U., China) .....	405
<b>"Thermal Residual Stress in SiCw/Al Composites"</b> Wei-Dong FEI, Q.Y. Liu, C.K. Yao (Harbin Inst Tech, China) .....	265
<b>"Squeeze Casting of Silicon Carbide Particulate Reinforced Magnesium Matrix Composites"</b> Jason LO, R. Santos, A.K. Kuriakose, G. Carpenter (CANMET, Canada), A. Luo (Inst. Magnesium Tech., Canada) .....	533

## RECYCLED MATERIALS

chair: Satish KUMAR (Georgia Tech.)

<b>"Glass Mat Reinforced Thermoplastics from Carpet Waste"</b> John Muzzy, Satish KUMAR, Yi Zhang (Georgia Tech.) .....	481
<b>"Polymeric Wastes it use to develop Polymer-Oligomer Composite"</b> A. ALVAREZ-CASTILLO (Inst. Zacatepec, Mexico), V.M. Castano (I. Fisica, Mexico) .....	61
<b>"Mechanical Characterization of a Pavement Base Course Material Made from Stabilized Waste Aggregate-Fiber Composite"</b> Khaled SOBHAN (Bucknell U., PA) .....	779
<b>"Improved Properties of Polyolefine-Recyclates"</b> Harald LEHMANN (Martin-Luther U., Germany) .....	505
<b>"Tribological Performance of Recycled Glass Bead Filled HDPE Composite"</b> Wagih W. MARZOUK, M.A. Elrahman, T.M. Salem (Minia U., Egypt), Charles L. Beatty (U. Florida) .....	565
<b>"Wear and Friction of HDPE-Recycled Glass Bead Composite at Elevated Temperatures"</b> W.W. Marzouk, M.A. ELRAHMAN, T.M. Salem (Minia U., Egypt), Charles L. Beatty (U. Florida) .....	253

## SMART COMPOSITES

chairs: Nimal RAJAPAKSE (U. Manitoba, Canada)

Alex KALAMKAROV (T.U. Nova Scotia, Canada)

<b>"A Finite Strip Method for the Analysis of Piezoelectric Thin-Film Strip Resonators"</b> Yook-Kong YONG, Z. Zhang (Rutgers, NJ) .....	796
<b>"Recent Development in Piezocomposites for Hydrostatic Sensing and Actuation Applications"</b> Qiming ZHANG (Penn St.U.) .....	981
<b>"The Characterisation of Piezoelectric and Electrostrictive Materials for Sensors and Actuators"</b> Binu K. MUKHERJEE, S. Sherrit, H.D. Wiederick (Royal Mil. College, Canada) .....	611
<b>"Intelligent Pneumatic Actuator with an Integrated Electronic Control Unit"</b> Emil IONESCU, Rares Comsa (Transilvania U., Romania) .....	387
<b>"Temperature Effects on Frequency and Loss Factor of Smart Damping Structures"</b> Qinghua CHEN, Cesar Levy (Florida Int. U.) .....	159
<b>"Intelligent Fibrous Flexible Composites Containing Crosslinked Polyethylene Glycols"</b> Tyrone L. VIGO (US Dept. Agriculture, N. Orleans) .....	883
<b>"Sensing/Actuating Characteristics of Piezo Laminated Composite Plates using Layer-Wise Displacement Theory"</b> In LEE, Jae-Hung Han (KAIST, Korea) .....	499
<b>"Self-Monitoring of Strain and Damage by Carbon Fiber Polymer-Matrix Composites"</b> Xiaojun WANG, Deborah D.L. Chung (SUNY-Buffalo, NY) .....	905
<b>"Fast Current Limiters Based on Particulate Polymer Composites"</b> Ralf STRUMPLER (ABB Corp, Switzerland) .....	801



<b>"Behavior of Piezo-Composites under Large Thermal Variations"</b> Ayo O. ABATAN, John F. Malluck (Clark Atlanta U., GA).....	41
<b>"High Speed Plastic Optical Fiber Network in Multimedia"</b> Yasuhiro Koike(Keio U.), Takaaki ISHIGURE (Kanagawa Acad.Sci Tech, Japan).....	395
<b>"A Combined Research and Course Development in Vibrations and Dynamics of Smart Composites"</b> Yi-Yuan YU (New Jersey Inst Tech.) .....	963
<b>"Interrogation of Fiber-Grating Smart Structures using a Tunable Er-Doped Fiber Laser"</b> Shing LEE, Junfeng Cao (U. New Orleans).....	503
<b>"Intelligent Methodology for Design of Composites"</b> Lars HILDEBRAND, Madjid Fathi, Bernd Reusch (U.Dortmund,Germany).....	359
<b>"The Statistical Failure Analysis of Optical Fiber Sensors Embedded within the Smart Composite Structures"</b> D.C. Lee, D.C. Seo, Jung-Ju LEE (Korea Adv Inst Sci Tec.).....	501
<b>"On the Application of Pultruded Smart Composites in Civil Engineering"</b> Douglas MacDONALD, Alex Kalamkarov (TU Nova Scotia, Canada).....	549
<b>"Theoretical Modelling for Dielectric and Electromechanical Characteristics of Piezoelectric-Polymer Composite with Different Connectivities"</b> G. PRASAD, T.Bhimasankaram, S.V.Suryanarayana, G.S.Kumar(Osmania,India).....	689
<b>"The ARO Adaptive Structures Program"</b> Gary ANDERSON (Army Res.Off., NC).....	63
<b>"Micromechanics of Piezoceramics"</b> Nimal RAJAPAKSE (U.Manitoba, Canada).....	697

## SPACECRAFT COMPOSITES

chair: Matt FENSKE (NASA Goddard, MD)  
Sandeep GULATI (NASA Jet Propulsion Lab, CA)

<b>"Acoustic Emission Signals Identification by Network Representation of Sensor Data"</b> David WEN (Research Dev.Lab, CA), Michael Zack(Jet Prop.Lab,CA).....	919
<b>"Composite Design Considerations for Large, Dimensionally Stable Reflectors"</b> Richard A. BRAND, Vasudevan Thirumalai (App.Aero.Struct Corp,CA).....	131
<b>"Advanced Composite Spacecraft Structures"</b> Harry DURSCH (Boeing Defense Space,WA) .....	241
<b>"Development of a New Class of Satellite: a Composite Lightweight Affordable Spacecraft Structure"</b> Timothy C. THOMPSON, Lucie Parietti(Los Alamos NL, NM).....	845
<b>"Wrinkling Phenomena in Laminated Structures"</b> Michail ZAK (NASA Jet Propulsion Lab, CA).....	971

## SPORTS COMPOSITES

developer,chair: Clive GRANT (U.Newcastle upon Tyne, UK)

<b>"An Investigation on the Design and Rapid Manufacture of a Composite Bicycle Frame"</b> Dimitris Katsanis, Stephen GROVE (U.Plymouth, UK).....	323
<b>"The Design of Composite Vaulting Poles"</b> Paul M. WEAVER, S.C. Burgess (Cambridge U., UK).....	913
<b>"Improved Dynamic Performance of a Bat"</b> Clive GRANT (U.Newcastle upon Tyne, UK).....	319

## TEXTILE COMPOSITES

chairs: Youjiang WANG (Georgia Tech.)  
Sabit ADANUR (Auburn U., AL)  
Paul SAWHNEY (US Dept.Agriculture,N.Orleans)  
Sam IBEKWE (Southern U., LA)

<b>"Influence of External Factors on the Strength of Woven Fabric Reinforced Laminates"</b> N. SANDULESCU, N. Constantin, G. Jiga, A. Hadar (Bucharest,Romania).....	727
<b>"Finite Element Modeling of Twill Weave Composites for Homogenization Applications"</b> Sun-Pui NG, Ping-Cheung Tse, Kwok-Jing Lau (Hong Kong Poly.U.) .....	627
<b>"On the Use of a CFD Code to Analyze the Flow and Thermal Behavior of Textile Composite for Rocket Motors"</b> Patrick F. MENSAH, Sam Ibekwe, Sahib S. Chehl(Southern U., Baton Rouge,LA) .....	583
<b>"Mechanical Behaviors of Autoclave-Cured, and Resin Transfer Molding Fabricated Composite Materials"</b> Lucious BARNUM, Sam Ibekwe, Patrick Mensah, Sahib Chehl (Southern U.,Baton Rouge,LA) .....	101
<b>"Properties of Kenaf/Cotton Blend Yarns and Fabrics"</b> Patricia BEL-BERGER, L. Kimmel (US Dept Agriculture,LA), G.Ramaswamy(Mississippi St.U.) .....	109
<b>"Shear Behavior of Tubular Braided Composites"</b> M.H. Abdel Latif, Nahid AZAB, M. Chaaban (Ain Shams U.,Egypt), I.L.Kamel, Frank Ko (Drexel U.,PA) .....	83
<b>"Fabrication of Composites Glass/PBT using Hybrid Textile Structures"</b> Izabella KRUCINSKA (U.Lodz,Poland), Slawomir Krucinski(Cleveland Clinic,OH) .....	467
<b>"F.E. Simulations of Textile Composite Forming including the Biaxial Fabric Behaviour"</b> Philippe BOISSE, K. Buet, A. Cherouat (U.Paris, France).....	123
<b>"Thermoplastic Composites Created from Needle-Punched Textile Preform"</b> Zsuzsa FEJES-KOZMA, J. Gaal, T. Tama (T.U.Budapest,Hungary).....	267
<b>"Impact Behavior of Veil-Interleaved Laminated Composites"</b> Alan J. LESSER (U.Massachusetts-Amherst).....	507
<b>"Mechanical Response and Failure Modes of Woven Glass Reinforced Plastic Thick Laminate"</b> Prabhakaran K.Centala, Akhtar S.KHAN(U.Maryland-Baltimore).....	441
<b>"Textile Composite Rods Loaded in Torsion"</b> Yu M. TARNOPOL'SKII, V.L. Kulakov (Latvia Acad of Sci.) .....	833

<b>"Study on Densification of Three Dimensional Textile Reinforced Ceramic Matrix Composites via Precursor Pyrolysis"</b> Haifeng HU, Fengrong Liu, Bo Su (Changsha I.T., Hunan, China).....	373
<b>"Design of Textile Composite Materials using an Optimization Approach"</b> Ragavan Vaidyanathan (Kellogg Co., TX), Yasser GOWAYED (Auburn U., AL) .....	317
<b>"Polyimide Resin Composites Reinforced with 3-D Glass-Fiber Fabrics"</b> Shen CHOU, Hong-En Chen, Tsai-Hung Cheng (Nat. Taiwan Ins. Tech.).....	181
<b>"Residual Tensile Fatigue Strength of Plain Woven Carbon/Epoxy Laminates Subjected to Low-Velocity Impacts"</b> Masahiro MORISHITA, Masamichi Kawai, T. Nakahara (U. Tsukuba, Japan).....	599
<b>"The Relationship of the Structure of Various Commingled Yarns with Entanglement and the Mechanical Properties of their Composites"</b> Long Li, Jianyong Yu, Shanyuan WANG (China Textile U., Shanghai).....	901
<b>"Degradation of the Mechanical Properties of GRP Laminates by Stitching"</b> Adrian P. MOURITZ, M.Z. Shah Khan (Defence Sci Tech Org, Australia) .....	603
<b>"Compressive Properties of Stitched Woven Fiberglass Fabric Reinforced Composite Sections for Civil Engineering Applications"</b> Sabit ADANUR, Sreekanth R. Gongalareddy (Auburn U, AL) .....	49
<b>"Consolidation and Properties of Braided Thermoplastic Composites from Powder Coated Carbon Tows"</b> Youjiang WANG, J. Muzzy, A. Ramasamy (Georgia Tech.).....	907
<b>"Properties of Some Bi-Component Core-Wrap Yarns and Fabrics"</b> Paul SAWHNEY, Linda B. Kimmel (US Dept Agriculture, N. Orleans), P. Radhakrishnaiah (Georgia Tech.).....	731
<b>"Simulation of the Shaping of Woven Fabrics"</b> Roger BLANLOT, Jean-Louis Billoet (ENSAM Paris, France) .....	117

## THERMOPLASTICS AND THERMOSETS

Chairs: Su-Seng PANG (Louisiana St. U.)  
Alan R. WEDGEWOOD (Dupont DE)

<b>"A Study on Processing-Structure-Properties of Long Fiber Reinforced Thermoplastics"</b> Thomas R. SKOURLIS, K. Pochiraju, C. Chassapis, S. Manoochehri (Stevens Inst. Tech.).....	771
<b>"Global-Local Analysis of Thermoforming Process of Thermoplastic Composite Laminate by the Homogenization Method"</b> Shih-Wei HSIAO, Noboru Kikuchi (U. Michigan).....	369
<b>"Induction Welding of Thermoset Composite Adherends using Thermoplastic Susceptors"</b> Alan R. WEDGEWOOD (Dupont, DE), Patrice E. Hardy (Boeing, WA).....	915
<b>"Elastic Moduli of Carbon Fiber/Nylon-6 Thermoplastic Composites due to Hygrothermal Effects"</b> Wen-Jinn LIOU, C.I. Tseng, C.R. Lee (Feng Chia U., Taiwan).....	525
<b>"Modeling Interlaminar Slip of Advanced Thermoplastic Composite During Forming"</b> Sheng-Jye HWANG (N. Cheng Kung U., Taiwan).....	379

<b>"Cutting Mechanisms in the Milling Process of Carbon Fibre Reinforced Plastics"</b> F. Klocke, S. RUMMENHOLLER (Aachen, Germany).....	719
<b>"Composites from a Commodity Plastics with Special Properties"</b> Viera KHUNOVA (Slovak T.U., Slovakia), Mohini M. Sain (U. Quebec, Canada).....	443
<b>"Optimization of Thermoformed Reinforced Thermoplastic Products including Effects of Forming Process"</b> Henk deBOER, A.A. Polynkine, F. van Keulen, Otto K. Bergsma, Adriaan Beukers (TU Delft, Netherlands).....	213

## TRIBOLOGY, WEAR AND MACHINING OF COMPOSITES

chair: Sri BANDYOPADHYAY (U. New South Wales, Australia)  
K.G. SATYANARAYANA (CSIR Trivandrum, India)

<b>"Analysis for Ultrasonic Machining of Ceramic Composites"</b> T.C. Lee, Chi-Wai CHAN (Hong Kong Poly. U.).....	139
<b>"Measuring and Reduction of Particle Emissions Caused by Milling of Fibre Reinforced Plastics"</b> F. Klocke, Christoph WUERTZ (Aachen, Germany).....	941
<b>"Understanding Machining of Composites through Fracture Analysis"</b> Malur N. Srinivasan (Lamar U., TX), Carlos R. Corleto (Texas A&M-Kingsville), Rathi BHATACHARYA (Bradley U., IL) .....	113
<b>"Improved Composite Specimen Preparation using Laser Machining Techniques"</b> Michael FLAMAN (Oregon I.T.), Donald McMurchie (Oregon Grad. I. Sci. Tech.).....	275
<b>"Development of Strong Lightweight Polymeric Plates using Micromachining"</b> David Hall, William JORDAN (Louisiana Tech. U.) .....	419
<b>"Erosive Wear Behaviour of AL203-Fibre Reinforced Aluminium Based Metal Matrix Composites (MMCs)"</b> Q. FANG, P. Sidky, M.G. Hocking, S. Long (Imperial Coll., UK) .....	261
<b>"Development of Abrasion Wear Resistant Arc Sprayed 304/316 Stainless Steel-Titanium Diboride Coatings"</b> Serge DALLAIRE (NRC, Quebec, Canada).....	201
<b>"Two Failure Modes for Plasma Sprayed Coatings under Severe Wear Conditions"</b> Donald McMURCHIE, Paul Clayton, Milton Scholl (Oregon Grad I. Sci. Tech.) .....	573
<b>"Surface Photografting and Polymer Interface Engineering"</b> Bengt Ranby (Royal I.T., Sweden), Wan-Tai YANG (Beijing U., China).....	949
<b>"Interfacial Control in Carbon Fibre Epoxy Composites"</b> Carol JONES, Kirsten E. Atkinson (U. Liverpool, UK) .....	413
<b>"In-situ Preparation of TiB2 Reinforced Al Based Composite"</b> S.W. QIN, L. Lu, M.O. Lai, F.L. Chen (Nat. U. Singapore).....	693
<b>"Particulate Reinforced High Ductility AL-Cr MMC"</b> Nilratan Bandyopadhyay, Malay K. BANERJEE (B.E. Coll, India), S. Bandyopadhyay (NSW U., Australia).....	88
<b>"In-situ Composites Based on Al-Cr Age Hardenable Matrix Alloy"</b> Nilratan BANDYOPADHYAY, Malay K. Banerjee (B.E. Coll, India), S. Bandyopadhyay (NSW U., Australia) .....	91
<b>"Tribological Behavior of Filled Epoxies in Reciprocating Motion"</b> S.K. MALHOTRA, K.K.K. Sanyasi Raju (IIT-Madras, India).....	559
<b>"Wear Characteristics of Silicon Carbide Reinforced Cast Aluminum Alloy Matrix Composites and Weldments"</b> R.S. Salimath, S.C. PANIGRAHI, B.K. Dhindaw (IIT-Kharagpur, India) .....	661



"Role of Alloying Elements in Synthesizing Aluminum Metal Matrix Composites by Stir Casting" R.M. Pillai, B.C. Pai, K.G. SATYANARAYANA (CSIR, India) .....	729
"Abrasive Wear of Thermally Aged 6061 AL-SiC Composites" G. MELHEM, P. Krauklis, A.P. Mouritz, S. Bandyopadhyay (U.New S.Wales, Australia) .....	577
"Wear and Temperature Resistant Composites" Daniela F. TARATA (U. Craiova, Romania) .....	831
"Drilling Studies of an AL203/AL Metal Matrix Composite Part II: Drilling Force Measurements and Quality of Drilling" B. MUBARAKI, R. Fowle (Sydney) P.J. Heath (Melbourne), P. Mathew, S. Bandyopadhyay (Sydney, Australia) .....	605
"Tribologically Property Improvement of Aluminium Alloy with AL-Cu-SiC Composite" G. Dixit, Sanjay SONI, S. Dixit (MCAT Bhopal, India) .....	754

## VIBRATION

chairs: Raghu ECHEMPATI (U. Mississippi)  
Jamal NAYFEH (U. Cen Florida)  
C.C. CHAO (N. Tsing Hua U., Taiwan)

"Analysis of the Flexural Fatigue and Fracture of Unidirectional Graphite/Epoxy Composites at Low Temperatures" Nick RIVIECCIO, Jamal Nayfeh (U. Cen. Florida) .....	707
"Dynamic Characterization for Orthotropic Shells using Bayesian Estimators and Rayleigh-Ritz Models" Kim-Ho IP, Ping-Cheung Tse, Tai-Cheung Lai (Hong Kong Poly. U.) .....	389
"Nonlinear Motion of Postbuckled Laminated Plates" Jamal NAYFEH (U. Cen. Florida) .....	619
"Simple Method of Vibration Analysis of Simple-Supported Floor Panels with Point Mass/Masses" Duk-Hyun KIM (Korea Composites, Seoul) .....	445
"Optimal Damping Capacity of Laminated Plates subjected to Torsion" M'hamed HAMD AOUI, Epiphane Ramahefarison (Toulouse, France) .....	339
"Effect of Lamination Arrangement on Modal Characteristics of Laminated Composite Circular Cylindrical Shells" Altan KAYRAN, Gunay Anlas (Bogazici U., Turkey) .....	435
"Fundamental Frequency of Symmetric Composite Plates on a Winkler Foundation" Oscar BARTON Jr. (US Naval Acad., MD) .....	103
"Modeling and Simulation for a Composite Laminate Beam at High Strain Rate" Jin-Chein LIN (Kuang Wu Inst. Tech, Taiwan) .....	521
"Free Vibration of Laminated Skew Plates" Wanmin HAN, Stuart Dickinson (U. Western Ontario, Canada) .....	343
"Prediction and Measurement of Deformation and Damping of Layered Composite Circular Rings" Wai-Keung CHAN, Ping-Cheung Tse, Tai-Cheung Lai (Hong Kong Polytech U.) .....	143
"Free Vibrations of Adhesively Bonded, Partially Stiffened Stepped-Thickness, Composite Plates" Umur YUCEOGLU, V. Ozerciyes (Middle East T.U., Turkey) .....	967

"Mechanism of Vibrating Fatigue Failure of a Reinforced Concrete Member" Hrista STAMENKOVIC (Riverside, CA) .....	791
"Free and Forced Vibration Analysis of Postbuckled Delaminated Beam-Plates" Tai-Ping CHANG, J.Y. Liang (Nat Chung-Hsing U., Taiwan) .....	145
"Analysis of Natural Frequencies of a Layered Composite Plate with Delamination" M. Krawczuk, A. Zak, Wieslaw M. OSTACHOWICZ (Polish Acad Sci.) .....	649
"On the Dynamic Response of Antisymmetric Angle-Ply Laminated Plates" Hirotohi OKAZAKI, Vijayan Baburaj, T. Koga (U. Tsukuba, Japan) .....	643
"The Natural Frequencies and Mode Shape of Composite Beam with Edge Cap" G.C. Michael TSAI (N. I-Lan Inst., Taiwan) .....	857
"Transient Dynamic Response Analysis of Composite Laminates subjected to Thermal-Mechanical Loads" C.A. Shankara, N.G.R. IYENGAR (Indian Inst of Tech.) .....	399
"Three-Dimensional Vibration of Moderately Thick Laminated Curved Panels- a Comparison" C.Y. CHERN, C.C. Chao (N. Tsing-Hua U., Taiwan) .....	167
"Impact and Damping Characteristics of Pultruded Glass-Graphite Epoxy Composites" Murthy V.S.L.N. KOWSIKA, Dev Barpanda, P. Raju Mantena (U. Mississippi) .....	463
"Dynamic Response of the Coupler of a Four-Bar Linkage Fabricated from Pultruded Composite Materials" Meganathan MOHANRAJ, Raghu Echempati, P.R. Mantena (U. Mississippi) .....	597
"Dynamic Analysis of Laminated Composite Beams with Multiple Damping Layers by the Modal Strain Energy Method" Mohan D. Rao, Raghu ECHEMPATI (U. Mississippi) .....	243

## MISCELLANEOUS TOPICS

"Investigation of Alloys Crystallization in the Systems ZrO <sub>2</sub> (HfO <sub>2</sub> )-Y <sub>2</sub> O <sub>3</sub> -Eu <sub>2</sub> O <sub>3</sub> " Elena R. ANDRIEVSKAYA, Valery V. Kovylyaev, Linda M. Lopato (Kiev, Ukraine) .....	67
"On the Interface Crack Contact Model for a Plate under Bending Loading" Ye A. BOBYLOV, V.V. Loboda (Ukraine) .....	119
"Assessment of the Improvement in the Nonlinear Seismic Properties of Earth Composites using Linear Direct Inverse Analysis" Hesham A. ELSHAZLY, T. Hasegawa, A. Murakami (Kyoto U., Japan) .....	255
"Failure Analysis of Composite Laminates under Large Deflection" Marco DiSciava, Ugo ICARDI, Michele Villani (Torino, Italy) .....	381
"Elastic Composites with Periodical System of Parallel Macrocracks: Analysis of Stability in Compression" Igor A. GUZ' (Ukraine) .....	329
"Effective Properties and Their Bounds for the Stochastic Periodic Fiber Composites" Marcin KAMINSKI (T.U. Lodz, Poland) .....	427
"3-D Stress-Strain Analysis of Composite Plates with Nonplanar Interfaces" Maria KASHTALIAN (I. Mechanics, Kiev, Ukraine) .....	433
"A Difference between Reliabilities of Homogeneous and Composite Materials" Igor KOKSHAROV (Russia) .....	453
"Boron Suboxide-New Sintering Additive for Silicon Nitride Ceramics" Nina Orlovskaya, Valerij KOVYLAYEV (Kiev, Ukraine) .....	461

"Energetic Model of Fracture of the Composites with Statistical Distribution of Structural Element Sizes" Nickolaj LUGOVOY, Yu Podrezov (Kiev, Ukraine) .....	535
"Strength, Fracture Toughness, Phase Composition and Structure of Al <sub>2</sub> O <sub>3</sub> -ZrO <sub>2</sub> Al <sub>2</sub> O <sub>3</sub> -ZrO <sub>2</sub> -TiN Ceramics after Annealing" Nina ORLOVSKAYA, Valerij Kovylayev, Sergej Firstov (Kiev, Ukraine) .....	647
"Metastable T. Phase and T-M Transformation of ZR02 in the System ZR02-CEO2-Y203" Victor P. RED'KO, L.M. Lopato (Kiev, Ukraine) .....	701
"Different Physical Field Measurements at Delamination of Composite Plates" Igor V. SIMONOV, E.A. Deviatkin (Moscow, Russia) .....	765
"Stress Analysis of Intersecting Composite Shells" Vadim N. SKOPINSKY (Motor Car Const.Inst, Moscow) .....	767
"On One Approach to the Interface Crack Fracture Parameters Determination" V.V. Loboda, S.A. SMIRNOV, A.E. Shevelova (Ukraine) .....	773

## RESEARCH AND DEVELOPMENT OF Si<sub>3</sub>N<sub>4</sub> CERAMIC VALVES FOR AN AUDI 4 CYL. 5 VALVE-MOTOR

**H. Bauer, H.G. Haldenwanger, K. Huber**  
Audi AG, 85045 Ingolstadt, Germany

The automotive industry's challenge is not only to produce cheaper but also to build fuel consumption optimized vehicles. One possible method is to decrease the weight of the vehicles. Another way to go forward is to look for better technical concepts or to check existing concepts for their potential example of the valve actuating system. The following article gives an introduction to the efforts in research and development which must be overcome until mass production of an engine with ceramic valves can be started.

With the application of ceramic valves, it is possible to reduce the valve-spring force proportional to the oscillating masses. These lower valve-spring forces lead to a reduction of the frictional work of about 30% in idle. The result of this effort is a reduction of fuel consumption up to 10%. Further advantages of Si<sub>3</sub>N<sub>4</sub> valves are lower noise emission of the engine and the possibility of optimizing the gas exchange in case of adapting the cam contour of the camshaft.

### TECHNICAL BACKGROUND

It is well known that the friction of the valve actuating system in idle is very high especially in engines with 4 or 5 valves per cylinder it takes about 30% of the frictional work of the whole engine (Ref.1). This means that only for the operation of the valves in idle, the motor "looses" or needs a torque of about 10 Nm.

Regarding the enormous speed in the research and development of materials and their properties especially in the field of ceramics, it now seems possible to produce inlet valves as well as outlet valves for the application in vehicle engines. The material of the ceramic valves which are running successfully in several prototype vehicles is Si<sub>3</sub>N<sub>4</sub>. Ceramic valves of Si<sub>3</sub>N<sub>4</sub> with the density of 3.26 g/cm<sup>3</sup> are about 60% lighter of weight than valves made of steel. Besides these Si<sub>3</sub>N<sub>4</sub> valves have the advantage of a better temperature, corrosion and wear resistance.

### STEPS OF DEVELOPMENT

Before such a substitution of the valve material can be realized, it is necessary to initiate a very complex testing procedure of the valve actuating system for checking the suitability of the suggested material. This testing procedure starts with measuring stress, strain and bending of the valves simultaneously at several places on the valve in relation to the engine speed and load. Furthermore, it is necessary to check the valve-seat contact and the valve acceleration at critical engine rotation frequencies.

These investigations first are made with a cylinder-head which is driven by an electric motor. Based on these results, the efforts of the valve were then simulated and calculated in a generated FEM-model. To get a better impression of the calculation results, it is very helpful to compare the results of the Si<sub>3</sub>N<sub>4</sub> valves efforts to those of the steel valves.

Additionally, the effects of several realistic mechanical efforts on the valves are simulated,