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F. S. Chau
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- 7522 2T **Performance comparison of motion estimation algorithms on digital video images** [7522-238]
N. A. Ali, Univ. of South Australia (Australia); A. S. Ja'afar, Univ. Teknikal Malaysia Melaka (Malaysia); K. S. Anathakrishnan, Univ. of South Australia (Australia)
- 7522 2U **Improvement in accuracy of a digital image correlation method by a coarse-to-fine approach** [7522-81]
S. Yokokota, K. Machida, Z. G. Zhang, Tokyo Univ. of Science (Japan)
- 7522 2V **Creep properties identification of PBX using digital image correlation** [7522-206]
B. Guo, H. Xie, Tsinghua Univ. (China); P. Chen, Q. Zhang, Beijing Institute of Technology (China)

SENSORS AND ACTUATORS, ULTRASONIC TECHNIQUES

- 7522 2W **The acoustic field characteristic of OPCM ultrasonic phased array actuator/sensor and experimental analysis** [7522-350]
Y. Luo, Z. Wang, Jiangsu Univ. (China)
- 7522 2X **Dynamic response of quartz crystal microbalances in contact with silicone oil droplets** [7522-22]
H. Zhuang, Singapore-MIT Alliance (Singapore); H. P. Lee, S. P. Lim, National Univ. of Singapore (Singapore)
- 7522 2Y **Synthesized design of flexible structures for semiconductor manufacturing equipments** [7522-105]
S. Hashimoto, M. Konuma, K. Shimosakai, M. Nitta, Gunma Univ. (Japan)
- 7522 2Z **Fiber Bragg grating sensor multiplexing system based on the time- and wavelength-division technique** [7522-267]
Y. Dai, T. Fu, J. Leng, Harbin Institute of Technology (China); A. Asundi, Nanyang Technological Univ. (Singapore)

- 7522 30 **Development of optical FBG force measurement system for the medical application** [7522-242]
H. Song, K. Kim, J. Suh, J. Lee, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 7522 31 **Effect on the use of ultrasonic cavitation for biodiesel production from crued *Jatropha curcas* L. seed oil with a high content of free fatty acid** [7522-294]
I. Worapun, K. Pianthong, P. Thaiyasuit, C. Thinwongpituk, Ubonratchathani Univ. (Thailand)
- 7522 32 **Fiber Bragg grating sensors for real-time monitoring of evacuation process** [7522-348]
G. P. A. S., G. M. Hegde, A. S., Indian Institute of Science Bangalore (India)

DYNAMIC MATERIALS AND STRUCTURES, VIBRATION ANALYSIS

- 7522 33 **Transverse vibrations of linear beam system carrying elastically mounted series of discrete masses** [7522-120]
S. Arkhipov, Buryat State Univ. (Russian Federation)
- 7522 34 **Research on vibration behavior of 300km/h EMU trailer wheel set** [7522-87]
W. Wang, Z. Liu, Q. Li, H. Zou, Beijing Jiaotong Univ. (China)
- 7522 35 **Development of active vibration isolation system for precision machines** [7522-352]
H. Z. Li, W. J. Lin, G. L. Yang, A*STAR Singapore Institute of Manufacturing Technology (Singapore)
- 7522 36 **Variational principle of carbon nanotubes with temperature changes** [7522-159]
T. Fan, Harbin Engineering Univ. (China)
- 7522 37 **Moving force identification based on wavelet finite element method** [7522-45]
Q. You, The Hong Kong Polytechnic Univ. (Hong Kong, China) and Nanjing Univ. of Aeronautics and Astronautics (China); S. S. Law, The Hong Kong Polytechnic Univ. (Hong Kong, China); Z. Y. Shi, Nanjing Univ. of Aeronautics and Astronautics (China)
- 7522 38 **Dynamic analysis of engine mounts at different orientations** [7522-314]
O. L. Ean, Z. M. Ripin, Univ. Sains Malaysia (Malaysia)
- 7522 39 **Experiment investigation for dynamic behavior of hybrid fiber effects on reactive powder concrete** [7522-177]
L. Wang, B. Pang, Z. Yang, R. Chi, Harbin Institute of Technology (China)

STRUCTURE HEALTH MONITORING

- 7522 3A **Plastic optical fibre sensor for damage detection in offshore structures** [7522-243]
K. S. C. Kuang, C. G. Koh, National Univ. of Singapore (Singapore)
- 7522 3B **Selective mode excitation of Lamb wave in composite laminates** [7522-263]
S. Saravanan, Nanyang Technological Univ. (Singapore); N. Q. Guo, Nanyang Technological Univ. (Singapore) and Monash Univ. Malaysia (Malaysia); B. S. Wong, F. Ju, Nanyang Technological Univ. (Singapore)

- 7522 3C **Lamb-wave-based damage detection using wave signal demodulation and artificial neural networks** [7522-65]
F. Ju, Nanyang Technological Univ. (Singapore); N. Guo, Nanyang Technological Univ. (Singapore) and Monash Univ. Malaysia (Malaysia); W. Huang, S. Subramanian, Nanyang Technological Univ. (Singapore)
- 7522 3D **Effect of periodic structure on sound propagation** [7522-103]
A. Gupta, C. H. Chew, K. M. Lim, National Univ. of Singapore (Singapore)

SMART MATERIALS AND STRUCTURES

- 7522 3E **Recent progress of smart composite material in HIT (Invited Paper)** [7522-362]
J. Leng, K. Yu, Y. Liu, Harbin Institute of Technology (China)
- 7522 3F **Influence of mechanical force field on the electromechanical stability of dielectric elastomers (Invited Paper)** [7522-199]
Y. Liu, L. Liu, J. Leng, Harbin Institute of Technology (China)
- 7522 3G **Real-time detection of axial force for reliable tightening control** [7522-290]
C. Li, National Institute of Advanced Industrial Science and Technology (Japan); C.-N. Xu, National Institute of Advanced Industrial Science and Technology (Japan) and CREST, Japan Science and Technology (Japan); Y. Adachi, N. Ueno, National Institute of Advanced Industrial Science and Technology (Japan)
- 7522 3H **Experimental research on viscoelastic characteristics of shape memory polymers** [7522-17]
Z. F. Li, Z. D. Wang, Beijing Jiaotong Univ. (China)
- 7522 3I **Dual piezoelectric actuators for the traveling wave ultrasonic linear motor** [7522-319]
P. Suybangdum, P. Smithmaitrie, Prince of Songkla Univ. (Thailand); P. Laoratanakul, National Metal and Materials Technology Ctr. (Thailand)
- 7522 3J **Research on seismic behavior and filling effect of a new CFT column-CFT beam frame structure** [7522-117]
Y. Wang, Shenyang Univ. of Technology (China); H. Shima, Kochi Univ. of Technology (Japan)
- 7522 3K **Effect of chain extender on properties of silicone rubber sealant** [7522-181]
J. Liu, S. Wu, Y. Mi, G. Zhu, S. Zheng, Wuhan Univ. of Technology (China)

AEROSPACE MATERIALS AND COMPOSITES, BRIDGE AND ROADS

- 7522 3L **Development of space telescope mirror made by light and thermally stable CFRP** [7522-75]
J. Koyanagi, Japan Aerospace Exploration Agency (Japan); Y. Arao, H. Terada, Waseda Univ. (Japan); S. Utsunomiya, S. Takeda, Japan Aerospace Exploration Agency (Japan); H. Kawada, Waseda Univ. (Japan)
- 7522 3M **Picture frame experiment and analytical model of the pre-impregnated woven fabric composite** [7522-92]
W. Wang, L. Sun, Harbin Engineering Univ. (China)

- 7522 3N **Monitoring of internal residual strain changes in CFRP using FBG sensors** [7522-288]
S. Takeda, J. Koyanagi, S. Utsunomiya, Japan Aerospace Exploration Agency (Japan);
Y. Kinoshita, Y. Arai, H. Kawada, Waseda Univ. (Japan)
- 7522 3O **Research on tensile strength characteristics of bridge deck pavement bonding layers**
[7522-152]
S. Wu, J. Han, Wuhan Univ. of Technology (China)
- 7522 3P **Research on durability of self-leveling silicone rubber as aqueduct joint sealant** [7522-183]
M. Chen, Y. Mi, S. Wu, J. Liu, Wuhan Univ. of Technology (China)
- 7522 3Q **Analysis of creep effects for a cable-stayed bridge with composite girder** [7522-254]
B. Jia, Q. Yan, South China Univ. of Technology (China)

SPECIAL SESSION ON ADVANCED X-RAY INSPECTION AND TESTING

- 7522 3R **Planar cone-beam computed tomography for high-resolution industrial application
(Invited Paper)** [7522-69]
T. Liu, A*STAR Singapore Institute of Manufacturing Technology (Singapore)
- 7522 3S **Metrology CT technology and its applications in the precision engineering industry
(Invited Paper)** [7522-246]
G. Schick, Carl Zeiss Pte. Ltd. (Singapore)
- 7522 3T **Pincushion distortion correction in x-ray imaging with an image intensifier** [7522-74]
T. Liu, A. A. Malcolm, J. Xu, A*STAR Singapore Institute of Manufacturing Technology
(Singapore)
- 7522 3U **X-ray CT image segmentation: automatic sandwich structure layer separation using
reduced dimension Hough transformation** [7522-125]
J. Xu, T. Liu, A*STAR Singapore Institute of Manufacturing Technology (Singapore);
R. Kakarala, Nanyang Technological Univ. (Singapore); X. M. Yin, A*STAR Singapore Institute
of Manufacturing Technology (Singapore)

EXPERIMENTAL ANALYSIS OF MECHANICAL PROPERTY I

- 7522 3V **Study on strength properties of reinforced expensive soils with failure material** [7522-118]
W. Ding, Shandong Univ. (China); J. Liu, Shandong Jiaotong Univ. (China); Q. Liu, Shandong
Univ. (China); S. Lei, Chang'an Univ. (China)
- 7522 3W **Experiments to find constitutive relation for materials undergoing large deformation**
[7522-310]
H. Hariharaputhiran, U. Saravanan, Indian Institute of Technology Madras (India)
- 7522 3X **Analysis on volume invariability of metal circular shaft in torsion deformation** [7522-46]
L.-H. Yang, G.-P. Zou, Y.-Z. He, H. Wang, Harbin Engineering Univ. (China)
- 7522 3Y **Mechanical properties of alloy Mg-Li rod in tension** [7522-174]
X. Zhang, G. Zou, Y. Cao, B. Yue, Harbin Engineering Univ. (China)

- 7522 3Z **Detection and location of debris cloud impact damage** [7522-209]
K. Zhang, B. Pang, Z. Liu, R. Chi, Harbin Institute of Technology (China)
- 7522 40 **Study of mechanical, physical, and corrosion behavior of 0.5% cobalt alloyed austempered ductile iron** [7522-222]
B. Abdullah, A. Jaffar, S. K. Alias, Univ. Teknologi MARA (Malaysia); A. Ramli, Univ. Industri Selangor (Malaysia); M. F. Izham, Univ. Teknologi MARA (Malaysia)

EXPERIMENTAL ANALYSIS OF MECHANICAL PROPERTY II

- 7522 41 **Influence of repeated quenching on the rolling contact fatigue of bearing steel** [7522-333]
E. C. Santos, T. Honda, K. Kida, Kyushu Univ. (Japan)
- 7522 42 **Effect of powder contents on stress relaxation of glass powder reinforced epoxy** [7522-221]
T. Sakai, Tokyo Metropolitan Univ. (Japan); K. Okabe, S. Yoneyama, Aoyama Gakuin Univ. (Japan)
- 7522 43 **Evaluation of low temperature properties of warm mix asphalt** [7522-208]
J. Wen, Z. Liu, S. Wu, Wuhan Univ. of Technology (China)
- 7522 44 **Time response analysis in suspension system design of a high-speed car** [7522-95]
C. P. Pagwiwoko, Univ. of Nottingham, Malaysia Campus (Malaysia)
- 7522 45 **Mechanical, physical, and corrosion characteristics of 2% vanadium alloyed ductile iron** [7522-336]
B. Abdullah, A. Jaffar, S. K. Alias, R. Jaafar, Univ. Teknologi MARA (Malaysia); A. Ramli, Univ. Industri Selangor (Malaysia); A. Faitullah, Univ. Teknologi MARA (Malaysia)

PHASE RETRIEVAL AND IMAGE PROCESSING

- 7522 46 **New developments in optical dynamic testing** [7522-121]
Y. Fu, Nanyang Technological Univ. (Singapore); P. B. Phua, Nanyang Technological Univ. (Singapore) and DSO National Labs. (Singapore)
- 7522 47 **A modified WFT for shape and deformation measurement** [7522-56]
H. Niu, C. Quan, C. J. Tay, National Univ. of Singapore (Singapore)
- 7522 48 **Coherence-enhancing diffusion and windowed Fourier filtering for fringe pattern denoising** [7522-321]
H. Wang, K. Qian, Nanyang Technological Univ. (Singapore)
- 7522 49 **Challenges of digital holography in micro-optical measurement** [7522-232]
H. Yan, Nanyang Technological Univ. (Singapore); A. Tian, Xian Technological Univ. (China); A. Asundi, Nanyang Technological Univ. (Singapore)
- 7522 4A **New noise detection scheme for noisy phase map of objects containing height discontinuities** [7522-131]
J.-F. Weng, Y.-L. Lo, National Cheng Kung Univ. (Taiwan)

TOMOGRAPHY AND MACHINE VISION

- 7522 4B **Observation of fretting fatigue cracks by micro-computed-tomography using ultrabright synchrotron radiation** [7522-179]
Y. Nakai, D. Shiozawa, Kobe Univ. (Japan); T. Kurimura, Mitsubishi Heavy Industries, Ltd. (Japan); K. Kajiwara, Japan Synchrotron Radiation Research Institute (Japan)
- 7522 4C **Application of computed tomography to quality inspection of brass alloy** [7522-83]
G. B. Suparta, Gadjah Mada Univ. (Indonesia); N. Handayani, Univ. Islam Negri (Indonesia)
- 7522 4E **Preliminary study on the transmitted light tomography** [7522-111]
A. I. Natalisanto, Mulawarman Univ. (Indonesia) and Gadjah Mada Univ. (Indonesia); G. B. Suparta, A. Harjoko, Gadjah Mada Univ. (Indonesia)
- 7522 4F **The segmentation of texture surface under varying illuminant direction** [7522-266]
J. Cong, Y. Yan, Northeastern Univ. (China)
- 7522 4G **A hybrid numerical-experimental method for determination of dynamic fracture properties of material** [7522-299]
S. Mihradi, I. S. Putra, T. Dirgantara, D. Widagdo, L. X. Truong, Institut Teknologi Bandung (Indonesia)
- 7522 4H **Active contours technique for fringe evaluation of complicated fringe patterns** [7522-349]
R. Joishi, National Institute of Technology Surathkal (India); K. P. J. Reddy, G. M. Hegde, Indian Institute of Science Bangalore (India)

ANALYSIS OF DISPLACEMENT AND STRAINS, DIGITAL IMAGE CORRELATION

- 7522 4I **Image rectification method of digital negative x-ray scan of weld** [7522-58]
Y. Yuan, X. Zhou, Shenyang Univ. (China); J. Cong, Northeastern Univ. (China)
- 7522 4J **Performance evaluation of the correlation and smoothing methods of the digital image correlation and its application to the opening specimens** [7522-308]
T. Dirgantara, A. Sukma Jaya, I. S. Putra, Institut Teknologi Bandung (Indonesia)
- 7522 4K **A true 3D physical model test study on the stability of an underground cavern group in Shuangjiangkou Hydropower Station** [7522-38]
W. Zhu, Shandong Univ. (China); L. Zhang, National Univ. of Singapore (Singapore); Y. Li, Q. Zhang, Shandong Univ. (China)

Part Three

SPECIAL SESSION ON COMMERCIALIZATION OF RESEARCH

- 7522 4L **Compact handheld digital holographic microscopy system development** [7522-127]
V. R. Singh, Nanyang Technological Univ. (Singapore); L. Sui, Nanyang Technological Univ. (Singapore) and Xi'an Univ. of Technology (China); A. Asundi, Nanyang Technological Univ. (Singapore)

- 7522 4M **Development of dynamic shape and strain measurement system by sampling moiré method** [7522-359]
K. Shimo, M. Fujigaki, A. Masaya, Wakayama Univ. (Japan); Y. Morimoto, Moiré Institute Inc. (Japan)
- 7522 4N **Twisted nematic liquid crystal cell characterization using rotating polarizers including full-field cell gap thickness measurement** [7522-269]
K. Dev, A. Prakarsa, Nanyang Technological Univ. (Singapore); Y. X. Jiang, Singapore Polytechnic (Singapore); H. L. Lee, Ngee Ann Polytechnic (Singapore); A. Asundi, Nanyang Technological Univ. (Singapore)
- 7522 4O **High-accuracy and real-time shape measurement using whole-space tabulation board** [7522-353]
A. Masaya, M. Fujigaki, R. Murakami, Wakayama Univ. (Japan); Y. Morimoto, Moiré Institute Inc. (Japan)
- 7522 4P **Physical phase compensation in digital holographic microscopy** [7522-115]
W. Qu, O. C. Chee, Ngee Ann Polytechnic (Singapore); Y. Yu, Shanghai Univ. (China); V. R. Singh, A. Asundi, Nanyang Technological Univ. (Singapore)

INTERFEROMETRIC AND DIFFRACTIVE TECHNIQUES, HOLOGRAPHY, AND SPECKLES

- 7522 4Q **Crack detection in photovoltaic cells using electronic speckle pattern interferometry** [7522-289]
T.-K. Wen, C.-C. Yin, National Chiao Tung Univ. (Taiwan)
- 7522 4R **Digital speckle shearing interferometry use of linear CCD scanning** [7522-291]
J. Zhao, J. Di, W. Sun, Q. Wang, X. Jiao, X. Yan, Northwestern Polytechnical Univ. (China)
- 7522 4S **Thin film thickness and refractive index measurement by multiple beam interferometry** [7522-361]
T. Y. Chen, Y. J. Lin, S. G. Hu, S. L. Yang, J. C. Chung, National Cheng Kung Univ. (Taiwan)
- 7522 4T **Application of speckle technique in corrosion process monitoring of an aluminum alloy** [7522-164]
J. Lu, G. Zou, Harbin Engineering Univ. (China)
- 7522 4U **Measurement of defect size and location of wall thinned pipe using ESPI and shearography** [7522-223]
K. Kim, D. Jung, H. Chang, H. Jung, Chosun Univ. (Korea, Republic of)
- 7522 4V **Effect of separation length on dual fibre Bragg gratings** [7522-19]
S. Nafisah, Univ. Teknologi Malaysia (Malaysia); Saktioto, Univ. Teknologi Malaysia (Malaysia) and Univ. of Riau (Indonesia); M. Fadhali, Ibb Univ. (Yemen); P. P. Yupapin, King Mongkut's Institute of Technology Ladkrabang (Thailand); J. Ali, Univ. Teknologi Malaysia (Malaysia)
- 7522 4W **Effect of load variation and shearing direction on the phase measurement in shearography** [7522-282]
W. S. Wan Abdullah, Malaysian Nuclear Agency (Nuclear Malaysia) (Malaysia)

- 7522 4X **External disturbance of potential energy photon in fiber Bragg grating** [7522-24]
H. Mohd Hairi, Univ. Teknologi Malaysia (Malaysia); Saktioto, Univ. Teknologi Malaysia (Malaysia) and Univ. of Riau (Indonesia); M. Fadhalı, Ibb Univ. (Yemen); P. P. Yupapın, King Mongkut's Institute of Technology Ladkrabang (Thailand); J. Ali, Univ. Teknologi Malaysia (Malaysia)

LASERS, INFRARED THERMOGRAPHY MEASUREMENT, AND OTHERS

- 7522 4Y **Improved active non-destructive inspection using periodic binary heating sequences** [7522-173]
G. Arroud, Artesis Univ. College of Antwerp (Belgium) and Vrije Univ. Brussel (Belgium); P. Guillaume, Vrije Univ. Brussel (Belgium)
- 7522 4Z **Measurement of defect thickness of the wall thinning defect pipes by lock-in infrared thermography technique** [7522-212]
K. Kim, K. Kim, H. Jung, H. Chang, Chosun Univ. (Korea, Republic of)
- 7522 50 **Development of living body information monitoring system** [7522-328]
H. Sakamoto, Y. Ohbuchi, I. Torigoe, Kumamoto Univ. (Japan); H. Miyagawa, Yasukawa Information System Corp. (Japan); N. Murayama, Y. Hayashida, T. Igasaki, Kumamoto Univ. (Japan)
- 7522 51 **Circular apertures for contact hole patterning in 193-nm immersion lithography** [7522-100]
C. J. Tay, C. Quan, M. L. Ling, National Univ. of Singapore (Singapore); Q. Lin, S. K. Tan, G. S. Chua, Chartered Semiconductor Manufacturing Ltd. (Singapore)
- 7522 52 **Tunable coupling ratio for optical switch application** [7522-23]
Saktioto, Univ. Teknologi Malaysia (Malaysia) and Univ. of Riau (Indonesia); N. F. Hanim, M. Fadhalı, Univ. Teknologi Malaysia (Malaysia); P. Yupapın, King Mongkut's Institute of Technology Ladkrabang (Thailand); J. Ali, Univ. Teknologi Malaysia (Malaysia)

POSTER SESSION

- 7522 53 **Phase unwrapping work of photoelastic stress analysis** [7522-186]
M. J. Huang, P. C. Sung, H. L. An, National Chung Hsing Univ. (Taiwan)
- 7522 55 **Displacement and strain measurement of micro part using digital microscopy holographic interferometry** [7522-252]
C. Sekiguchi, S. Yoneyama, Aoyama Gakuin Univ. (Japan)
- 7522 56 **Compact fringe projection profilometer** [7522-136]
L. Huang, S. S. Chng, Nanyang Technological Univ. (Singapore); C. P. Lee, Ngee Ann Polytechnic (Singapore); P. S. K. Chua, A. Asundi, Nanyang Technological Univ. (Singapore)
- 7522 57 **Time-average fringe method for vibration mode analysis** [7522-230]
X. Su, Q. Zhang, Y. Wen, L. Xiang, Sichuan Univ. (China)
- 7522 58 **Three-dimensional shape measurement of object in water using fringe projection and phase value tracking** [7522-195]
Q. Zhang, Q. Wang, Z. Hou, Y. Liu, X. Su, Sichuan Univ. (China)

- 7522 59 **Study on wavelet transform profilometry based on fringe projection with two carrier frequencies** [7522-240]
W. Chen, Y. Zhao, X. Su, Sichuan Univ. (China)
- 7522 5A **Inner crack reconstruction and mechanical analysis for rock-specimen-based phase measuring profilometry** [7522-285]
Y. Cao, Y. He, Sichuan Univ. (China)
- 7522 5B **Influence of OPD in wavelength-shifting interferometry** [7522-144]
H. Wang, A. Tian, B. Liu, J. Dang, Xi'an Technological Univ. (China)
- 7522 5C **Analysis of asphericity measurement in lateral shearing interferometry** [7522-146]
B. Liu, A. Tian, H. Wang, C. Wang, Xi'an Technological Univ. (China)
- 7522 5D **Camera calibration method based on bundle adjustment** [7522-08]
L. Sui, T. Zhang, Xi'an Univ. of Technology (China)
- 7522 5E **Improved inertia moment method of dynamic speckle analysis and its application** [7522-143]
J. Lu, G. Zou, Y. Liu, D. Sun, Harbin Engineering Univ. (China)
- 7522 5F **Research of three-dimensional edge model to identify overlapped objects** [7522-54]
L. Zhu, P. Yuan, J. Cong, H. Liu, Northeastern Univ. (China)
- 7522 5G **Polarization-interferometric nonlinear confocal microscopy for measuring nano-sized objects** [7522-61]
C. Egami, H. Tanaka, H. Murakami, S. Ota, Shizuoka Univ. (Japan) and JST-CREST (Japan)
- 7522 5H **Design and performance tests of a distributed power-driven wheel loader** [7522-62]
X. Jin, L. Shi, Y. Bian, Tongji Univ. (China)
- 7522 5I **Experimental study on fatigue performance and damage model of aluminum alloy welding joints for high-speed train car body** [7522-78]
W. Wang, Q. Li, Z. Liu, B. Wang, Beijing Jiaotong Univ. (China)
- 7522 5J **Experimental study on tensile mechanical behaviors of 5A06 aluminum alloy under short time elevated temperature** [7522-36]
W. Li, W. Niu, Z. Hao, M. Li, S. Hu, Y. Cheng, Chinese Academy of Engineering Physics (China)
- 7522 5K **An analytical method on the surface residual stress for the cutting tool orientation** [7522-207]
Y. Li, Shandong Univ. (China) and Shandong Jianzhu Univ. (China); J. Zhao, W. Wang, Shandong Univ. (China)
- 7522 5L **Failure mechanism of epoxy polymer: transition from ductile to brittle failure** [7522-340]
W. Wu, G. Ma, Nanyang Technological Univ. (Singapore)
- 7522 5M **PC floor systems for microelectronics manufacturing buildings** [7522-198]
K. Hong, Yonsei Univ. (Korea, Republic of); S. Lee, Kunsan National Univ. (Korea, Republic of); Y. Kwon, Samsung Engineering Co., Ltd. (Korea, Republic of); H. Chun, Chodang Univ. (Korea, Republic of); K. Cho, Samsung Engineering Co., Ltd. (Korea, Republic of); S. Kim, Yonsei Univ. (Korea, Republic of)

- 7522 5N **Operational modal analysis of vehicle system based on SSI under operational conditions** [7522-295]
S. Zhou, Beijing Jiaotong Univ. (China); Y. Xie, Jining Vocational Technology College (China); J. Xie, Beijing Jiaotong Univ. (China); F. Li, Jining Vocational Technology College (China)
- 7522 5O **A measurement of a control rod drop using an LVDT** [7522-96]
M.-H. Choi, J.-H. Kim, H. Huh, J.-Y. Yu, D.-S. Sohn, Korea Atomic Energy Research Institute (Korea, Republic of)
- 7522 5P **Residual stress distribution of wheel tread for freight car due to aging effect** [7522-130]
S.-J. Kwon, D.-H. Lee, J.-W. Seo, S.-T. Kwon, Korea Railroad Research Institute (Korea, Republic of)
- 7522 5Q **Experimental study of cumulative effect of residual stress on machined surface on HSM** [7522-197]
Y. Li, Shandong Univ. (China) and Shandong Jianzhu Univ. (China); J. Zhao, W. Wang, Shandong Univ. (China)
- 7522 5R **The effect to bending fatigue strength of 65 mn under torsion strain-hardening** [7522-256]
G. Zou, Q. Xue, W. Li, Harbin Engineering Univ. (China)
- 7522 5S **Digital holographic display** [7522-338]
C. P. Lee, Y. P. Chia, Ngee Ann Polytechnic (Singapore); V. R. Singh, A. Asundi, Nanyang Technological Univ. (Singapore); X. J. Khoo, K. L. Tay, J. Zhou, Hwa Chong Institution (High School Section) (Singapore)
- 7522 5T **Multiphase pumping: indoor performance test and oilfield application** [7522-114]
X. Kong, H. Zhu, S. Zhang, China Univ. of Petroleum (China); J. Li, Oil Research Institute (China)
- 7522 5U **Effects of liquid viscosity on liquid film flow in gas-liquid two-phase annular flow** [7522-337]
K. Mori, A. Nakata, Osaka Electro-Communication Univ. (Japan)
- 7522 5V **Visualization study on the static flow field around a straight-bladed vertical axis wind turbine** [7522-342]
Y. Li, Northeast Agricultural Univ. (China); K. Tagawa, Tottori Univ. (Japan)
- 7522 5W **Optimization of helico-axial multiphase pump impeller based on orthogonal experimental design** [7522-50]
J. Zhang, H. Zhu, Y. Li, C. Yang, China Univ. of Petroleum (China)
- 7522 5X **Numerical analysis and experiment research of cylinder valve port cavitating flow** [7522-30]
W. Jia, C. Yin, Nanjing Univ. of Technology (China)
- 7522 5Y **Optical monitoring study on estuarine sediment incipient under marine hydrodynamic** [7522-16]
H. Qin, S. Li, Shandong Univ. (China); L. Zhang, National Univ. of Singapore (Singapore)
- 7522 5Z **Experimental study of optical fibers influence on composite** [7522-51]
R.-M. Liu, D.-K. Liang, Nanjing Univ. of Aeronautics and Astronautics (China)

- 7522 60 **Two-dimensional strain sensitivity of epoxy-matrix carbon fiber smart layer** [7522-236]
S. Zhu, H. Zheng, Z. Li, Wuhan Univ. of Technology (China)
- 7522 61 **An improved method for testing tension properties of fiber-reinforced polymer rebar**
[7522-15]
G. Yuan, J. Ma, G. Dong, Tongji Univ. (China)
- 7522 62 **Analysis of causes of crack for a rectangular slab bridge based on ANSYS** [7522-53]
Z. He, South China Univ. of Technology (China); P. Xu, Transport Planning and Research
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Introduction

The 4th International Conference on Experimental Mechanics (ICEM 2009), in conjunction with the 8th Asian Conference on Experimental Mechanics (ACEM8), was successfully held from 18–20 November 2009 at Holiday Inn Atrium Hotel, Singapore. The conference was attended by 256 delegates from 21 countries.

The conference program included three keynote and 19 invited presentations given by eminent experts in their respective fields. Professor Kyung-Suk Kim of Brown University (USA) delivered a lecture entitled “Hybrid multi-scale experiments and high performance computing for cross-scale engineering of nano and microstructures.” Professor Masaaki Sato of Tohoku University (Japan) presented the second keynote lecture, entitled “Mechanobiology of endothelial cell and the cytoskeletons.” The third keynote lecture was presented by Professor Shulian Zhang of Tsinghua University (China) on “Nano-scale measurement instruments based on new principle in lasers.” The 19 invited presentations were given by experts from Belgium, China, Germany, Japan, Singapore, Turkey, UK, and USA.

Apart from the above, 233 papers were presented in 32 oral sessions and 66 papers were presented in nine poster sessions. The Students with Experts Lunch provided a chance to promote personal and professional growth through networking, and provided students with a better perspective of their research. This conference covered eight thematic topics ranging from traditional solid mechanics to fluid mechanics and dynamics to the more current micro and nano mechanics, biomechanics and smart structures and non-destructive testing (NDT). There were six special sessions; two each in Experimental Solid Mechanics and Hybrid Methods & Image Processing, and one each in Non-Destructive Testing & Smart Structures and Commercialization of Research.

We take this opportunity to thank all speakers and authors for contributing to the success of the conference, the members of the international advisory committee for their assistance and enthusiastic support, the session chairs, our sponsors, and the organizing committee for ensuring the efficient execution of the conference program.

C. Quan
Chair, Scientific Program Committee, ICEM2009



Group photo of delegates at the opening ceremony

Keynote Speakers Abstracts

Kyung-Suk KIM
Brown University, USA

Title: Hybrid Multi Scale Experiments and High Performance Computing for Cross Scale Engineering of Nano and Microstructures

In the past decade, the engineering community has begun to develop and enhance the capabilities of technological devices and systems based on nano and microstructures. New discoveries and new inventions are emerging in cross-scale engineering of nano and microstructures, hybridizing supercomputing simulations and scale-bridging experiments. Examples of recent developments in hybrid experiments will include a nano pyramid flattening experiment to study size-scaling of plastic deformation in nanoscale asperities for understanding and controlling the wear and fatigue degradation that occurs between surfaces of engineered materials in contact. The examples will also include ultrasonication experiments which have led to the discovery of a new carbon nanotube scission mechanism caused by ultrasonication, and the ion-beam irradiation growth of nano-porous thin amorphous carbon films on a PDMS compliant substrate, being developed for renewable energy and clean environment technology applications.

Masaaki SATO
Tohoku University, Japan

Title: Mechanobiology of Endothelial Cell and the Cytoskeletons

Endothelial cells (ECs), lining on the luminal wall of blood vessels, change their morphology and physiological functions due to hemodynamic stimuli. Many of reports have shown that ECs elongate and align to the direction of flow after exposure to physiological levels of wall shear stress (WSS, 1~2 Pa), and such morphological changes of ECs have been thought to influence the functions. However, only a few studies have investigated the effect of wall shear stress gradient (WSSG) on ECs. In my talk I will present morphological responses of ECs under high WSS and high WSSG condition using a T-shaped flow chamber to evaluate the effects of WSSG to ECs. After 24 h exposure to flow, ECs under high WSS (10 Pa) without WSSG condition oriented perpendicular to the flow, whereas ECs at high WSS (10 Pa) with WSSG condition did not cause EC alignment. After 72 h exposure to flow, ECs exposed to WSSG were not polarized whereas ECs at high WSS without WSSG condition orientated and elongated to the direction of flow. These results indicate that a WSSG may suppress orientation of ECs to the flow direction. ECs respond to mechanical stimuli and change their morphology as shown above to be adapting to the mechanical environments. The cytoskeletal structure, mainly actin filaments, also changes the location and the alignment. We have been interested in the roles of cytoskeletons to elucidate the mechanosensing mechanisms. One of the key components to determine cell morphology is stress fiber, bundles of actin filaments, as a structural component. With respect to this, tensile properties of isolated single stress fibers were obtained with in vitro micromanipulation. Preexisting tension in the stress fibers was then evaluated from a combination of their tensile properties and preexisting strain. The result revealed that physiological tension level of the stress fibers was 1-10 nN order of magnitude, which was comparable to that of the traction force applied by adherent cells at their focal adhesion sites. Traction forces were estimated using micropatterned substrates with arrays of micropillars, showing an average of 11.8 nN. This work is supported financially in part by the Grant-in-Aid for Scientific Research (Scientific Research A #17200030 and Specially Promoted Research #20001007) by the Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT), and the Mitsubishi Foundation.

Shulian ZHANG
Tsinghua University, China

Title: Nano-Scale Measurement Instruments Based on New Principle in Lasers

This paper introduces several nano-scale measurement technologies/instruments based on new physical principles developed in the speaker's group.

Laser Nanometer Ruler, a completely new displacement sensor based on orthogonally polarized HeNe laser cavity tuning. This instrument possesses nano-scale resolution and large measurement range up to tens of mm, as well as the inherent function of trace to the source of light wave without frequency stabilization.

Laser Feedback Nanometer Ruler, another novel displacement sensor based on the orthogonally polarized feedback effect in the HeNe lasers and Nd: YAG laser caused by an extra-cavity 45° wave plate. Its measurement range is up to 150 mm, and the laser beam is very easy to be collimated to the target.

Quasi-common-path Nd: YAG Laser Feedback Interferometers. Working in a totally non-cooperative way this instrument does not require any target mirror/prism as in common interferometers, which makes it capable of characterizing the movement of various objectives such as neuroscience aluminum, neuroscience steel, neuroscience cast iron, glass, and paint surfaces.

Laser Feedback Profiler, a non-contact surface topography measurement instruments based on the feedback effect of the Nd: YAG laser. Due to the super-high sensitivity to the reflected light, it can be used to measure the challenging profile of the transparent (such as glass) surfaces.

The resolution and accuracy of these measurement instruments were gradually enhanced in past 10 years and now have reached nm and sub-nm scopes. We believe that these instruments are able to supplement or partially replace the current sensors.

Abstract for paper 7522-160

Analysis of Broken Accident of FRP Insulator Rod installed in Neutral Section of Electric Railway overhead line

D. Jang, H.-C. Kim, K. Lee, Korea Railroad Research Institute (Korea, Republic of)

The accident of broken insulator rod leads to interruption of moving the subway. We investigate the analysis of analysis of breaking accident of FRP insulator rod installed in neutral section for overhead catenary feeding system. In order to analysis of accident reason, SEM is used to analysis microscopic structure on surface of cross section of broken FRP insulator rod. At the same time, we examine the change of atomic amount on surface of broken accident insulator through EDX analysis. Also, in order to check the mechanical strength, the tensile strength test is conducted. As obtained results, examination of broken insulator from SEM and EDX analysis, the shape of cross section is similar to brittle fracture. From the SEM picture, the resin was damaged by internal discharge and basic resin material, cutting glass fibers were located on the same surface and the surface of cutting glass fiber was smooth. We known that the main ingredients were detected CaCO_3 , SiO_2 and Al_2O_3 from EDX analysis.

Submission ID : ICEMA00038-00052

Presentation Type : Contributed Oral

Topic/Symposium : (C08) NDTSS: Automation of NDT procedures

Keywords : Nondestructive; Algorithm; Measurement

Blind Eddy Current Sorting: A Case Study

Shyamsunder Baskaran

IQC Advanced Inspection Solutions, Chennai, India

Eddy Current Testing is an indirect measurement based test that can be used for flaw detection, conductivity and magnetic permeability measurements. It is used in the manufacturing industry for ensuring that the finished product meets specifications, a process that is called "sorting". Being an indirect method, the technique requires calibration with reference standards. In this case study a procedure deployed to identify good parts in a mixed batch of "good"s and "unknown"s in the absence of reference standards is presented. The procedure makes use of prior statistical knowledge and established statistical tools such as the k-Nearest Neighbour (kNN) to provide a heuristic that helps us isolate a reference standard from the mixed population.

An overview of eddy current testing for segregation and the deployed statistical methods are presented. The procedure is then developed from a statistics perspective. The procedure is applied on actual industrial data and the results are presented.

Submission ID : ICEMA00160-00369

Presentation Type : Contributed Poster

Topic/Symposium : (E05) BLS: Mechanobiology

Keywords : Biomechanical; Mechanobiology; Cell

Suppression of Bone Resorption using Fluid Shear Stress and Neurotransmitter

Ji Hyun Kwag; Byung Gwan **Kim**; Kyung Hwan **Kim**; Chi Hyun **Kim**

Department of Biomedical Engineering, College of Health Science, Wonju, South Korea

Oscillatory fluid flow-induced shear stress suppresses bone resorption by regulation of the receptor activator of NF- κ B ligand (RANKL) and osteoprotegerin (OPG) signaling. Neurotransmitters such as calcitonin-gene related peptide (CGRP) and vasoactive intestinal peptide (VIP) are present in bone tissue and may have the potential to interact with mechanical signal-induced bone remodeling. In this study, we quantified the effects of the neurotransmitters and/or mechanical loading on the suppression of bone resorptive activities. MC3T3-E1 pre-osteoblasts were subcultured on glass slides and placed in custom-built sterile parallel plate flow chambers under sterile conditions. Oscillatory fluid flow-induced shear stress of maximum ± 1 Pa was applied for 1 hr. RANKL and OPG gene expression and protein synthesis were quantified using real-time RT-PCR and ELISA. CGRP and VIP suppressed RANKL and increased OPG protein release. Similar results were obtained with fluid flow-induced shear stress. Combined neurotransmitter and fluid flow-induced shear stress did not further enhance the changes. Results from this study suggest that the bone resorptive aspect of bone balance may be regulated similarly by neurotransmitter and mechanical loading through RANKL and OPG signaling. However, further in vitro and in vivo studies need to be performed to fully understand this mechanism.

Submission ID : ICEMA00253-00389

Presentation Type : Contributed Oral

Topic/Symposium : (D06) MNM: Micro and nano-metrology

Keywords : AFM; Biochips; Biosensors

Quantitatively Characterize the Structure, Surface Properties, and Dynamics of MEMS Device

Wanxin Sun

Veeco Asia Pte Ltd, Singapore

MEMS devices have been extensively used in a variety of applications, ranging from inkjet printer, accelerometer in consumable electronics, to biomedical sensing. With increasing demand on functionalities of MEMS devices, the scale of integration has increased significantly over the past a few years. With the shrinkage in dimension and increased complexity, the accuracy in fabrication and surface treatments become critical factors affecting the final performance of the devices. In this report, we review applications of different techniques on the measurements of dimensions in XYZ, surface roughness, mechanical properties, electric properties, and surface hydrophobicity with nanometer resolution. The challenges and feasibility of measurements under controlled environment, e.g. in vacuum, or liquid, are also discussed in this report. Besides these static properties, the dynamics of motion devices affect their applications directly. At the end of this report, we discuss the dynamic characterization of motion in 3D with nanometer accuracy, for example in-plane, out-of-plane motion in hundreds of KHz.

Submission ID : ICEMA00251-00391

Presentation Type : Contributed Oral

Topic/Symposium : (A06) ESM: Nondestructive testing evaluation and fault detection

Keywords : Techniques; Analysis; Nondestructive

Column Test-rig Facility for Column Scanning Studies

Rasif Mohd Zain; Roslan Yahya

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Distillation columns are considered as one of the most critical components in oil and gas plants. The plant performance depends on the ability of these columns to function as intended. Defective columns may lead to serious consequences to the plant operation, and hence the quality of product. In order to perform any inspection techniques to distillation column for NDT practitioner, the best facility was designed when the adjustable defeats of distillation column test rig has been developed. The paper discussed the development and the function of this facility.

Submission ID : ICEMA00277-00522

Presentation Type : Invited Oral

Topic/Symposium : (A05) ESM: Whole-field distribution analysis of displacement & strain

Keywords : MEMS; Displacements; Measurement

Two Grating-based Methods for Deformation Evaluation of MEMS

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Quantitative evaluation of the structure deformation of MEMS is of importance for the design and functional control of Microsystems. In this investigation, a geometric phase analysis technique and digital phase moiré method based on gratings are developed to meet the deformation evaluation requirement of MEMS. The geometric phase analysis technique is performed on the basis of regular gratings, instead of natural atom lattice. The regular gratings with a pitch of range from micrometer to nanometer will be directly fabricated on the measured surface of MEMS devices by using a Focus Ion Beam (FIB). Phase information can be obtained from Bragg filtered images after Fast Fourier Transform (FFT) and Inverse Fast Fourier Transform (IFFT) of SEM scanning images. And then in-plane displacements field and local strain field related to the phase information will be evaluated. The digital phase moiré method is performed by the superimposition of the SEM images of specimen gratings and the digital reference grating designed. Four steps phase shifting technique is used to provide a high sensitivity for deformation measurement. Gaussian blur algorithm will be applied to getting rid of the details of both the specimen and reference gratings in resulting digital moiré. Obtained results show that both the two techniques can be well applied to the deformation measurement with nanometer sensitivity and stiction force estimation of a MEMS device.

Submission ID : ICEMA00329-00527

Presentation Type : Contributed Oral

Topic/Symposium : (A05) ESM: Whole-field distribution analysis of displacement & strain

Keywords : Displacements; Microscopy; Moiré

Recent Progress on the Full Field Deformation Measurement in Micro/nano-scale Using Grating Techniques

Huimin Xie¹; Kishimoto **Satoshi**²; Asundi **Anand**³; Fulong **Dai**¹

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2. *National Institute for Materials Science, Japan*

3. *School of AME, Nanyang Technological University, Singapore*

The micro-electronic devices are greatly promoted with the rapid development of electronics industry. The study on the reliability of the micro-electronic devices is the foundation of designing novel electronic products, and the relative research has drawn great attention of the researchers. From the experiment aspect, the difficulty comes from the minute size of the measured object, whose deformation is hard to be measured using the traditional moiré technique.

In this study, the development of micro-moiré methods is introduced; grid phase analysis method under high resolution microscopes and the relative application to analysis of mechanics behavior of the micro-electronic devices are discussed. The successful results show that the methods have a good potential in the full field deformation analysis in micro-and nano-scale.

Submission ID : ICEMA00277-00556

Presentation Type : Contributed Oral

Topic/Symposium : (H06) HMIP: Digital image correlation and applications

Keywords : Correlation; Measurement; Thin films

CTE Measurement Using a Novel Deformation Pattern-based Digital Image Correlation

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A novel digital image correlation method, deformation pattern based digital image correlation (DPDIC), was proposed for measuring residual stress in conjunction with a hole drilling technique in 2008. This study extends DPDIC to the measurement of the Coefficient of Thermal Expansion (CTE). With DPDIC, intrinsic parameters that represent a particular mechanical behaviour of an object under investigation are used as the direct variables in correlation computation. Here the intrinsic parameter is the CTE. This turns CTE measurement into a purely numerical computational process, i.e. a search of an optimal trial CTE that will maximise the correlation between the original digital image and deformed image (acquired at different temperatures of the test sample) with affine transformation. It leads to the direct output of CTE without the need to manipulate displacement data. Results of CTEs from DPDIC and conventional DIC methods are compared with the actual CTE, showing an improved accuracy. Further applications of DPDIC are expected to include other specific measurement tasks with known deformation patterns, such as the measurement of Poisson's ratio, stress intensity factors, J-integral etc.

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Presentation Type : Contributed Poster

Topic/Symposium : (A13) ESM: Experimental analysis of mechanical properties

Keywords : Thermography; Fracture; SEM

Damage Characterization in Composite Materials Using Infrared Camera

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The tensile testing was performed on polymer matrix composites, and high-speed infrared camera was used to characterize the damage evolution during the tests. The tensile specimens were prepared from glass fiber reinforced epoxy matrix composite panel. A high-speed infrared (IR) camera was employed for in-situ monitoring of progressive damages, in terms of surface temperature of composite samples, during tensile testing. After tensile testing, the microstructural characterization using scanning electron microscope (SEM) was performed to correlate the mechanical failure mode with thermographic results. In this research, the IR thermography and SEM techniques were used to facilitate a better understanding of damage evolution and failure mode of polymer matrix composite materials during tensile testing.

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Topic/Symposium : (E09) BLS: AFM, optical traps, nanoindentation etc

Keywords : AFM

Quantification of Osteoclastic Resorption Pit Volume using AFM

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Bone is regulated by the balance between bone forming osteoblasts and resorbing osteoclasts. Osteoclasts dissolve bone by acidification forming 3D excavations (pits) which lead to bone loss. The conventional tools for analyzing resorption pits are tartrate-resistant acid phosphatase (TRAP) staining and toluidine blue staining. These are qualitative 2D analysis of resorption pits observing TRAP activity, pit number, and multinucleated cell morphology. However, osteoclastic bone resorption occurs in 3D and quantification of the resorption depth is vital in understanding whether a trabecula has been disconnected. Therefore, it is important to quantify the 3D resorption volume which includes area and depth. In this study, we quantified osteoclastic resorption pit volume using atomic force microscope (AFM) and obtained the pit depth (maximum and average), area, and volume. Bone marrow cells were incubated in 25 ng/ml macrophage colony-stimulating factor (M-CSF) and 35 ng/ml receptor activator for nuclear factor κ B ligand (RANKL) to differentiate osteoclasts. Dentine discs cultured with osteoclasts for 1, 2, 3 weeks were stained with toluidine blue. AFM was used to scan 3D pit topology and MATLAB was used to calculate volumetric integration. Currently, 1 week results have been obtained where AFM analysis resulted in a 2.5 μm max pit depth and 108,086 μm^3 pit volume after 1 week. We have shown that osteoclastic resorption pit can be quantified 3D using AFM. This technique may be applied in understanding how to maintain bone mass by controlling bone resorption.