

OFS-13

13th International Conference on Optical Fiber Sensors

&

Workshop on

***Device and System Technology toward
Future Optical Fiber Communication and Sensing***

Byoung Yoon Kim

Kazuo Hotate

Chairs / Editors

April 12-16, 1999

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Kyongju, Korea

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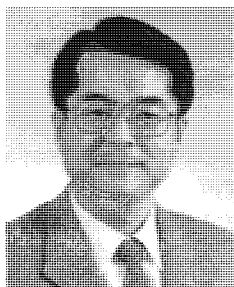
Foreword

This conference is the 13th of the OFS series and is the first to be held in Korea. Since the first conference in 1983, the OFS meetings have been held approximately every one and a half years, providing an exciting forum for reporting and discussing latest progress in optical fiber sensors and related components. As in the previous meetings, this conference presents many exciting invited and contributed papers, with rapidly advancing commercial application of fiber sensor technologies. For example, oil and gas monitoring sensors and fiber grating sensors show considerable growth. A special feature added to this conference is the half-day workshop on "Device and system technology toward future optical fiber communication and sensing" that is intended for stimulating closer interaction between the communities working on sensors and communications.

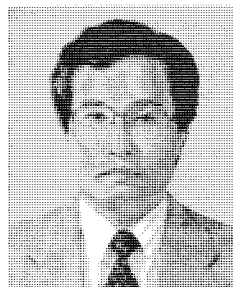
In recent years, we have witnessed the economic problems in many countries including this part of the world, which are gradually being overcome. On the other hand, we are also witnessing an explosive growth of optical communications both in market and technologies. It is well known that many of the key technologies used in optical communications are adopted directly from those developed for fiber sensors. For example, many basic components for wavelength division multiplexed systems can be found somewhere in the past OFS proceedings. It is safe to say that the loyal participants in the OFS conferences are the leaders of fiber optics technologies not only for the sensors but also for communications. This tradition of introducing innovations in optical fiber technology continues on at OFS-13, and will do so in the future.

We would like to thank the members of the Technical Program Committee for putting together the high quality technical program. The local organizing committee members both in Korea and in Japan worked hard to make the conference successful, and proved that joint international efforts can really work nicely. We would like to extend our thanks to any scientists and engineers who are actively participating, and to supporting organizations for their financial support.

We hope that you enjoy not only the conference but also the ancient capital city of Shilla Kingdom at the peak of the cherry blossom.



Byoung Yoon Kim
General Chair



Kazuo Hotate
Technical Program Chair

General Chair

Byoung Yoon Kim, *Korea Advanced Institute of Science and Technology, Korea*

Technical Program Chair

Kazuo Hotate, *The University of Tokyo, Japan*

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Agenda of Sessions

Monday April 12, 1999	Tuesday April 13, 1999	Wednesday April 14, 1999	Thursday April 15, 1999	Friday April 16, 1999
	9:00am~10:00am Tu1 Opening Remarks and Plenary Talk <i>Convention Hall C</i>	8:30am~10:10am W1 Multiplexing and Sensor Networking <i>Convention Hall C</i>	8:30am~10:10am Th1 Sensors for Electromagnetic Phenomena <i>Convention Hall C</i>	8:30am~10:25am F1 Distributed Sensing II / Sensing for Optical Fiber Communication <i>Diamond Hall</i>
	10:00am~10:20am Coffee Break	10:10am~10:30am Coffee Break	10:10am~10:30am Coffee Break	10:25am~10:45am Coffee Break
	10:20am~12:15pm Tu2 Physical and Mechanical Sensors I <i>Convention Hall C</i>	10:30am~12:25pm W2 Chemical, Environ- mental, Biochemical and Medical Sensors <i>Convention Hall C</i>	10:30am~12:25pm Th2 Passive and Active Devices for Photonic Sensing <i>Convention Hall C</i>	10:45am~12:40pm F2 System Applications and Field Tests <i>Diamond Hall</i>
	12:15pm~1:45pm Lunch Break	12:25pm~1:55pm Lunch Break	12:25pm~1:55pm Lunch Break	12:40pm~1:00pm Closing Remarks <i>Diamond Hall</i>
1:00pm~3:05pm WS1 Workshop Session I <i>Diamond Hall</i>	1:45pm~3:40pm Tu3 Fiber Optic Gyroscope <i>Convention Hall C</i>	1:55pm~3:55pm P1 Poster Session I <i>Convention Hall A</i>	1:55pm~3:55pm P2 Poster Session II <i>Convention Hall A</i>	
3:05pm~3:25pm Coffee Break	3:40pm~4:00pm Coffee Break			
3:25pm~5:30pm WS2 Workshop Session II <i>Diamond Hall</i>	4:00pm~5:55pm Tu4 Interferometry and Polarimetry <i>Convention Hall C</i>	3:55pm~5:45pm W3 Distributed Sensing I <i>Convention Hall C</i>	3:55pm~5:50pm Th3 Physical and Mechanical Sensors II <i>Convention Hall C</i>	
			5:50pm~6:10pm Coffee Break	
6:00pm~8:00pm Reception		6:30pm~8:30pm Conference Banquet <i>Convention Hall</i>	6:10pm~7:40pm Th4 Postdeadline Session <i>Convention Hall C</i>	

CONTENTS

OFS-13

13th International Conference on Optical Fiber Sensors

1	WS1	Workshop Session I
15	WS2	Workshop Session II
25	Tu1	Plenary Session
31	Tu2	Physical and Mechanical Sensors I
63	Tu3	Fiber Optic Gyroscope
103	Tu4	Interferometry and Polarimetry
133	W1	Multiplexing and Sensor Networking
161	W2	Chemical, Environmental, Biochemical and Medical Sensors
187	P1	Poster Session I
325	W3	Distributed Sensing I
353	Th1	Sensors for Electromagnetic Phenomena
379	Th2	Passive and Active Devices for Photonic Sensing
409	P2	Poster Session II
543	Th3	Physical and Mechanical Sensors II
569	F1	Distributed Sensing II / Sensing for Optical Fiber Communication
601	F2	System Applications and Field Tests
632		Key to Authors and Chairpersons

Monday, April 12, 1999



1:00 pm - 5:30 pm

Workshop on

"Device and System Technology toward Future Optical Fiber Communication and Sensing"

1:00 pm - 3:05 pm

1 WS1 ■ Workshop Session I

A. M. Vengsarkar, *Bell Laboratories, Lucent Technologies, USA, Chairperson*

1:00 pm - 1:05 pm

Opening Remarks

B. Y. Kim, *Korea Advanced Institute of Science and Technology, Korea, General Chair*

1:05 pm (*Invited*)

2 WS1-1 ■ Frontier in High Speed Time Division Multiplexing Technology for Fiber Communications

S. Kawanishi, *NTT, Japan.*

1:45 pm (*Invited*)

8 WS1-2 ■ Progress in Wavelength Division Multiplexing Technology for Fiber Communications

A. R. Chraplyvy, *Bell Laboratories, Lucent Technologies, USA.*

2:25 pm (*Invited*)

9 WS1-3 ■ Progress on Automatic Monitoring System for Fiber-Optic Subscriber Networks

N. Tomita, *NTT, Japan.*

3:05 pm - 3:25 pm

Coffee Break

3:25 pm - 5:30 pm

15 WS2 ■ Workshop Session II

K. Hotate, *The University of Tokyo, Japan, Chairperson*

3:25 pm (*Invited*)

16 WS2-1 ■ Components for Optical Networking

A. M. Glass, *Bell Laboratories, Lucent Technologies, USA.*

4:05 pm (*Invited*)

17 WS2-2 ■ Planar Lightwave Circuits for Optical Communications and Sensing

K. Okamoto, *NTT, Japan.*

4:45 pm (*Invited*)

23 WS2-3 ■ Fiber Gratings as Functional Devices for Optical Communications and Sensing

M. N. Zervas and R. I. Laming, *University of Southampton, UK.*

5:25 pm - 5:30 pm

Closing Address

K. Hotate, *The University of Tokyo, Japan, Technical Program Chair*

Tuesday, April 13, 1999



9:00 am - 10:00 am

25 Tu1 ■ Plenary Session

B. Y. Kim, *Korea Advanced Institute of Science and Technology, Korea, Chairperson*

K. Hotate, *The University of Tokyo, Japan, Chairperson*

9:00 am - 9:15 am

Opening Remarks

B. Y. Kim and K. Hotate*, *Korea Advanced Institute of Science and Technology, Korea and *The University of Tokyo, Japan.*

9:15 am (Plenary)

26 Tu1-1 ■ Realization of a Synthesized Radio Telescope Larger than the Diameter of the Earth -The Accomplishments of the Space VLBI Satellite HALCA-

H. Hirose, *Institute of Space and Astronautical Science, Japan.*

10:00 am - 10:20 am

Coffee Break

10:20 am - 12:15 pm

31 Tu2 ■ Physical and Mechanical Sensors I

J. L. Santos, *INESC, Portugal, Chairperson*

J. Noda, *NTT Advanced Technology Corporation, Japan, Chairperson*

10:20 am (Invited)

32 Tu2-1 ■ Fiber Bragg Grating Sensor System for Civil Structure Monitoring: Applications and Field Tests

S. T. Vohra, M. D. Todd, G. A. Johnson, C. C. Chang and B. A. Danver, *US Naval Research Lab., USA.*

10:45 am

38 Tu2-2 ■ An Investigation of the Tensile Strength of Fibre Bragg Gratings

S. W. James, C. -Y. Wei, C. -C. Ye, R. P. Tatam and P. E. Irving, *Cranfield Univ., UK.*

11:00 am

42 Tu2-3 ■ High Pressure and Temperature Sensing for the Oil Industry Using Fiber Bragg Gratings Written onto Side Hole Single Mode Fiber

R. J. Schroeder, T. Yamate and E. Udd*, *Schlumberger-Doll Research and *Blue Road Research, USA.*

11:15 am

- 46 **Tu2-4 ■ Ultra-High Resolution Dynamic Strain Sensing for Structural Diagnostics with Fiber Bragg Grating Laser Sensor**
K. P. Koo, A. B. Tveten and S. T. Vohra, *US Naval Research Lab., USA.*

11:30 am

- 50 **Tu2-5 ■ A Stress Sensor with a Fiber Optic Vertical Coupler for Matrix-Readout Multi-Point Measurements**
K. Nakamura and M. Uchiyama, *Tokyo Inst. of Technology, Japan.*

11:45 am

- 54 **Tu2-6 ■ An Optical Fiber Sensor for the Measurement of Elevated Temperatures**
T. F. Morse, Y. He and F. Luo, *Brown Univ., USA.*

12:00 m

- 58 **Tu2-7 ■ Performance Enhancement of Strain and Temperature Sensors Using Long Period Fiber Grating**
Y. G. Han, C. S. Kim, K. Oh, U. C. Paek and Y. Chung, *Kwangju Inst. of Science and Technology, Korea.*

12:15 pm - 1:45 pm
Lunch Break

1:45 pm - 3:40 pm

- 63 **Tu3 ■ Fiber Optic Gyroscope**
G. A. Sanders, *Honeywell Inc., USA, Chairperson*
M. Oh, *Agency for Defense Development, Korea, Chairperson*

1:45 pm (Invited)

- 64 **Tu3-1 ■ Industrial Applications of FOG**
T. Kumagai, H. Kajioka, W. Ohnuki, M. Akiyama and S. Saito, *Hitachi Cable, Japan.*

2:10 pm

- 78 **Tu3-2 ■ Reduction of Backscattering Induced Noise by Ternary Phase Shift Keying in Monolithically Integrated Micro Optic Gyro on Silica Planar Lightwave Circuit**
K. Suzuki, K. Takiguchi* and K. Hotate, *The Univ. of Tokyo and *NTT Opto-Electronics Lab., Japan.*

2:25 pm

- 82 **Tu3-3 ■ Loss and Gyroscopic Sensing Using Rayleigh Scattering in a Fiber Ring Resonator**
A. K  ng, L. Th  venaz and Ph. A. Robert, *Swiss Federal Inst. of Technology, Switzerland.*

2:40 pm

- 86 **Tu3-4 ■ Wavelength Stable, High Power Amplified Superfluorescent Source for Gyroscope Application**
D. M. Dagenais, L. Goldberg, R. P. Moeller and W. K. Burns, *US Naval Research Lab., USA.*

2:55 pm

- 90 **Tu3-5 ■ Suppression of Bias Fluctuation in Direction Switched Fiber Laser Gyroscope**
S. H. Chang and B. Y. Kim, *KAIST, Korea.*

3:10 pm

- 94 **Tu3-6 ■ Lock-In Detection for Mode-Locked Fiber Laser Gyroscope**
J. B. Hong, Y. B. Yeo, B. W. Lee* and B. Y. Kim, *KAIST and *FiberPro, Korea.*

3:25 pm

- 98 **Tu3-7 ■ Stabilization of Gyroscope with Fiber Amplifier/ Source Configuration by Tracking of Optimum Modulation Condition**
H. G. Park and Y. -J. Chin*, *Chonbuk National Univ. and *KAIST, Korea.*

3:40 pm - 4:00 pm

Coffee Break

4:00 pm - 5:55 pm

- 103 **Tu4 ■ Interferometry and Polarimetry**
J. Blake, *Texas A&M University, USA, Chairperson*
H. Kajioka, *Hitachi Cable, Ltd., Japan, Chairperson*

4:00 pm (Invited)

- 104 **Tu4-1 ■ Resonator Fiber Optic Gyro Using Digital Serrodyne Modulation -Method to Reduce the Noise Induced by the Backscattering and Closed-Loop Operation Using Digital Signal Processing-**
K. Hotate and G. Hayashi, *The Univ. of Tokyo, Japan.*

4:25 pm

- 108 **Tu4-2 ■ Absolute Strain/Temperature Sensing with Highly Birefringent Two-Mode Fiber and Acoustooptic Fiber Scanner**
Y. Wang, P. G. Sinha and T. Yoshino, *Gunma Univ., Japan.*

4:40 pm

- 112 **Tu4-3 ■ Dual Heterodyne Demodulation for Elimination of Signal Fading in Fiber-Optic Interferometers**
W. J. Lee, B. K. Kim*, K. H. Han and B. Y. Kim, *KAIST and *KIST, Korea.*

4:55 pm

- 116 **Tu4-4 ■ Polarization Dependence of Amplitude Modulation by Guided Acoustic-Wave Brillouin Scattering**
Y. Tanaka and K. Ogusu, *Shizuoka Univ., Japan.*

5:10 pm

- 120 **Tu4-5 ■ Packaging Interferometric Sensors for Civil Structural Monitoring**
D. Inaudi, B. Glisic* and S. Vurpillot*, *SMARTEC and *IMAC, Switzerland.*

5:25 pm

- 124 **Tu4-6 ■ A Low-Coherence Interferometer System for Simultaneous Measurement of Refractive Index and Thickness Ranging from 20 μm to a Few Millimeters**
S. Inoue, H. Maruyama*, T. Mitsuyama, M. Ohmi, K. Ihara* and M. Haruna, *Osaka Univ. and *Kyushu Matsushita Electric, Japan.*

5:40 pm

- 128 **Tu4-7 ■ Performance of Apodized Bragg Gratings in Dynamic Strain Measurements Using Interferometric Interrogation**
K. Pran, G. Wang, G. B. Havsgård and S. Knudsen, *Norwegian Defence Research Establishment, Norway.*


Wednesday, April 14, 1999

8:30 am - 10:10 am

133 W1 ■ Multiplexing and Sensor Networking

D. D. Sampson, *The University of Western Australia, Australia, Chairperson*
Y. Chung, *Kwangju Institute of Science and Technology, Korea, Chairperson*

8:30 am (Invited)

134 W1-1 ■ Distributed and Multiplexed Fibre Grating Sensors

J. P. Dakin and M. Volanthen, *Univ. of Southampton, UK.*

8:55 am

141 W1-2 ■ Effects of Fiber Bragg Grating Spectrum Distortion on Scanning Fabry-Perot and Fiber Interferometer Based Wavelength Shift Detection Schemes

C. C. Chang, G. A. Johnson and S. T. Vohra, *US Naval Research Lab., USA.*

9:10 am

145 W1-3 ■ Sea-Test of a 27 Channel Fibre Bragg Grating Strain Sensor System on an Air Cushion Catamaran

K. Pran, G. B. Havsgård, R. Palmstrøm, G. Wang, G. A. Johnson*, B. A. Danver* and S. T. Vohra*, *Forsvarets Forskningsinstitutt, Norway and *US Naval Research Lab., USA.*

9:25 am

149 W1-4 ■ Dense Wavelength-Division Demultiplexing of Interferometrically Interrogated Fiber Bragg Grating Sensors

K. B. Rochford and S. D. Dyer, *National Inst. of Standards and Technology, USA.*

9:40 am

153 W1-5 ■ Enhanced Multiplexing Capacity of FBGs Strain Sensing Using Combination of Intensity and Wavelength Division Multiplexing

L. Zhang, Y. Liu, J. A. R. Williams and I. Bennion, *Aston Univ., UK.*

9:55 am

157 W1-6 ■ Sensor Network for Structural Strain and High Hydraulic Pressure, Using Optical Fiber Grating Pairs, Interrogated in the Coherence Domain

J. P. Dakin, V. Foufelle, S. J. Russell, O. Hadeler, W. Ecke*, E. Geinitz*, J. Schauer* and R. Willsch*, *Univ. of Southampton, UK and *Inst. for Physical High Technology, Germany.*

10:10 am - 10:30 am

Coffee Break

10:30 am - 12:25 pm

161 W2 ■ Chemical, Environmental, Biochemical and Medical Sensors

M. Haruna, *Osaka University, Japan, Chairperson*
D. Lee, *Chungnam National University, Korea, Chairperson*

10:30 am (Invited)

- 162 **W2-1 ■ Fiber Gratings for Chemical Sensing**
R. A. Lieberman and J. Prohaska, *Intelligent Optical Systems, USA.*

10:55 am

- 163 **W2-2 ■ Temperature Referenced Fibre Bragg Grating Refractometer Sensor for On-Line Quality Control of Petrol Products**
K. Usbeck, W. Ecke, V. Hagemann, R. Mueller and R. Willsch, *Inst. für Physikalische Hochtechnologie, Germany.*

11:10 am

- 167 **W2-3 ■ In Vivo Radiotherapy Dose Monitoring System**
A. L. Huston and B. L. Justus, *US Naval Research Lab., USA.*

11:25 am

- 171 **W2-4 ■ Hydrogen Sensors Based on Palladium Electroplated Fiber Bragg Gratings (FBG)**
Y. T. Peng, Y. Tang and J. S. Sirkis, *Univ. of Maryland, USA.*

11:40 am

- 175 **W2-5 ■ Characterization of Fiber Bragg Grating (FBG) Based Palladium Tube Hydrogen Sensors**
Y. Tang, T. Peng, S. M. Lee, J. S. Sirkis, B. A. Childers*, J. P. Moore* and L. D. Melvin, *Univ. of Maryland and *NASA Langley Research Center, USA.*

11:55 am

- 179 **W2-6 ■ In Vivo Observations of Cytochrome P4501A Isozyme Reaction in Liver of Living Rats by Using Fiber-Optic Sensor**
I. Sasaki, A. Kawanabe, I. Yamakawa, A. Kazusaka*, S. -J. Yoon* and S. Fujita*, *Hokkaido Inst. of Technol. and *Hokkaido Univ., Japan.*

12:10 pm

- 183 **W2-7 ■ Optical Fibers for the Cultural Heritage II: The Monitoring of Lighting in Museum Environments**
A. G. Mignani, R. Falciai, C. Trono and B. Tiribilli*, *IROE-CNR and *Inst. Nazionale di Ottica, Italy.*

12:25 pm - 1:55 pm

Lunch Break

1:55 pm - 3:55 pm

- 187 **P1 ■ Poster Session I**

Physical and Mechanical Sensors (1)

- 188 **P1-1 ■ A Prototype Fiber-Optic Discrete Level-Sensor for Liquid Propane-Butane**
V. de Leon, V. Svirid* and S. N. Khotiaintsev, *Autonomous Puebla Univ. and *Mexico National Autonomous Univ., Mexico.*

- 192 **P1-2 ■ Signal Characteristics of EFPI in the Delaminated Composites**
C. S. Hong, J. W. Park, C. Y. Ryu and H. K. Kang, *KAIST, Korea.*

- 196 **P1-3 ■ Composite Strengthening and Instrumentation of the Horsetail Falls Bridge with Long Gauge Length Fiber Bragg Grating Strain Sensors**
J. Seim, E. Udd, W. Schulz and H. M. Laylor*, *Blue Road Research and *Oregon Dept. of Transportation, USA.*

- 200 P1-4 ■ Fluorescence Characteristics of Several Yb-Doped Optical Fibers for Temperature Sensing Applications**
S. A. Wade, S. F. Collins, G. W. Baxter, T. Sun*, Z. Y. Zhang*, K. T. V. Grattan*, A. W. Palmer* and G. Monnom**, *Victoria Univ., Australia, *City Univ., UK and **Univ. de Nice-Sophia, France.*
- 204 P1-5 ■ Multiple Sensor Optical Fiber Network for Vibration Monitoring**
M. Willsch, S. Mohr, D. Pallas, J. Niewisch and T. Bosselmann, *Siemens, Germany.*
- 208 P1-6 ■ Sensor Applications of Germanosilicate Fiber Bragg Gratings Fabricated by Direct Writing Method**
K. Kondo, T. Genji, T. Nakai, K. Imamura and Y. Imada, *Mitsubishi Cable Ind., Japan.*
- 212 P1-7 ■ Transmission Loss Characteristics of a Silica-Based Image Fiber Induced by γ -ray Irradiation**
K. Ara and M. Masui, *Ibaraki Univ., Japan.*
- 216 P1-8 ■ Multimode Fiber Bragg Gratings for Fiber-Optic Bending Sensors**
T. Mizunami, T. Niiho and T. V. Djambova, *Kyushu Inst. of Technology, Japan.*
- Sensors for Electromagnetic Phenomena**
- 220 P1-9 ■ Optical Faraday Extrinsic Current Sensor Using Semimagnetic Semiconductors and One Down-Lead Optical Fibre**
A. Gh. Podoleanu, R. G. Cucu and D. A. Jackson, *Univ. of Kent, UK.*
- 224 P1-10 ■ Range-Variable Optical Voltage Sensors Based on Periodically Poled LiNbO₃**
Y. J. Rao, H. Gnewuch, C. N. Pannell and D. A. Jackson, *Univ. of Kent, UK.*
- 228 P1-11 ■ Optical Measurement System for Power Cable Monitoring**
C. Helmig and D. Peier, *Univ. Dortmund, Germany.*
- 232 P1-12 ■ Thermally Stable Lithium Niobate Integrated-Optic Voltage Sensor with Variable Sensing Ranges**
Y. -S. Yim and S. -Y. Shin, *KAIST, Korea.*
- Chemical, Environmental, Biochemical and Medical Sensors**
- 236 P1-13 ■ Optical Fiber Humidity Sensor Formed by the Ionic Self-Assembly Monolayer Process**
F. J. Arregui, Y. Liu*, K. Lenahan*, C. Holton*, I. R. Matias and R. O. Claus*, *Univ. Publica de Navarra, Spain and *Verginia Tech., USA.*
- 240 P1-14 ■ A Fiber-Optic Triple Sensor for Dose Measurements in Radiation Therapy**
H. Bueker, F. W. Haesing and F. Cremer*, *Forschungszentrum Jülich and *Univ. of Clinic Hamburg-Eppendorf, Germany.*
- 244 P1-15 ■ Optical Fiber Water Concentration Sensor Using Tm³⁺:YAG Fluorescent Light**
M. Yokota and T. Yoshino, *Gunma Univ., Japan.*
- 248 P1-16 ■ Applications of Fiber-Optic Refractive Index Measurements in Chemical Processing**
F. X. Desforges, B. Blocksidge, A. Levy, M. Girault*, Ph. Martin*, H. C. Lefevre*, C. Boyer**, J. C. Viguie**, I. Harter**, M. Cecil*** and W. Farr***, *Photonetics, USA, *Photonetics, **IFP Solaize, France and ***Owensboro Grain Edible Oils, USA.*
- 252 P1-17 ■ Erbium-Doped Fiber Laser for Gas Sensing**
K. Mizuno, A. Mugino*, K. Kondow, H. Kuze and N. Takeuchi, *Chiba Univ. and *Furukawa Electric, Japan.*
- 256 P1-18 ■ Fiber Laser Intra-Cavity Spectroscopy (FLICS)**
T. F. Morse, J. Hernández-Cordero and E. Wetjen, *Brown Univ., USA.*

- 260 P1-19 ■ Miniaturized Low-Cost Surface Plasmon Resonance Sensor Prototype with Spectral Fiber-Optic Readout for Application in Biochemical Monitoring**
P. Pfeifer, U. Aldinger*, G. Schwotzer, P. Steinrück* and R. Willsch, *Inst. for Physical High Technology and *Inst. of Molecular Biotechnol., Germany.*

- 264 P1-20 ■ Evaluation of Materials for Humidity Sensing Using Low Coherence Interferometry**
S. Mc Murtry, J. D. Wright and D. A. Jackson, *Univ. of Kent, UK.*

Fiber Optic Gyroscope

- 268 P1-21 ■ Development of the Small Size 3-Axis Fiber Optic Gyroscope**
R. Usui, E. Asami, M. Kadota and K. Okada, *Japan Aviation Electronics Ind., Japan.*

- 272 P1-22 ■ Gain-Clamped Fiber Amplifier/Source for Gyroscope**
H. G. Park and Y. -J. Chin*, *Chonbuk National Univ. and *KAIST, Korea.*

- 276 P1-23 ■ Fiber Optic Rate Gyro Development**
J. C. Ha, B. Smith* and J. Bush**, *Air Force Research Lab., *Mercer Engineering Research Center and **Optiphase, USA.*

- 280 P1-24 ■ Low Cost Gyrocompass Using Fiber Optic Gyroscope**
Y. Masuda, K. Kawano, M. Nagai, A. Ohno, M. Kobayashi and J. Itoh, *Japan Aviation Electronics Ind., Japan.*

- 284 P1-25 ■ Taper Twisting for Higher FOGs Production Yield**
V. Logozinski, V. Listvin and V. Solomatin, *FIZOPTIKA, Russia.*

Interferometry and Polarimetry

- 288 P1-26 ■ Dynamic Focus Applied for Correct Determination of Flow Speed of a Biological Liquid Using OCT**
A. Gh. Podoleanu, J. A. Rogers and D. A. Jackson, *Univ. of Kent, UK.*

- 292 P1-27 ■ A Novel All-Fiber Ellipsometer**
L. R. Jaroszewicz, A. Kiezun and R. Switto, *Military Univ. of Technol., Poland.*

- 296 P1-28 ■ The Role of the Principal States of Polarization in Embedded Fiber Optic Sensors**
A. Eyal and M. Tur, *Tel-Aviv Univ., Israel.*

- 300 P1-29 ■ Wavelength Scanning Fiber Optic Sensing with Two Optimized Fabry-Perot Interferometers**
Y. Wang, Y. Liao and Q. Tian, *Tsinghua Univ., China.*

Multiplexing and Sensor Networking

- 304 P1-30 ■ Multi-Channel Optical Hydrophone Array with Time and Wavelength Division Multiplexing**
P. J. Nash and G. A. Cranch, *DERA-Winfrith, UK.*

- 308 P1-31 ■ Time Domain Multiplexing for a Bragg Grating Strain Measurement Sensor Network**
R. Ashoori, Y. M. Gebremichael, S. Xiao, J. Kemp, K. T. V. Grattan and A. W. Palmer, *City Univ., UK.*

- 312 P1-32 ■ System of Eight Multiplexed Sensors Based on HB Fibers for Simultaneous Measurement of Pressure and Temperature**
W. J. Bock and W. Urbanczyk*, *Université du Québec à Hull, Canada and *Technical Univ. of Wroclaw, Poland.*

- 316 P1-33 ■ Study of Cross-Talk of Parallel Fabry-Perot Sensors in the Coherence Multiplexing**
Y. -L. Lo, *National Cheng Kung Univ., Taiwan.*

- 320 **P1-34 ■ Highly-Multiplexed Grating-Sensors for Temperature-Referenced Quasi-Static Measurements of Strain in Concrete Bridges**
P. J. Henderson, D. J. Webb, D. A. Jackson, L. Zhang* and I. Bennion*, *Univ. of Kent and *Aston Univ., UK.*

3:55 pm - 5:45 pm

- 325 **W3 ■ Distributed Sensing I**
K. Blotekjaer, *Norwegian University of Science and Technology, Norway, Chairperson*
B. Lee, *Seoul National University, Korea, Chairperson*

3:55 pm (Invited)

- 326 **W3-1 ■ Optical Fiber Sensors for Downwell Monitoring Applications in the Oil and Gas Industry**
A. D. Kersey, *CiDRA, USA.*

4:20 pm (Invited)

- 332 **W3-2 ■ Urban Gas Monitoring System Using Optical Sensors**
H. Tai, *Tokyo Gas, Japan.*

4:45 pm

- 337 **W3-3 ■ Measurement of Brillouin Gain Spectrum Distribution along an Optical Fiber with a High Spatial Resolution Using a Novel Correlation-Based Technique -Demonstration of 45 cm Spatial Resolution-**
K. Hotate and T. Hasegawa, *The Univ. of Tokyo, Japan.*

5:00 pm

- 341 **W3-4 ■ A Multichannel Fiber Optic Sensor Using Bragg Gratings and Brillouin Optical Time Domain Analysis for Temperature and Strain Measurements**
R. Posey, Jr. and S. T. Vohra, *US Naval Research Lab., USA.*

5:15 pm

- 345 **W3-5 ■ Monitoring of Large Structure Using Distributed Brillouin Fibre Sensing**
L. Thevenaz, M. Facchini, A. Fellay, Ph. Robert, D. Inaudi* and B. Dardel**, *Swiss Federal Inst. of Technology, *SMARTEC and **Alcatel Cable Suisse, Switzerland.*

5:30 pm

- 349 **W3-6 ■ 16 km Distributed Temperature Sensor Based on Coherent Detection of Spontaneous Brillouin Scattering Using a Brillouin Laser**
V. Lecoëuche, D. J. Webb, C. N. Pannell and D. A. Jackson, *Univ. of Kent, UK.*

Thursday, April 15, 1999



- 8:30 am - 10:10 am
- 353 **Th1 ■ Sensors for Electromagnetic Phenomena**
A. Wang, *Virginia Polytechnic Institute and State University, USA, Chairperson*
K. Kurosawa, *Tokyo Electric Power Company, Japan, Chairperson*

8:30 am (Invited)

- 354 Th1-1 ■ Electro-Optic Kerr Effects in Optical Fiber Current Sensors**
A. H. Rose, S. M. Etzel and K. B. Rochford, *NIST, USA*.

8:55 am

- 358 Th1-2 ■ Waveguide Birefringence Temperature Sensitivity in Multi-Turn Integrated Optics Current Sensors**
V. Minier, A. Burlet-Gaillard and N. L. Thomas, *Groupeement d'Electromagnétisme Expérimental et d'Optoelectronique, France*.

9:10 am

- 362 Th1-3 ■ Frequency Division Multiplexed Polarimetric Fiber Laser Sensor Array for Current Sensing**
J. C. Yong, M. L. Lee, S. H. Yun, J. S. Park* and B. Y. Kim, *KAIST and *Korea Telecom, Korea*.

9:25 am

- 366 Th1-4 ■ Extension of the Measuring Range of Magneto Optic Current Sensors Using Two Wavelengths Evaluation**
M. Willsch, S. Mohr and T. Bosselmann, *Siemens, Germany*.

9:40 am

- 370 Th1-5 ■ High Frequency Response of Optical Magnetic Field Sensors Using Rare-Earth Iron Garnet Films**
N. Itoh, K. B. Rochford*, H. Minemoto and S. Ishizuka, *Matsushita Electric Industrial, Japan and *NIST, USA*.

9:55 am

- 374 Th1-6 ■ Polarimetric Current Sensor Using a In-Line 22.5 Degree Faraday Rotator**
F. Briffod, L. Thevenaz, P. -A. Nicati, A. Kueng and Ph. Robert, *Swiss Federal Inst. of Technology, Switzerland*.

10:10 am - 10:30 am
Coffee Break

10:30 am - 12:25 pm

- 379 Th2 ■ Passive and Active Devices for Photonic Sensing**
W. W. Morey, *3M Bragg Grating Technologies, USA, Chairperson*
H. G. Park, *Chonbuk National University, Korea, Chairperson*

10:30 am (Invited)

- 380 Th2-1 ■ Wavelength-Swept Mode-Locked Fiber Laser for Sensor Interrogations**
S. H. Yun and B. Y. Kim, *KAIST, Korea*.

10:55 am

- 385 Th2-2 ■ Characteristics of Long Period Fiber Grating Utilizing Periodic Stress Relaxation under High Temperature Environment**
S. Yamasaki, M. Akiyama, K. Nishide, A. Wada and R. Yamauchi, *Fujikura, Japan*.

11:10 am

- 389 Th2-3 ■ Bragg Grating Sensor Interrogation Scheme Using Wavelength-Time Encoding and a Draw Tower Fiber Grating Array**
V. Hagemann, G. Sluyterman v. L., M. Rothhardt and H. -R. Müller, *Inst. für Physikalische Hochtechnologie, Germany*.

11:25 am

- 393 **Th2-4 ■ Long-Period Gratings Fabrication Using Microlens Array**
S. Y. Liu and H. Y. Tam, *Hong Kong Polytechnic Univ., China.*

11:40 am

- 397 **Th2-5 ■ Mode Hop Free Single Mode Fibre Laser with Frequency Scanning for Fibre Optic Spectroscopy**
S. K. Kim, G. Stewart, W. Johnstone and B. Culshaw, *Univ. of Strathclyde, UK.*

11:55 am

- 401 **Th2-6 ■ A Study on Fiber Bragg Grating External Cavity Laser Module as a Light Source for All Fiber Ring Resonator Type Trace Gas Sensor**
A. Mugino, K. Mizuno, H. Nasu and K. Nakamura, *Furukawa Electric, Japan.*

12:10 pm

- 405 **Th2-7 ■ Dynamic Tuning of a Multimode Laser Diode for Fibre Bragg Grating Demodulation**
L. A. Ferreira, J. L. Santos*, E. V. Diatzikis** and F. Farahi**, *INESC-Porto, *Univ. do Porto, Portugal and **Univ. of North Carolina at Charlotte, USA.*

12:25 pm - 1:55 pm
Lunch Break

1:55 pm - 3:55 pm

- 409 **P2 ■ Poster Session II**

Physical and Mechanical Sensors (2)

- 410 **P2-1 ■ Fiber-Optic Extrinsic Fabry-Perot Interferometer Sensors with Three-Wavelength Digital Phase Demodulation**
M. Schmidt and N. Fürstenau, *German Aerospace Center, Germany.*

- 414 **P2-2 ■ Progress Towards an Orthogonal Strain State Sensor Based Optical Fiber Technology**
X. D. Jin, T. Rossmann, J. S. Sirkis, D. Devoe and V. Venkat*, *Univ. of Maryland at College Park and *Analytical Service & Materials, USA.*

- 418 **P2-3 ■ Temperature Sensor Using the Self-Interference of a Long-Period Fiber Grating**
B. H. Lee and J. Nishii, *Osaka National Res. Inst., Japan.*

- 422 **P2-4 ■ Optical Fiber Temperature Sensor Scheme Using Tm:Doped Yttrium Oxide Powder-Based Probe**
Z. Y. Zhang, T. Sun, K. T. V. Grattan and A. W. Palmer, *City Univ., UK.*

- 426 **P2-5 ■ A New Technique for the Measurement of Thin Film Growth**
T. F. Morse, Y. He, F. Luo and A. Kussmaul*, *Brown Univ. and *Lasertron, USA.*

- 430 **P2-6 ■ Development of a Hetero-Core Fiber Sensor**
K. Tajima, Y. Choi, K. Watanabe and Y. Kubota, *Soka Univ., Japan.*

- 434 **P2-7 ■ Fibre Optic Low Coherence Vibration Sensor Based on Heterodyne Detection**
G. M. Dobre, D. J. Webb, S. F. O'Neill, C. N. Pannell and D. A. Jackson, *Univ. of Kent, UK.*

- 438 **P2-8 ■ A Fiber Bragg Grating Temperature Sensor with Artificial Neural Networks**
S. -L. Tsao, J. Wu* and B. -C. Yeh*, *Yuan Ze Univ. and *National Taiwan Univ., Taiwan.*

442 P2-9 ■ More Accurate Coupling Function Approach for Optical Transducers Based on Power Coupling between Multimode Fibers

A. Cobo, M. A. Morante, J. L. Arce, C. Jauregui and J. M. López-Higuera, *Univ. of Cantabria, Spain.*

Distributed Sensing

446 P2-10 ■ Phase Plate Process for Advanced Fiber Bragg Grating Components Realisation

C. Martinez, P. Jougla, S. Magne and P. Ferdinand, *LETI-DEIN-SPE-CEA/Saclay, France.*

450 P2-11 ■ Survey and Comparison of Distributed Fibre Optic Sensing Methods for Measuring Location and Quantity Information

I. Alasaarela, P. Karioja and H. Kopola, *VTT Electronics, Finland.*

Sensing for Optical Fiber Communication

454 P2-12 ■ Phase-Decorrelated FMCW Reflectometry for Long Optical Fibers by Using a Laser Diode with Modulated External-Cavity

K. Iiyama, T. Maeda and S. Takamiya, *Kanazawa Univ., Japan.*

Passive and Active Devices for Photonic Sensing

458 P2-13 ■ Short Pulse Generation in the Mode-Locked Fiber Laser Using Cholesteric Liquid Crystal

D. I. Chang, H. Y. Kim, M. Y. Jeon, H. K. Lee, D. S. Lim, K. H. Kim, I. S. Kim* and S. T. Kim*, *ETRI and *LG Cable & Machinery, Korea.*

462 P2-14 ■ Efficiency Improved Er³⁺ Doped Fiber Fluorescent Sources with 80 nm Bandwidth through Seed Photon Generation in the Unpumped EDF

J. H. Lee, U. -C. Ryu and N. Park, *Seoul National Univ., Korea.*

466 P2-15 ■ Stability of Distributed Feedback Fiber Lasers with Optical Feedback

E. Rønnekleiv and S. W. Løvseth, *Norwegian Univ. of Science and Technology, Norway.*

470 P2-16 ■ Applications and Field Tests of a Fibre Bragg Grating Sensor System

J. Peupelmann and J. Meissner, *Dresden Univ. of Technol., Germany.*

474 P2-17 ■ Growth and Sensitivity of the Resonant Peaks of Long Period Gratings

S. Pilevar, T. W. MacDougall* and C. C. Davis, *Univ. of Maryland and *3M Bragg Grating Technol., USA.*

478 P2-18 ■ Investigation of Densification-Induced Residual Stresses in Bragg Gratings Using FEA

S. Chen, B. Liu, J. Sirkis, M. K. Park* and H. Singh**, *Univ. of Maryland, USA, *Myongji Univ., Korea and **3M Bragg Grating Technol., USA.*

482 P2-19 ■ Characterisation of Photonic Crystal Fibre

M. J. Gander, R. McBride, J. D. C. Jones, T. A. Birks*, J. C. Knight*, P. St. J. Russell*, P. Blanchard**, J. G. Burnett** and A. H. Greenaway**, *Heriot-Watt Univ., *Univ. of Bath and **DERA, UK.*

486 P2-20 ■ Polymer-Packaged Fiber Bragg Grating with Enhanced Thermal Sensitivity

B. -O. Guan, Z. -Y. Guo, Z. -G. Liu and X. -Y. Dong, *Nankai Univ., China.*

490 P2-21 ■ Accurate Characterization of In-Fiber Gratings Devices

B. M. A. Rahman, M. Plura and K. T. V. Grattan, *City Univ., UK.*

494 P2-22 ■ Dispersion Measurements of Modal Birefringence for Birefringent Single-Mode Fibers with White-Light Channelled Spectrum Interferometry

K. Nishizawa and Y. Ohtsuka*, *Polytechnic Univ. and *Moritex Inst. of Advanced Technol., Japan.*

- 498 **P2-23 ■ Design Theory and Fabrication of a New Fused-Taper Optical Fiber Mode Converter**
T. Lin, Y. Furuumi, M. Imai, Y. Tsuji* and M. Koshiba*, *Muroran Inst. of Technology and *Hokkaido Univ., Japan.*

System Applications and Field Tests

- 502 **P2-24 ■ River Levee Strain Measurement Using Fiber Optic Distributed Strain Sensor**
H. Naruse, T. Uchiyama, T. Kurashima and S. Unno*, *NTT and *Foundation of River and Basin Integrated Communications, Japan.*
- 506 **P2-25 ■ Fiberscope-Type Environmental Recognition Devices**
O. Tohyama, S. Maeda, K. Abe, M. Murayama and T. Tachibana, *Mitsubishi Cable Ind., Japan.*
- 510 **P2-26 ■ Field Testing a Fiber-Optic Microinterferometer Sensor System for Airport Ground Traffic Monitoring**
N. Fürstenau, W. Schmidt and M. Schmidt, *German Aerospace Center, Germany.*
- 514 **P2-27 ■ Measurements of Overhead Transmission Line Loads with Bragg Gratings**
L. Bjerkan, *SINTEF, Norway.*
- 518 **P2-28 ■ Using an In-Fiber Bragg-Grating Sensor for Measurement of Thermal Expansion Coefficient in Structures**
Y.-L. Lo and H.-S. Chuang, *National Cheng Kung Univ., Taiwan.*
- 522 **P2-29 ■ Optical Fibre Sensors for Weigh-in-Motion of Road Vehicles: State of the Art and Future**
P. Wierzbą, P. Suopajarvi*, P. Karioja* and H. Kopola*, *Technical Univ. of Gdańsk and *VTT Electronics, Finland.*

New Concepts for Photonic Sensing

- 526 **P2-30 ■ Utilisation of Optical Fibre Measurement Techniques in Determination of Residual Stresses of Composites**
H. Lahtinen, M. Jurvakainen, A. Pramila, H. Tabell, M. Kusevic, O. Hormi, V. Lyöri, M. Heikkinen, R. Myllylä, P. Suopajarvi* and H. Kopola*, *Univ. of Oulu and *VTT Electronics, Finland.*
- 530 **P2-31 ■ Real-Time Measurement for Static and Dynamic Strain Using a Fiber Bragg Grating and the ASE Profile of EDFA**
S. C. Kang, H. Yoon*, S. B. Lee*, S. S. Choi* and B. Lee, *Seoul National Univ. and *KIST, Korea.*
- 534 **P2-32 ■ Minimization of Interferometric Noise in a Fibre Bragg Grating Sensor Using a Tunable Laser and a First Derivative Interrogation Technique**
C. C. Chan, J. M. Gong*, W. Jin and M. S. Demokan, *Hong Kong Polytechnic Univ. and *Tsinghua Univ., China.*
- 538 **P2-33 ■ Erbium-Doped Fiber Temperature Sensor with High Resolution Using 1480 nm Pump Scheme**
J. Jung and B. Lee, *Seoul National Univ., Korea.*

3:55 pm - 5:50 pm

543 Th3 ■ Physical and Mechanical Sensors II

H. Nagai, *Anritsu Corporation, Japan, Chairperson*
S. H. Park, *Yonsei University, Korea, Chairperson*

3:55 pm (Invited)

- 544 **Th3-1 ■ Fiber Bragg Grating Reliability Studies in Europe**
H. G. Limberger, *Swiss Federal Inst. of Technology, Switzerland.*

4:20 pm

- 545 Th3-2 ■ Performance of Elastic Beam Fiber Bragg Grating Accelerometers**
M. D. Todd, B. A. Althouse, G. A. Johnson and S. T. Vohra, *US Naval Research Lab., USA.*

4:35 pm

- 549 Th3-3 ■ Ultrasonic Field and Temperature Sensor Based on Short In-Fibre Bragg Gratings**
M. W. Hathaway, N. E. Fisher, D. J. Webb, C. N. Pannell, D. A. Jackson, L. R. Gavrilov*, J. W. Hand*, L. Zhang** and I. Bennion**, *Univ. of Kent, *Hammersmith Hospital and **Aston Univ., UK.*

4:50 pm

- 553 Th3-4 ■ Fluid Discrimination in Multi-Phase Flow**
R. T. Ramos and E. J. Fordham, *Schlumberger-Doll Research, USA.*

5:05 pm

- 557 Th3-5 ■ High Sensitivity Pressure Sensors Utilizing Advanced Polymer Coatings**
S. T. Vohra, A. Dandridge, C. C. Chang, G. A. Johnson, A. B. Tveten and G. M. Nau, *US Naval Research Lab., USA.*

5:20 pm

- 561 Th3-6 ■ Directional Shape Sensing Using Bend Sensitivity of Long Period Fiber Gratings**
H. J. Patrick and S. T. Vohra, *US Naval Research Lab., USA.*

5:35 pm

- 565 Th3-7 ■ Fiber-Bragg-Grating Underwater Acoustic Sensor**
N. Takahashi, S. Takahashi and K. Tetsumura, *National Defense Academy, Japan.*

5:50 pm - 6:10 pm
Coffee Break

6:10 pm - 7:40 pm

Th4 ■ Postdeadline Session

D. A. Jackson, *University of Kent, UK, Chairperson*
J. S. Sirkis, *University of Maryland, USA, Chairperson*


Friday, April 16, 1999

8:30 am - 10:25 am

- 569 F1 ■ Distributed Sensing II / Sensing for Optical Fiber Communication**
R. Willsch, *Institute for Physical High Technology, Germany, Chairperson*
R. Yamauchi, *Fujikura Ltd., Japan, Chairperson*

8:30 am (Invited)

- 570 F1-1 ■ Fiber Optic Sensors for Fly-by-Light Aircraft**
M. Kobayashi, *Teijin Seiki, Japan.*

8:55 am

- 576 **F1-2 ■ Direct Distributed Velocity Sensing by Using Fiber-Optic Low Coherence Interferometer**
Y. Imai and K. Tanaka, *Kyushu Institute of Technology, Japan.*

9:10 am

- 580 **F1-3 ■ Location of Time-Varying Strain Disturbances Over a 40 km Fibre Section, Using a Dual-Sagnac Interferometer with a Single Source and Detector**
S. J. Russell and J. P. Dakin, *Univ. of Southampton, UK.*

9:25 am

- 584 **F1-4 ■ Fading Noise Reduction for Coherent Optical Frequency Domain Reflectometry with 30-cm Spatial Resolution and 15-dB Dynamic Range**
K. Tsuji and T. Horiguchi, *NTT, Japan.*

9:40 am

- 588 **F1-5 ■ Distributed Intragrating Sensing Using Phase Retrieval**
J. Skaar and H. E. Engan, *Norwegian Univ. of Science and Technol., Norway.*

9:55 am

- 592 **F1-6 ■ Lightning Location by Detecting Polarization Fluctuations in OPGW**
M. Kurono, M. Kuribara and H. Sumitani*, *Central Research Inst. of Electric Power Industry and *Chugoku Electric Power Co., Inc., Japan.*

10:10 am

- 596 **F1-7 ■ Distributed Fiber Strain Sensor Based on Dispersive Microwave Frequency Shifting**
J. U. Kang, *Johns Hopkins Univ., USA.*

10:25 am - 10:45 am
Coffee Break

10:45 am - 12:40 pm

- 601 **F2 ■ System Applications and Field Tests**
D. Inaudi, *SMARTEC SA, Switzerland, Chairperson*
K. Nakamura, *The Furukawa Electric Co., Ltd., Japan, Chairperson*

10:45 am (Invited)

- 602 **F2-1 ■ Applications of Fibre Optic Sensors and Instrumentation in the Oil and Gas Industry**
P. Eigenraam, B. S. Douma and A. P. Koopman, *Shell International Oil Products, Netherlands.*

11:10 am

- 608 **F2-2 ■ Comparative Study of MGy Dose Level γ -radiation Effect on FBGs Written in Different Fibres**
A. I. Gusarov, D. S. Starodubov*, F. Berghmans**, O. Deparis, Y. Defosse, A. F. Fernandez**, M. Decréton**,
P. Mégret, M. Blondel, *Faculté Polytechnique de Mons, *D-STAR Technol. and **SCK-CEN, Belgium.*

11:25 am

- 612 **F2-3 ■ Optical Fibre Probes for Total Pressure and Total Temperature Measurement in a Turbine Test Rig**
J. S. Barton, J. M. Kilpatrick, W. N. MacPherson, J. D. C. Jones, K. S. Chana*, J. S. Anderson*, D. R. Buttsworth**
and T. V. Jones**, *Heriot-Watt Univ., *DERA Pyestock and **Oxford Univ., UK.*

11:40 am

616

F2-4 ■ Vibration Monitoring of a Ship Waterjet with Fiber Bragg Gratings

G. A. Johnson, S. T. Vohra, B. A. Danver, K. Pran*, G. B. Havsgård* and G. Wang*, *US Naval Research Lab., USA and *Forsvarets Forskningsinstitut, Norway.*

11:55 am

620

F2-5 ■ Exploiting the Faraday Effect for High Resolution Current Measurement

S. Mohr, M. Willsch, M. Wollenhaupt, T. Bosselmann and M. Bretschneider*, *Siemens and *Technical Univ. of Ilmenau, Germany.*

12:10 pm

624

F2-6 ■ Investigation of Fiberoptic Bragg Grating Sensors for Applications in the Aviation Industry

M. Trutzel, D. Betz, M. Holz, L. Staudigel, O. Krumpholz, H. -F. Siegling, R. Sangkohl, W. Martin, H. -C. Mühlmann*, T. Müllert* and H. Ahrendt*, *Daimler-Benz and *Daimler-Benz Aerospace Airbus, Germany.*

12:25 pm

628

F2-7 ■ A New Approach to Investigate Temperature Drifts in Magneto-optic Current Transformers

S. Mohr and T. Bosselmann, *Siemens, Germany.*

12:40 pm - 1:00 pm

Closing Remarks

B. Y. Kim, *Korea Advanced Institute of Science and Technology, Korea.*

International Optical Fibre Sensors Conference OFS-13 POSTDEADLINE SESSION, THURSDAY, APRIL 15, 1999

- 4 TH4-1 ▪ Noise Properties of Dual Mach-Zehnder Interferometers Employing Narrowband Fiber ASE Sources**
Hyo Sang Kim, Ronald P. H. Haaksman, Trevor P. Newson, and David J. Richardson,
Univ. of Southampton, UK
- 8 TH4-2 ▪ Distributed optical fibre sensing in synthetic fibre ropes and cables**
D. Uttamchandani, B. Culshaw, M. S. Overington*, M. Parsey*, M. Facchini** and
L. Thévenaz**, *Univ. of Strathclyde, UK, *Tension Technology International Ltd., UK and*
***EPFL Swiss Federal Institute of Technology, Switzerland*
- 12 TH4-3 ▪ Humidity sensing by measurement of the refractive index of air**
Stefan Mc Murtry, John D. Wright, David A. Jackson, *Univ. Of Kent, UK*
- 16 TH4-4 ▪ Fibre Bragg Grating Sensors and Sensing Systems for Civil Engineering and Mine Applications**
S. Fischer, B. Verwilghen, M. Voet*, M. Jobmann**, F. Glötzl***, M. Bugaud**** and
P. Ferdinand****, *ID FOS RESEARCH e.e.i.g., Belgium and Vrije Univ. Brussel, Belgium,*
ID FOS RESEARCH e.e.i.g., Belgium, **DBE mbH, Germany, *Glötzl Baumeßtechnik mbH,*
*Germany and ****LETI (CEA – Technologies Avancées) - DEIN-SPE-CE/Saclay, France*