Contents

xi Conference Committee

xiii Introduction

I. Vergara, G. Van Caenegem, F. Ibáñez, European Commission (Belgium)

PLENARY PRESENTATION

6589 02 The nano revolution: bottom-up manufacturing with biomolecules (Plenary Paper) [6589-200]
Y.-F. Li, SETI Institute (USA); J. Li, C. Paavola, NASA Ames Research Ctr. (USA); H. Kagawa, S. L. Chan, SETI Institute (USA); J. D. Trent, NASA Ames Research Ctr. (USA)

SESSION 1 POWER GENERATION AND LOW-POWER ARCHITECTURES

6589 03 Fabrication and characterization of a passive silicon-based direct methanol fuel cell [6589-01]
J. P. Esquivel, N. Sabaté, J. Santander, N. Torres, C. Cané, Ctr. Nacional de Microelectrónica-IMB (Spain)

6589 04 Low-power low-latency MAC protocol for aeronautical applications [6589-02]
J. Sabater, M. Kluge, S. Bovelli, J. Schalk, EADS Deutschland GmbH (Germany)

6589 05 Design and implementation of mechanical resonators for optimized inertial electromagnetic microgenerators [6589-03]
C. Serre, A. Pérez-Rodríguez, N. Fondevilla, Univ. Barcelona (Spain); E. Martincic, Univ. Paris-Sud-XI (France); J. R. Morante, Univ. Barcelona (Spain); J. Montserrat, J. Esteve, Ctr. Nacional de Microelectrónica (Spain)

6589 06 Implementation of hard magnetic thin films on suspended cantilevers for electromagnetic energy harvesters [6589-04]
E. Makarona, T. Spelliotis, A. Darsinou, C. Tsamis, S. Chatzandroulis, D. Niarhos, National Ctr. for Scientific Research Demokritos (Greece)

SESSION 2 OPTICAL MEMS

6589 07 A compact optical ethylene monitoring system [6589-05]
J. Wölleinstein, S. Hartwig, J. Hildenbrand, A. Eberhardt, Fraunhofer Institute for Physical Measurement Techniques (Germany); M. Moreno, Univ. de Barcelona (Spain); J. Santander, R. Rubio, Ctr. Nacional de Microelectrónica (Spain); J. Fonollosa, Univ. de Barcelona (Spain); L. Fonseca, Ctr. Nacional de Microelectrónica (Spain)
Oxygen measurements at high pressures using a low-cost polarization-stabilized widely tunable vertical-cavity surface-emitting laser [6589-06]
B. Scherer, J. Wöllenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany); M. Weidemüller, W. Salzmann, Albert-Ludwigs-Univ. (Germany); J. M. Ostermann, F. Rinaldi, R. Michalzik, Univ. Ulm (Germany)

Thermo-activated nano-material for use in optical devices [6589-07]
S. Mias, LAAS-CNRS (France); J. Sudor, LAAS-CNRS (France) and CEA-LETI (France); H. Camon, LAAS-CNRS (France)

Dye based light sensor for tag integration [6589-08]
I. Sayhan, EADS Deutschland GmbH (Germany); B. Hoetzer, J. Wöllenstein, Fraunhofer Institute for Physical Measurement Technique (Germany); E. Rose, Th. Becker, EADS Deutschland GmbH (Germany)

SESSION 3 MICROFLUIDIC SYSTEMS

LTCC: a fascinating technology platform for miniaturized devices (Invited Paper) [6589-09]
U. Schmid, Saarland Univ. (Germany)

Ferromagnetic 3D impeller-shaped micro-stirrer bar for micromixing [6589-10]
A. K. Nallani, Intel Corp. (USA) and Univ. of Texas at Dallas (USA); J.-B. Lee, Univ. of Texas at Dallas (USA)

Development of MEMS-based liquid chromatography modules for agrofood applications [6589-11]
A. Benvenuto, L. Lorenzelli, C. Collini, V. Guarnieri, A. Adami, E. Morganti, FBK-irst (Italy)

Microfluidic chamber with acoustic actuation by LiNbO3 interdigital transducers for tumor cell investigations [6589-64]
M. Gruber, R. Heming, Univ. of Hagen (Germany); E.-M. Schnaeker, Univ. of Muenster (Germany); T. Seiler, Univ. of Hagen (Germany)

SESSION 4 AEROSPACE APPLICATIONS

Presentation of silicon platforms for wireless advanced networks of sensors for aeronautics application [6589-13]
K. Moreau, C. Ruby, S. Rolet, B. Petitjean, V. Rouet, EADS France (France)

A novel low-power fluxgate sensor using a macroscale optimisation technique for space physics instrumentation [6589-14]
G. Dekoulis, F. Honary, Lancaster Univ. (United Kingdom)

Investigations on the passivation of thin film flow sensors on flexible substrates [6589-15]
U. Schmid, A. Ababneh, H. Seidel, Saarland Univ. (Germany); R. Wagner, K. Bauer, EADS Deutschland GmbH (Germany)
<table>
<thead>
<tr>
<th>SESSION 5</th>
<th>PHYSICAL SENSORS</th>
</tr>
</thead>
</table>
| 6589 0I   | A tuning fork gyroscope with compensated imbalance signal [6589-16]  
E. Arnold, F. Nuscheler, EADS Deutschland GmbH (Germany) |
| 6589 0J   | A new micromachined sensor system for tactile measurements of high-aspect ratio microstructures [6589-18]  
M. Balke, E. Peiner, Technical Univ. Braunschweig (Germany); L. Doering, Physikalisch-Technische Bundesanstalt (Germany) |
| 6589 0K   | Searching for hypothetical forces in the Casimir regime using a MEMS based force sensor [6589-19]  
R. S. Decca, Indiana Univ.-Purdue Univ. Indianapolis (USA); D. López, Alcatel Lucent, Bell Labs. (USA); D. E. Krause, Wabash College (USA) and Purdue Univ. (USA); E. Fischbach, Purdue Univ. (USA) |
| 6589 0L   | Resonance frequencies and modal shape characterization of piezoelectric microcantilevers [6589-49]  
P. Sanz-González, J. Hernando, J. Vazquez, J. L. Sanchez-Rojas, ETSI Industriales (Spain) |
| 6589 0M   | Silicon cantilever sensor for micro-/nanoscale dimension and force metrology [6589-58]  
E. Peiner, Technical Univ. Carolo-Wilhelmina at Braunschweig (Germany); L. Doering, Physikalisch-Technische Bundesanstalt (Germany); M. Balke, Technical Univ. Carolo-Wilhelmina at Braunschweig (Germany); A. Christ, Martin Luther Univ. Halle-Wittenberg (Germany) |
| 6589 0N   | Feedback loops with electrically driven microcantilevers [6589-59]  
J. Malo, J.-I. Izpura, Univ. Politécnica de Madrid (Spain) |

<table>
<thead>
<tr>
<th>SESSION 6</th>
<th>SMART SYSTEM INTEGRATION</th>
</tr>
</thead>
</table>
| 6589 0O   | Fabrication process for a flexible tag microlab [6589-20]  
E. Abad, Fundación Tekniker (Spain); B. Mazzolai, Scuola Superiore Sant’Anna (Italy); A. Juarros, D. Gómez, Fundación Tekniker (Spain); A. Mondini, Scuola Superiore Sant’Anna (Italy); I. Sayhan, T. Becker, EADS Deutschland GmbH (Germany) |
| 6589 0P   | Ultra-low-power electronics and devices for a multisensing RFID tag [6589-21]  
S. Zampolli, I. Elmi, G. C. Cardinali, CNR-IMM Bologna (Italy); A. Scorzoni, M. Cicioni, Univ. degli Studi di Perugia (Italy); S. Marco, F. Palacio, J. M. Gómez-Cama, Univ. de Barcelona (Spain); I. Sayhan, T. Becker, EADS Corp. Research Ctr. (Germany) |
| 6589 0Q   | RFID reader with gas sensing capability for monitoring fruit along the logistic chain: array development and signal processing [6589-22]  
E. Llobet, A. Vergara, J. L. Ramírez, Univ. Rovira i Virgili (Spain); S. Zampolli, CNR-IMM (Italy); T. Becker, EADS Deutschland GmbH (Germany); L. Fonseca, CNM-CSIC (Spain) |
| 6589 0R   | Design of all-plastic distributed pressure sensors based on electroactive materials [6589-23]  
E. Ochofeco, J. A. Pomposo, H. Maciñor, Ctr. for Electrochemical Technologies (Spain); M. A. Arregui, F. Martínez, G. Obieta, Technological Research Ctr. (Spain); H. Grande, Ctr. for Electrochemical Technologies (Spain) |
### SESSION 7  FABRICATION AND PROCESS TECHNOLOGY

**6589 OS**  
**Two-dimensional MEMS array for maskless lithography and wavefront modulation (Invited Paper)** [6589-24]  

**6589 OT**  
**Plasma-activated wafer bonding: the new low-temperature tool for MEMS fabrication** [6589-25]  
V. Dragoi, G. Mittendorfer, C. Thanner, P. Lindner, EV Group (Austria)

**6589 OU**  
**The influence of varying sputter deposition conditions on the wet chemical etch rate of AlN thin films** [6589-26]  
A. Ababneh, H. Kreher, H. Seidel, U. Schmid, Saarland Univ. (Germany)

### SESSION 8  RF MEMS

**6589 OV**  
**Temperature stress impact on power RF MEMS switches** [6589-27]  
C. Bordas, K. Grenier, LAAS-CNRS (France); D. Dubuc, LAAS-CNRS (France) and Univ. of Toulouse (France); M. Paillard, J.-L. Cazaux, Alcatel Alenia Space (France); R. Plana, LAAS-CNRS (France) and Univ. of Toulouse (France)

**6589 OW**  
**Inductively coupled MEMS-based micro RFID transponder** [6589-28]  
H. M. Lu, The Univ. of Texas at Dallas (USA); C. Goldsmith, MEMtronics Inc. (USA); J.-B. Lee, The Univ. of Texas at Dallas (USA)

**6589 OX**  
**Germanium as an integrated resistor material in RF MEMS switches** [6589-29]  
K. Grenier, C. Bordas, S. Pinaud, L. Salvagnac, D. Dubuc, LAAS-CNRS, Univ. de Toulouse (France)

**6589 OY**  
**A metal-to-metal contact RF MEMS switch towards handsets applications** [6589-30]  
T. Vähä-Heikkilä, P. Rantakari, VTT Technical Research Ctr. of Finland (Finland)

### SESSION 9  CHEMICAL AND BIO-SENSORS

**6589 11**  
**Detection of unburned fuel as contaminant in engine oil by a gas microsensor array** [6589-32]  
S. Capone, M. Zuppa, D. S. Presicce, M. Epifani, L. Francioso, P. Siciliano, C. Distante, Institute of Microelectronics and Microsystems, CNR (Italy)

**6589 12**  
**Nano and micro stripe based metal oxide thin film gas sensor** [6589-33]  
S. Palzer, E. Morettan, Fraunhofer Institute for Physical Measurement Techniques (Germany); F. Hernandez Ramirez, A. Romano-Rodriguez, J. Ramon Morante, Univ. de Barcelona (Spain); J. Wollenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany)

**6589 13**  
**Nanofabrication of TiO2 nanowires: I-V characteristic and improvement of metal oxides gas sensing properties** [6589-34]  
L. Francioso, A. Forleo, A. M. Taurino, P. Siciliano, CNR-Institute for Microelectronics and Microsystems (Italy)
Bismuth film electrodes for heavy metals determination [6589-43]
V. Rehacek, I. Hotovy, M. Vojs, F. Mika, Slovak Univ. of Technology (Slovak Republic)

Gamma radiation and ozone sensing properties of In$_2$O$_3$:ZnO:SnO$_2$ thin films [6589-45]
K. Arshak, O. Korostynska, G. Hickey, Univ. of Limerick (Ireland)

Quartz crystal nano-balance for hydrogen sensing at room temperature using carbon nanotubes aggregates [6589-46]
M. Lucci, F. Toschi, V. Sessa, S. Orlanducci, E. Tamburri, M. L. Terranova, Univ. of Roma Tor Vergata (Italy)

Design and development of a microheater on GaAs for MEMS gas sensor array [6589-50]
I. Hotovy, V. Rehacek, Slovak Univ. of Technology (Slovak Republic); T. Lalinsky, S. Hascik, Institute of Electrical Engineering (Slovak Republic); F. Mika, Slovak Univ. of Technology (Slovak Republic)

Mixed metal oxide films as pH sensing materials [6589-55]
K. Arshak, E. Gill, O. Korostynska, A. Arshak, Univ. of Limerick (Ireland)

Micro and nanotechnologies for the development of an integrated chromatographic system [6589-60]
O. Casals, A. Romano-Rodríguez, X. Illa, C. Zamani, A. Vilà, J. R. Morante, Univ. of Barcelona (Spain); I. Gràcia, P. Ivanov, N. Sabaté, L. Fonseca, J. Santander, E. Figueras, C. Cané, Institut de Microelectrònica de Barcelona, CNM (Spain)

SESSION 10 BIO-MEMS AND ACUATORS

The MicroActive project: automatic detection of disease-related molecular cell activity (Invited Paper) [6589-35]
L. Furuberg, M. Mielnik, I.-R. Johansen, J. Voitel, SINTEF Microsystems and Nanotechnology (Norway); A. Gulliksen, Norchip A/S (Norway) and Univ. of Oslo (Norway); L. Solli, Norchip A/S (Norway) and NTNU (Norway); F. Karlsen, Norchip A/S (Norway); T. Bayer, F. Schönfeld, K. Dres, Institut für Mikrotechnik Mainz GmbH (Germany); H. Keegan, C. Martin, J. O’Leary, Coombe Women’s Hospital (Ireland) and IMTEK (Germany); L. Rieger, IMTEK (Germany); P. Koltay, BioFluidix (Germany)

DLC/TiNi microcage for biopsy applications [6589-36]
Y. Q. Fu, J. K. Luo, Univ. of Cambridge (United Kingdom); S. E. Ong, S. Zhang, Nanyang Technological Univ. (Singapore); A. J. Flewitt, W. I. Milne, Univ. of Cambridge (United Kingdom)

SMA micro actuators for active shape control, handling technologies, and medical applications [6589-37]
M. Leester-Schädel, B. Hoxhold, S. Demming, S. Büttgenbach, TU Braunschweig (Germany)

An alternative system for mycotoxin detection based on amorphous silicon sensors [6589-51]
D. Caputo, G. de Cesare, P. De Rossi, C. Fanelli, A. Nascetti, Univ. La Sapienza (Italy); A. Ricelli, CNR, Institute of Science of Food Production (Italy); R. Scipinotti, Univ. La Sapienza (Italy)
Pulse voltammetry wine defects identification by means of miniaturized microelectrodes [6589-52]
L. Francioso, CNR-Institute for Microelectronics and Microsystems (Italy); R. Bjorklund, Linköping Univ. (Sweden); P. Siciliano, CNR-Institute for Microelectronics and Microsystems (Italy); T. K. Rulcker, Linköping Univ. (Sweden)

Development of automated microrobot-based nanohandling stations for nanocharacterization [6589-54]
S. Fatikow, V. Eichhorn, F. Krohs, I. Mircea, C. Stolle, S. Hagemann, Univ. of Oldenburg (Germany)

Identification of wine defects by means of a miniaturized electronic tongue [6589-56]
G. Verrelli, Univ. of Rome Tor Vergata (Italy); L. Francioso, P. Siciliano, CNR-IMM (Italy); C. Di Natale, Univ. of Rome Tor Vergata (Italy) and CNR-IMM (Italy); A. D’Amico, Univ. of Rome Tor Vergata (Italy); R. Paolesse, Univ. of Rome Tor Vergata (Italy) and CNR-IMM (Italy); F. Logrieco, CNR-ISPA (Italy)

SESSION 11 MATERIALS AND SIMULATION

On the influence of nano-sized palladium clusters at the surface of SnO2 thin films on the gas response [6589-38]
S. Palzer, E. Moretton, Fraunhofer Institute for Physical Measurement Techniques (Germany); C. Yin, B. von Issendorf, FMF (Germany); J. Wöllenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany)

Three-dimensional simulation of sacrificial etching [6589-40]
J. Cervenka, H. Ceric, S. Selberherr, TU Vienna (Austria)

Application of PZT thick-films on adjusting purposes in micro-optical systems [6589-41]
C. Bruchmann, Friedrich Schiller Univ. Jena (Germany); B. Höfer, P. Schreiber, R. Eberhardt, W. Buss, T. Peschel, Fraunhofer Institut für Optik und Feinmechanik (Germany); S. Gebhardt, Fraunhofer Institut für Keramische Technologien und Systeme (Germany); A. Tünnermann, Friedrich Schiller Univ. Jena (Germany) and Fraunhofer Institut für Optik und Feinmechanik (Germany); E. Beckert, Fraunhofer Institut für Optik und Feinmechanik (Germany)

VHDL implementation of a communication interface for integrated MEMS [6589-47]
E. Magdaleno Castelló, M. Rodríguez Valido, A. J. Ayala Alfonso, Univ. de La Laguna (Spain)

Modelling and simulation of a micromachined angular rate sensor with optimised mechanical suspension [6589-48]
A. Kulygin, M. Gergen, U. Schmid, H. Seidel, Saarland Univ. (Germany)

Physical modeling of a highly sensitive linear MOS sensor for 2D detection of magnetic fields [6589-53]
A. Abou-Elnour, O. Abo-Elnor, Ajman Univ. of Science & Technology (United Arab Emirates); E. Y. Mohamed, Omm Al-Qura Univ. (Saudi Arabia); M. M. Ibrahim, Ain-Shams Univ. (Egypt)

Coupling coefficient determination based on simulation and experiment for ST-cut quartz saw delay-line response [6589-61]
Y.-C. Hsu, N.-B. Le, Southern Taiwan Univ. of Technology (Taiwan); L.-S. Jang, National Cheng Kung Univ. (Taiwan)
A domotic application for educational tasks [6589-63]
S. Alayón, C. González, Y. Vargas, L. Hernández, Univ. of La Laguna (Spain)

Author Index
Conference Committee

Symposium Chairs

José Fco. López, Universidad de Las Palmas de Gran Canaria (Spain)
Roberto Sarmiento Rodríguez, Universidad de Las Palmas de Gran Canaria (Spain)
Steve Kang, University of California, Santa Cruz (USA)

Conference Chair

Thomas Becker, EADS Deutschland GmbH (Germany)

Conference Cochair

Carles Cané, Centro Nacional de Microelectrónica-IMB, CSIC (Spain)
N. Scott Barker, University of Virginia (USA)

Program Committee

Kris Baert, IMEC (Belgium)
Joan Bausells, Centro Nacional de Microelectrónica (Spain)
James Becker, Montana State University (USA)
Thomas Bischoff, Infineon Technologies AG (Germany)
Nicolaas F. de Rooij, Université de Neuchâtel (Switzerland)
Rhonda Drayton, University of Minnesota (USA)
Martin Eickhoff, Technische Universität München/Walter Schottky Institute (Germany)
Guido Faglia, Università degli Studi di Brescia (Italy)
Carles Ferrer, Universidad Autònoma de Barcelona (Spain)
F. Javier Gracia, Centro de Estudios e Investigaciones Técnicas de Gipuzkoa (Spain)
Katia M. Grenier, LAAS-CNRS (France)
Klas Hjort, Uppsala University (Sweden)
Gianfranco Innocenti, Centro Richerche Fiat (Italy)
Jeong-Bong Lee, The University of Texas at Dallas (USA)
Santiago Marco Colás, Universidad de Barcelona (Spain)
Dean P. Neikirk, The University of Texas, Austin (USA)
Sergio Pacheco, Freescale Semiconductor, Inc. (USA)
John Papapolymerou, Georgia Institute of Technology (USA)
Ulrich Schmid, Saarland University (Germany)
Steven J. Setford, Cranfield University (United Kingdom)
Pietro Siciliano, Institute of Microelectronics and Microsystems, CNR (Italy)
Christos Tsamis, National Center for Scientific Research Demokritos (Greece)
Wouter van der Wijngaard, Kungliga Tekniska Högskolan (Sweden)
Jürgen Wöllenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany)
Session Chairs

1. Power Generation and Low-Power Architectures
   - Thomas Becker, EADS Deutschland GmbH (Germany)
   - Carles Cané, Centro Nacional de Microelectrónica-IMB, CSIC (Spain)

2. Optical MEMS
   - Katia M. Grenier, LAAS-CNRS (France)

3. Microfluidic Systems
   - Christos Tsamis, National Center for Scientific Research Demokritos (Greece)
   - Guido Faglia, Università degli Studi di Brescia (Italy)

4. Aerospace Applications
   - Jürgen Wöllenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany)
   - Thomas Becker, EADS Deutschland GmbH (Germany)

5. Physical Sensors
   - Ulrich Schmid, Saarland University (Germany)
   - Jeong-Bong Lee, The University of Texas at Dallas (USA)

6. Smart System Integration
   - Carles Cané, Centro Nacional de Microelectrónica-IMB, CSIC (Spain)

7. Fabrication and Process Technology
   - Katia M. Grenier, LAAS-CNRS (France)
   - Ulrich Schmid, Saarland University (Germany)

8. RF MEMS
   - Pietro Siciliano, Institute of Microelectronics and Microsystems, CNR (Italy)

9. Chemical and Bio-Sensors
   - Christos Tsamis, National Center for Scientific Research Demokritos (Greece)

10. Bio-MEMS and Acuators
    - Guido Faglia, Università degli Studi di Brescia (Italy)
    - Jürgen Wöllenstein, Fraunhofer Institute for Physical Measurement Techniques (Germany)

11. Materials and Simulation
    - Thomas Becker, EADS Deutschland GmbH (Germany)
Introduction

The conference Smart Sensors, Actuators and MEMS was held in Maspalomas, Gran Canaria, Spain, from May 2 to 4, 2007. About 60 contributions from Europe, America, and Asia were presented during 12 sessions including a poster session. A wide range of topics within the MEMS research and development area was covered. Starting from simulation and materials research, the spectrum was broadened by fabrication and process technologies, as well as sensor research for physical, biological, and chemical devices. Moreover, optical and RF MEMS were presented. Related to applications, work on smart system integration, microfluidic systems, actuators, energy scavenging, and low-power architectures was discussed. Finally, applications — mainly in the field of aerospace and logistics — were treated. The broad range of topics shows the highly interdisciplinary work done in the field of MEMS. Moreover, the variety of themes within the conference enabled discussions between researchers with different backgrounds.

The high quality of the oral and poster presentations has to be mentioned in general; however, I would like to highlight the three invited presentations of this conference. Liv Furuberg from SINTEF, Norway, gave a talk entitled “The MicroActive project: automatic detection of disease-related molecular cell activity.” Ulrich Schmid from Saarland University, Germany, gave a presentation entitled “LTCC: a fascinating technology platform for miniaturized devices.” And last but not least, Daniel Lopez from Bell Labs., USA, delivered a presentation on “Two-dimensional MEMS array for maskless lithography and wavefront modulation.”

Moreover, I appreciated not only the open and fruitful discussions within the sessions, but also discussion outside the conference rooms, inspired by the nice location. I would like to thank all participants for their individual contributions which made the conference a successful event in the international conference calendar.

Special thanks go to José Fco. López, Roberto Sarmiento Rodríguez, and Steve Kang for organising the conference, staff at SPIE Europe, and my co-chairs, Carles Cané and Scott Barker. Finally, I would like to thank the Programme Committee for doing the reviews and acting partly as session chairs.

Thomas Becker