Sensors & Transducers

Volume 19, Special Issue
February 2013

www.sensorsportal.com
ISSN 1726-5479

Editors-in-Chief: professor Sergey Y. Yurish,
Tel.: +34 696067716, e-mail: editor@sensorsportal.com

Editors for Western Europe
Meijer, Gerard C.M., Delft Univ. of Technology, The Netherlands
Ferrari, Vittorio, Università di Brescia, Italy

Editors for Eastern Europe
Sachenko, Anatoly, Ternopil National Economic University, Ukraine

Editors for North America
Katz, Evgeny, Clarkson University, USA
Datskos, Panos G., Oak Ridge National Laboratory, USA
Fabien, J. Josse, Marquette University, USA

Editors for South America
Costa-Felix, Rodrigo, Inmetro, Brazil

Editors for Asia
Ohyama, Shinji, Tokyo Institute of Technology, Japan
Zhengbing, Hu, Huazhong Univ. of Science and Technol., China

Editors for Asia-Pacific
Mukhopadhyay, Subhas, Massey University, New Zealand

Editors for Africa
Maki K.Habib, American University in Cairo, Egypt

Editorial Board

Abdul Rahim, Ruzairi, Universiti Teknologi, Malaysia
Abramchuk, George, Measur. Tech. & Advanced Applications, Canada
Asecu, Giorgio, George Mason University, USA
Atalay, Selcuk, Inonu University, Turkey
Atghaee, Ahmad, University of Tehran, Iran
Augutis, Vygantas, Kaunas University of Technology, Lithuania
Ayesh, Aladdin, De Montfort University, UK
Baliga, Shankar, University of California, San Diego, USA
Basu, Sukumar, Jadavpur University, India
Bouvet, Marcel, University of Burgundy, France
Campanella, Luigi, University La Sapienza, Italy
Carvalho, Vitor, Instituto Superior Técnico, Portugal
Chang, Wen-Yaw, Chung Yuan Christian University, Taiwan
Chang, Ching-Hua, National Taiwan Normal University, Taiwan
Chen, Wei, Hefei University of Technology, China
Cheng-Ta, Chiang, National Chia-Yi University, Taiwan
Chung, Yung-Ming, National Taiwan University, Taiwan
Cortes, Camilo A., Universidad Nacional de Colombia, Colombia
D’Amico, Arnaldo, Université de Tor Vergata, Italy
De Stefano, Luca, Institute for Microelectronics and Microsystems, Italy
Ding, Jianning, Changzhou University, China
Djordjevic, Alexandar, City University of Hong Kong, Hong Kong
Donato, Nicola, University of Messina, Italy
Dong, Feng, Tianjin University, China
Erkmen, Aydan M., Middle East Technical University, Turkey
Gaur, Elena, Coventry University, UK
Gole, James, Georgia Institute of Technology, USA
Gong, Hao, National University of Singapore, Singapore
Gonzalez de la Rosa, Juan Jose, University of Cadiz, Spain
Guillet, Bruno, Université de Caen, France
Hadjisavvas, Silas, The University of Reading, UK
Hui, David, University of New Orleans, USA
Jaffrezic-Renaud, Nicole, Claude Bernard University Lyon 1, France
Jamali, Mohammad, Qatar University, Qatar
Kanistras, Eugenijus, Vienna University of Technology, Austria
Kim, Min Young, Kyungpook National University, Korea
Kumar, Arun, University of Delaware, USA
Lay-Eskalille, Aimé, University of Lecce, Italy
Lin, Paul, Cleveland State University, USA
Liu, Alhua, Chinese Academy of Sciences, China

Mansor, Muhammad Naufal, University Malaysia Perlis, Malaysia
Marquez, Alfredo, Centro de Investigacion en Materiales Avanzados, Mexico
Mishra, Vivekanand, National Institute of Technology, India
Moghavvemi, Mahmoud, University of Malaya, Malaysia
Morello, Rosario, Universidad “Mediterranea” of Reggio Calabria, Italy
Muller, Immaca Sirajuddin, National Chemical Laboratory, Pune, India
Nabok, Aleksy, Sheffield Hallam University, UK
Neshkova, Milka, Bulgarian Academy of Sciences, Bulgaria
Passaro, Vittorio M.N., Politecnico di Bari, Italy
Penza, Michele, ENEA, Italy
Perreira, Jose Miguel, Instituto Politecnico de Setebal, Portugal
Pugacni, Lea, University of Ljubljana, Slovenia
Pullini, Daniele, Centro Ricerche FIAT, Italy
Reig, Candid, University of Valencia, Spain
Restivo, Maria Teresa, University of Porto, Portugal
Rodriguez Martinez, Angel, Universidad Politécnica de Cataluña, Spain
Sada, Aji, University of Mississippi, USA
Sadeghian Marnani, Hamed, TU Delft, The Netherlands
Sapozhnikova, Ksenia, D. I. Mendeleev Institute for Metrology, Russia
Sengal, Subodh Kumar, National Physical Laboratory, India
Shah, Kriyang, La Trobe University, Australia
Shi, Wendiyan, California Institute of Technology, USA
Smituli, Yuriy, Guanjiau University, Mexico
Song, Xu, An Yang Normal University, China
Srivastava, Arvind K., LightField Corp, USA
Stefanescu, Dan Mihai, Romanian Measurement Society, Romania
Sumriddetkajorn, Sarun, Nat. Electr. & Comp. Tech. Center, Thailand
Sun, Zhiquiang, Central South University, China
Sysoev, Victor, Saratov State Technical University, Russia
Thiranavukkarasu, I., Manipal University Karnataka, India
Vazquez, Carmen, Universidad Carlos III Madrid, Spain
Wang, Jianguo, Xiamen University, China
Xue, Ning, Agilent, Inc., USA
Yang, Dongfeng, National Research Council, Canada
Yang, Shuang-Hua, Shanghai Jiao Tong University, China
Zakaria, Zulkarnay, University Malaysia Perlis, Malaysia
Zhang, WeiPing, Shanghai Jiao Tong University, China
Zhang, Wenming, Shanghai Jiao Tong University, China

Sensors & Transducers Journal (ISSN 1726-5479) is a peer review international journal published monthly online by International Frequency Sensor Association (IFSA). Available in both: print and electronic (printable pdf) formats. Copyright © 2013 by International Frequency Sensor Association. All rights reserved.
## Contents

<table>
<thead>
<tr>
<th>Volume 19</th>
<th>Special Issue</th>
<th>February 2013</th>
<th><a href="http://www.sensorsportal.com">www.sensorsportal.com</a></th>
<th>ISSN 1726-5479</th>
</tr>
</thead>
</table>

### Research Articles

1. **Study on VSI Switching Frequency Optimization of PMSM Based Servo System**  
   Shi-xiong Zhang .......................................................................................................................... 1

2. **Application of an Improved Genetic Algorithm in Network Information Filtering**  
   Min Ren, Baoya Song, Jirong Jiang ............................................................................................ 7

3. **Compression of Power Quality Data Based on Improved DCT Transform**  
   Hua Ouyang, Hui Li, Mei Qian .................................................................................................... 13

4. **Mechanical Optimization Design Based on Genetic Algorithm**  
   Ying Sun, Yuesheng Gu and Hegen Xiong .................................................................................. 19

5. **Camera Pose Estimation in Dynamic Scenes with Background Tracking**  
   Dong Zhang and Ping Li ............................................................................................................. 25

6. **Application of Step Design Method to Realize the Synchronization of Genesio Chaotic System**  
   Yu ZhiPeng .................................................................................................................................. 34

7. **Short-term Probabilistic Load Forecasting with the Consideration of Human Body Amenity**  
   Ning Lu ......................................................................................................................................... 39

8. **Analysis on Rural Land Circulation Subject Interests**  
   Shi Dong-mei, Xu Yue-ming, Wang Jian, Tong Lei ....................................................................... 45

9. **A High Precision Multi-function Electronic Scale Based on PSoC3**  
   Lv Dian-ji, Peng Jian-sheng, Zhou Guo-juan, Xu Yong ............................................................... 51

10. **Studies on Equalization Strategy of Battery Management System for Electric Vehicle**  
    Nan Jinrui, Guo Meng .................................................................................................................. 57

11. **Design and Optimal Control of Parallel Robot**  
    Ying Sun, Yuesheng Gu and Hegen Xiong ................................................................................... 64

12. **Pure Surface Texture Mapping Technology and its Application for Mirror Image**  
    Wei Feng Wang, Hui Feng Yan, QinMao, Ming Liang Zhou .......................................................... 68

13. **Forming Flaws Analysis of Lead Screw Cold Roll-Beating Based on Stress-Strain Evolution**  
    He Wangyun, Li Yan, Yang Mingshun, Wang Ming ....................................................................... 74

14. **A Reflective Grating Microcantilever Biosensor**  
    Feng Wen, Yuejin Zhao, Xiaomei Yu, Cheng Gong, Jiancheng Yang ........................................... 83
The Fourth International Conference on Sensor Device Technologies and Applications

SENSORDEVICES 2013
25 - 31 August 2013 - Barcelona, Spain


Deadline for papers: 30 March 2013


The Seventh International Conference on Sensor Technologies and Applications

SENSORCOMM 2013
25 - 31 August 2013 - Barcelona, Spain


Deadline for papers: 30 March 2013


The Sixth International Conference on Advances in Circuits, Electronics and Micro-electronics

CENICS 2013
25 - 31 August 2013 - Barcelona, Spain

Tracks: Semiconductors and applications - Design, models and languages - Signal processing circuits - Arithmetic computational circuits - Microelectronics - Electronics technologies - Special circuits - Consumer electronics - Application-oriented electronics

Deadline for papers: 30 March 2013

A Reflective Grating Microcantilever Biosensor

Feng Wen, Yuejin Zhao, Xiaomei Yu, Cheng Gong, Jiancheng Yang

School of Optoelectronics, Beijing Institute of Technology, Beijing, 100081, China
National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Institute of Microelectronics, Peking University, Beijing 100871, China
National Key Laboratory for Electronic Measurement Technology, North University of China, Cheng Taiyuan, 030051, China

* Tel.: 13620610819
E-mail: 200908@bit.edu.cn, nucwenfeng@163.com

Received: 28 December 2012 /Accepted: 28 January 2013 /Published: 19 February 2013

Abstract: For measuring the deflections of the microcantilever biosensor, a reflective grating microcantilevers based on SOI were designed and fabricated, a high precision optical readout approach based on diffraction spectrum balancing feedback control was presented. The diffraction spectrum image was collected by a 12-bit digital area array monochrome CCD. According to the sum gray value of the image which subtracted each other at the balancing position and bending position to control a high precision motorized rotation stage revolve make the sum gray value remained in the balancing position always, then the motorized rotation stage revolving angle is just the cantilever bend angle. The resolution of motorized rotation stage is $35 \times 10^{-6}$ deg, the system practical measurement resolution is $1 \times 10^{-4}$ deg, that is to say, for a length of 250 um microcantilever, the tip measure resolution is up to 0.043 nm. Measurement results clearly demonstrate that this reflective grating microcantilever biosensor and this read out method has enormous potential application prospect in biological detecting.

Keywords: Reflecting grating, Microcantilever, Diffraction, Feedback balancing, CCD.

1. Introduction

Microcantilevers have been proved to be quite versatile and sensitive devices and have been used mainly in the trace detection of bio-chemical materials [1]. A micro cantilever biosensor developed is a device that can act as a physical, chemical or biological sensor by detecting changes in micro cantilever bending (static operation mode) or resonance frequency shift (dynamic operation mode) [2-6]. Compared with conventional ELISA or immunofluorescent assay, the microcantilever biosensor has the advantages of label-free operation, fast detection, and low cost. The specific interaction between the recognition molecules and the target biomarkers generates surface stress in microcantilever and in turn the deflection of the microcantilever [7]. The deflections of the microcantilever biosensor are usually of the order of few tens to few hundreds of a nanometer. Such extremely low deflection require high advances instrument for accurately measuring the deflections. As a consequence, most of the applications of microcantilever biosensors are done in laboratories equipped with sophisticated deflection detection and readout techniques [8].
Now the deflections can be measured using optical, piezoresistive, piezoelectricity and other readout methods [9-12]. However, a great discrepancy was not been avoided by piezoresistive readout or piezoelectricity because the tolerances of electronic components, wiring and the temperature affect [13]. Optical lever is the commonly used method [14-20], optical fiber reflective intensity [21-22], interferometric and diffraction-type [23-24]. But in common used optical readout the bulky and expensive apparatus is not absent [25].

In this paper, a reflective grating microcantilever is designed and fabricated; a high precision effective optical readout approach based on diffraction spectrum feedback balancing control was proposed. It has been validated by means of experiment that the proposed method is effective in increasing the sensitivity, resolution and improving measuring range.

### 2. Microcantilever Design and Fabrication

The sensor includes a reflective grating microcantilever and support silicon substrate. Au was sputtered on the SiO₂ as grating reflective material; also it was functionalized with thiol compounds as biological molecular sensitive layer. Specific interactions between the analytes and thiol compounds induce an apparent surface stress change and micromechanical bending of the cantilever. In order to get high sensitivity test by grating interference and diffraction, the mainly impact factors are the elastic coefficient of cantilever, grating constant and the total number of slots of grating. The cantilever was designed to be rectangular and featuring a dimension of 250 um × 50 um × 0.4 um, grating constant d is 40 um, in which a equals to b. The microcantilever sensor is in static working mode and requirements as far as possible in the state level without warping or drooping, in order to reduce the internal stress of buried oxide high temperature rapid thermal annealing process is necessary [26].

The cantilever was fabricated from a SOI wafer using a series of bulk silicon process. The main steps of the process flow were depicted in Fig. 1 and described as follows. Firstly, a SOI wafer was papered and cleaned (Fig. 1a), all the device layer was removed by isotropic etching using ASE system (Fig. 1b). In order to get reflective layer and bio-sensing layer, a Cr/Au layer with 30 nm Cr and 50nm Au was evaporated on the buried oxide layer using the ion sputtering system. (Fig. 1c). Lithography, defined metal grating shape and formed grating structure by stripping (Fig. 1d). Then, definition of cantilever beam shape and release window of the mask pattern, RIE SiO₂ down to the silicon substrate (Fig. 1e). At last, ASE system was employed to anisotropic etching Si 10 um and then isotropy etching Si 25 um to release the cantilever (Fig. 1f). Fig. 2 gives the designed process layout and the SEM image of the reflective grating microcantilever which was fabricated, cantilever beam bending upward much maybe due to the stress is not released thoroughly in the process of high temperature rapid thermal annealing.

### 3. Read out Method

#### 3.1. Light Source Characteristic

In this test system, the light source is 650 nm semiconductor laser. In order to get it’s actual characteristic, the spectrometer was measured. The fiber plug FC/PC of the light source was inserted into the plug of the spectrometer and start-up the system. then the practical tested spectrogram of laser was got as in Fig. 3. From the Fig. 3, it describes the light source distribution, the central wavelength is just the 650 nm and the width is just about 10 nm.

#### 3.2. Self-focusing Lens Collimator Characteristic

The mini collimator is a mini GRIN fiber lens, which was fabricated by a suit of unique techniques.
Compared with conventional collimator the mini collimator has the advantages of simplification, smaller optical spot size, high coupling efficiency, undergo higher light power and lower echo ullage. The light out from the collimator is Gaussian distribution, so at the appropriate distance we can regard it as parallel light. An experiment principle schemes was setup for getting the spot size as in Fig. 4. Light out from the 650 nm laser though a fiber, though a self-focusing lens collimator, (a filter lens which was used to reduce the intensity), an imaging lens to CCD. The CCD is 12 bit and has 659×494 pixels, each pixel is about 9.9 um × 9.9 um. The practical tested photo of the collimator spot can be seen in Fig. 5, in which Fig. 5(a) is the result of without filter lens, and Fig. 5(b) with filter lens. Fig. 5(a) shows that too high intensity light make the CCD saturation and the light of CCD lens reflected light and incident light interference generate the diffraction rings. Fig. 5(b) shows that with filter lens the light was reduced, CCD is not saturate, the white square box is 20 pixels, so the spot is about 200 um, that is to say, the mini collimator is good fit for detecting the deflection of the cantilever.

3.3. The Principle and Experimental System

Fig. 6 shows the sketch map of transmission grating diffraction, G is a grating ,the grating constant is d, diffraction angle is $\theta$, grating number is N, P is the receiving screen which at the focal distance of L2 lens. According to Huygens-Fresnel principle, $E_{P0}$ is a single slit diffraction zero order center geometric image point diffraction amplitude, $I_{P0}$ is a single slit diffraction zero order center namely geometric image point of the diffraction intensity, $E_{P0}$ is N slits interaction at $P_\theta$ diffraction amplitude can be expressed as (1):

$$E_{P\theta} = E_{PO} \frac{\sin \beta}{\beta^2} \frac{\sin N\gamma}{\sin \gamma}$$

$I_{P\theta}$ is the N slits interaction at the $P_\theta$ diffraction intensity can be expressed as (2):

$$I_{P\theta} = I_{PO} \frac{\sin^2 \beta}{\beta^2} \frac{\sin^2 N\gamma}{\sin^2 \gamma}$$

where $\frac{\sin^2 \beta}{\beta^2}$ is the Diffraction factor, $\frac{\sin^2 N\gamma}{\sin^2 \gamma}$ is the multiple beam interference factor, in which, $\beta = \frac{\pi b \sin \theta}{\lambda}$, $\gamma = \frac{\pi d \sin \theta}{\lambda}$, where $\lambda$ is the wavelength of the light source.

According to the extreme value of interference factor $\frac{d}{d\gamma} \left( \frac{\sin^2 N\gamma}{\sin^2 \gamma} \right) = 0$ can get $\sin \gamma = 0$ , $\sin N\gamma = 0$ and $N \tan \gamma = \tan N\gamma$, 

---

**Fig. 3.** The practical measured spectrogram of the 650 nm semiconductor laser.

**Fig. 4.** The sketch map of the collimator facular test.

**Fig. 5.** The practical tested photo of the collimator spot.

**Fig. 6.** The sketch map of transmission grating diffraction
when \( \sin \gamma = 0 \) get the main maximum value \( \frac{\sin^2 N\gamma}{\sin^2 \gamma} = N^2 \). The main maximum condition is \( \gamma = k\pi \), then can get \( d \sin \theta = k\pi \) is the famous grating equation. Under such conditions, the \( I_{P\theta} \) is \( N \) slits interaction at \( P_{\theta} \) diffraction intensity can be expressed as (3):

\[
I_{P\theta} = I_{P\theta 0} \frac{\sin^2 \beta}{\beta^2} \cdot N^2 \tag{3}
\]

According to the expression (3), the slot number \( N \) is bigger, interference stripe is brighter and sharper greatly.

When \( \sin N\gamma = 0 \) get the minimum value, minimum conditions is: \( \gamma = \frac{k\pi}{N} \), \( d \sin \theta = \frac{k\lambda}{N} \), In which, \( \frac{k}{N} \) integer. When \( N \tan \gamma = \tan N\gamma \) get secondary maximum.

According to the above analysis, Fig. 7 shows the Grating diffraction intensity distribution curve.

![Fig. 7. Grating diffraction intensity distribution curve.](image)

In this paper, the grating is working on reflective mode, but all above is applicable according to optical symmetry principle. Fig. 8 is the sketch map of light when the reflective grating cantilevers bend down. In the initial state, grating constant is \( d = a + b \) and the incident light angle is \( \beta \). If the cantilever beams bending angle is \( \alpha \). When \( \alpha \) is small, do not consider the cantilever beam deformation and approximating that of cantilever beam is a rigid body, only around the fixed end to rotate an angle, then get \( a' = a \cos(\alpha + \beta), \ b' = b \cos(\alpha + \beta) \). If other parameters unchanged, the variation of light intensity sensitivity can be expressed as (4):

\[
\frac{I_o - I_{o'}}{I_o} = \left| \frac{\cos^2(\alpha + \beta) - \cos^2 \beta}{\cos^2 \beta} \right| \tag{4}
\]

Further simplification can be expressed as (5):

\[
\frac{I_o - I_{o'}}{I_o} = |\cos(2\alpha) - \sin(2\alpha) \tan(2\beta) - 1| \tag{5}
\]

Expression (5) is a \( \tan \beta \) monotone decreasing function, in order to increase the sensitivity of the system, should adjust the angle of incidence of the light beam and make it as close to perpendicular to the incident.

![Fig. 8. The sketch map of light when the reflective grating cantilevers bend down.](image)
center of the image. Using Matlab calculate the sum gray value of the image which subtract each other at the balancing position and bend position, then according this sum gray value to precision control the motorized rotation stage make the sum gray value go back to the balancing position always, the revolving angle of the motorized rotation stage is also just the cantilever bend angle. This feedback balancing control method can get high sensitivity and high resolution.

![Fig. 9](image)

**Fig. 9.** The sketch map of the feedback balancing control read out method.

### 4. Results and Discussion

The diffraction stripe of the grating at the center of the image which was collected by CCD and sent to the computer is shown as Fig. 10(a). From this image we can see the center two bright stripes overlapping partly; this is because the reflective grating microcantilevers bend upward in the initial balancing position. When the microcantilever bends up or down, then the diffraction stripes move to the left or right. The moving distance is relevant to the microcantilever bend angle and other geometric parameters, for example, the distance and angle from the CCD to the reflective grating, the pixel size of the CCD, and so on. So, it is very difficult to measure the angle of the microcantilever which caused by weak deformation. In this paper, a feedback balancing position testing control method was proposed. First, we test the noise of the system, in the initial balancing position, nothing to do, just collect the two diffraction stripes images of the grating successively, and then the result of the two images difference is shown as Fig. 10(b). This result is means the noise is in proportion to the sum of the gray value. From Fig. 10(b) the difference is obvious. Sum value is 1700871, the noise come from the environment vibration noise and CCD electrical noise, because the system was set up in the laboratory in the 6 floor. When the microcantilever is unchanged, only control the precision motorized rotation stage rotate 0.0001, 0.001, 0.01 and 0.1 deg respectively, and collect the image of diffraction stripes respectively. The Fig. 10(c) - Fig. 10(f) is the results of the rotated image subtract the image in the initial balancing position. The Table 1 is the sum of the gray value corresponds to Fig. 10. From these results, we can find change obviously when the rotate angle change more the difference white area is more, and the gray value is greater. In the actual test, the specific interaction between the recognition molecules and the target biomarkers generates surface stress in microcantilever and in turn the cantilever is bend up gradually, if keeping the motorized rotation stage static, then find diffraction stripes of the grating the moving keep up with the cantilever bending up gradually like as Fig. 10(c) - Fig. 10(f). When the motorized rotation stage was controlled rotating around opposite direction accurately keep the current image is same as the initial balancing position image always. The rotate angle is just the cantilever bend up angle. This is called feedback balancing control method. This method can get high sensitivity and resolution. The step of motorized rotation stage is $35 \times 10^{-6}$ deg, but in the practical test, $1 \times 10^{-4}$ deg can be got because the noise which come from the environment vibration noise and CCD electrical noise, that is to say a 250 um long cantilever, the tip measure resolution is almost 0.43 nm.

![Fig. 10](image)

**Fig. 10.** The diffraction spectrum of the reflective grating cantilever.

<table>
<thead>
<tr>
<th>Rotate angle (deg)</th>
<th>Sum gray value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1700871</td>
</tr>
<tr>
<td>0.0001</td>
<td>17331817</td>
</tr>
<tr>
<td>0.001</td>
<td>3133450</td>
</tr>
<tr>
<td>0.01</td>
<td>6235451</td>
</tr>
<tr>
<td>0.1</td>
<td>12404001</td>
</tr>
</tbody>
</table>

**Table 1.** The sum of gray value of different rotate angle.
5. Conclusions

This work described a reflective grating microcantilever biosensor designed and fabricated process. A novel optical read out method based on diffraction spectrum balancing feedback control was proposed. The practical measurement resolution of the system is $1 \times 10^{-4}$ deg, that is to say, for a length of 250 um microcantilever, the tip measure resolution is up to 0.043 nm. Measurement results clearly demonstrate when the suitable receptor was immobilized on the surface of microcantilever, this method is suit for using much biochemical detection in the further research.

References

Aims and Scope

Sensors & Transducers is a peer reviewed international, interdisciplinary journal that provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes original research articles, timely state-of-the-art reviews and application specific articles with the following devices areas:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing and interfacing;
- Frequency (period, duty-cycle)-to-code converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Further information on this journal is available from the Publisher's web site: http://www.sensorsportal.com/HTML/DIGEST/Submission.htm

Subscriptions

An annual subscription includes 12 regular issues and some special issues. Annual subscription rates for 2013 are the following:

Electronic version (in printable pdf format): 400.00 EUR
Printed with b/w illustrations: 640.00 EUR
Printed full color version: 760.00 EUR

40 % discount is available for IFSA Members.

Prices include shipping costs by mail. Further information about subscription is available through IFSA Publishing's web site: http://www.sensorsportal.com/HTML/DIGEST/Journal_Subscription.htm

Advertising Information

If you are interested in advertising or other commercial opportunities please e-mail sales@sensorsportal.com and your enquiry will be passed to the correct person who will respond to you within 24 hours. Please download also our Media Planner 2013: http://www.sensorsportal.com/DOWNLOADS/Media_Planner_2013.pdf

Books for Review

Publications should be sent to the IFSA Publishing Office: Ronda de Ramon Otero Pedrayo, 42C, 1-5, 08860, Castelldefels, Barcelona, Spain.

Abstracting Services

This journal is cited, indexed and abstracted by Chemical Abstracts, EBSCO Publishing, IndexCopernicus Journals Master List, ProQuest Science Journals, CAS Source Index (CASSI), Ulrich's Periodicals Directory, Scirus, Google Scholar, etc. Since 2011 Sensors & Transducers journal is covered and indexed (including a Scopus, Embase, Engineering Village and Reaxys) in Elsevier products.

Instructions for Authors

Please visit the journal web page http://www.sensorsportal.com/HTML/DIGEST/Submission.htm Authors must follow the instructions very carefully when submitting their manuscripts. Manuscript must be send electronically in both: MS Word 2003 for Windows (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Modern Sensors, Transducers and Sensor Networks

Modern Sensors, Transducers and Sensor Networks is the first book from the Advances in Sensors: Reviews book Series contains dozens of collected sensor related state-of-the-art reviews written by 31 internationally recognized experts from academia and industry.

Built upon the series Advances in Sensors: Reviews - a premier sensor review source, the Modern Sensors, Transducers and Sensor Networks presents an overview of highlights in the field. Coverage includes current developments in sensing nanomaterials, technologies, MEMS sensor design, synthesis, modeling and applications of sensors, transducers and wireless sensor networks, signal detection and advanced signal processing, as well as new sensing principles and methods of measurements.

Modern Sensors, Transducers and Sensor Networks is intended for anyone who wants to cover a comprehensive range of topics in the field of sensors paradigms and developments. It provides guidance for technology solution developers from academia, research institutions, and industry, providing them with a broader perspective of sensor science and industry.

Order online:
http://sensorsportal.com/HTML/BOOKSTORE/Advance_in_Sensors.htm

www.sensorsportal.com