

ISSN 1726-5479

# **S**&**SENSORS** **TRANSDUCERS**

vol. 113  
**2** / 10



**Chemical Sensors,  
Biosensors, Immunosensors**

International Frequency Sensor Association Publishing



**Editors-in-Chief:** professor Sergey Y. Yurish, tel.: +34 696067716, fax: +34 93 4011989, e-mail: editor@sensorsportal.com

**Editors for Western Europe**

Meijer, Gerard C.M., Delft University of Technology, The Netherlands  
Ferrari, Vittorio, Università di Brescia, Italy

**Editor South America**

Costa-Felix, Rodrigo, Inmetro, Brazil

**Editor for Eastern Europe**

Sachenko, Anatoly, Ternopil State Economic University, Ukraine

**Editors for North America**

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

**Editor for Asia**

Ohyama, Shinji, Tokyo Institute of Technology, Japan

**Editor for Asia-Pacific**

Mukhopadhyay, Subhas, Massey University, New Zealand

**Editorial Advisory Board**

- Abdul Rahim, Ruzairi**, Universiti Teknologi, Malaysia  
**Ahmad, Mohd Noor**, Northern University of Engineering, Malaysia  
**Annamalai, Karthigeyan**, National Institute of Advanced Industrial Science and Technology, Japan  
**Arcega, Francisco**, University of Zaragoza, Spain  
**Arguel, Philippe**, CNRS, France  
**Ahn, Jae-Young**, Korea Institute of Science and Technology, Korea  
**Arndt, Michael**, Robert Bosch GmbH, Germany  
**Ascoli, Giorgio**, George Mason University, USA  
**Atalay, Selcuk**, Inonu University, Turkey  
**Atghiaee, Ahmad**, University of Tehran, Iran  
**Augutis, Vygantas**, Kaunas University of Technology, Lithuania  
**Avachit, Patil Lalchand**, North Maharashtra University, India  
**Ayesh, Aladdin**, De Montfort University, UK  
**Bahreyni, Behraad**, University of Manitoba, Canada  
**Baliga, Shankar, B.**, General Motors Transnational, USA  
**Baoxian, Ye**, Zhengzhou University, China  
**Barford, Lee**, Agilent Laboratories, USA  
**Barlingay, Ravindra**, RF Arrays Systems, India  
**Basu, Sukumar**, Jadavpur University, India  
**Beck, Stephen**, University of Sheffield, UK  
**Ben Bouzid, Sihem**, Institut National de Recherche Scientifique, Tunisia  
**Benachaiba, Chellali**, Universitaire de Bechar, Algeria  
**Binnie, T. David**, Napier University, UK  
**Bischoff, Gerlinde**, Inst. Analytical Chemistry, Germany  
**Bodas, Dhananjay**, IMTEK, Germany  
**Borges Carval, Nuno**, Universidade de Aveiro, Portugal  
**Bousbia-Salah, Mounir**, University of Annaba, Algeria  
**Bouvet, Marcel**, CNRS – UPMC, France  
**Brudzewski, Kazimierz**, Warsaw University of Technology, Poland  
**Cai, Chenxin**, Nanjing Normal University, China  
**Cai, Qingyun**, Hunan University, China  
**Campanella, Luigi**, University La Sapienza, Italy  
**Carvalho, Vitor**, Minho University, Portugal  
**Cecelja, Franjo**, Brunel University, London, UK  
**Cerda Belmonte, Judith**, Imperial College London, UK  
**Chakrabarty, Chandan Kumar**, Universiti Tenaga Nasional, Malaysia  
**Chakravorty, Dipankar**, Association for the Cultivation of Science, India  
**Changhai, Ru**, Harbin Engineering University, China  
**Chaudhari, Gajanan**, Shri Shivaji Science College, India  
**Chavali, Murthy**, VIT University, Tamil Nadu, India  
**Chen, Jiming**, Zhejiang University, China  
**Chen, Rongshun**, National Tsing Hua University, Taiwan  
**Cheng, Kuo-Sheng**, National Cheng Kung University, Taiwan  
**Chiang, Jeffrey (Cheng-Ta)**, Industrial Technol. Research Institute, Taiwan  
**Chiriac, Horia**, National Institute of Research and Development, Romania  
**Chowdhuri, Arijit**, University of Delhi, India  
**Chung, Wen-Yaw**, Chung Yuan Christian University, Taiwan  
**Corres, Jesus**, Universidad Publica de Navarra, Spain  
**Cortes, Camilo A.**, Universidad Nacional de Colombia, Colombia  
**Courtois, Christian**, Université de Valenciennes, France  
**Cusano, Andrea**, University of Sannio, Italy  
**D'Amico, Arnaldo**, Università di Tor Vergata, Italy  
**De Stefano, Luca**, Institute for Microelectronics and Microsystem, Italy  
**Deshmukh, Kiran**, Shri Shivaji Mahavidyalaya, Barshi, India  
**Dickert, Franz L.**, Vienna University, Austria  
**Dieguez, Angel**, University of Barcelona, Spain  
**Dimitropoulos, Panos**, University of Thessaly, Greece  
**Ding, Jianning**, Jiangsu Polytechnic University, China  
**Kim, Min Young**, Kyungpook National University, Korea South  
**Djordjevic, Alexandar**, City University of Hong Kong, Hong Kong  
**Donato, Nicola**, University of Messina, Italy  
**Donato, Patricio**, Universidad de Mar del Plata, Argentina  
**Dong, Feng**, Tianjin University, China  
**Drljaca, Predrag**, Instersema Sensoric SA, Switzerland  
**Dubey, Venketesh**, Bournemouth University, UK  
**Enderle, Stefan**, Univ. of Ulm and KTB Mechatronics GmbH, Germany  
**Erdem, Gursan K. Arzum**, Ege University, Turkey  
**Erkmen, Aydan M.**, Middle East Technical University, Turkey  
**Estelle, Patrice**, Insa Rennes, France  
**Estrada, Horacio**, University of North Carolina, USA  
**Faiz, Adil**, INSA Lyon, France  
**Fericean, Sorin**, Balluff GmbH, Germany  
**Fernandes, Joana M.**, University of Porto, Portugal  
**Francioso, Luca**, CNR-IMM Institute for Microelectronics and Microsystems, Italy  
**Francis, Laurent**, University Catholique de Louvain, Belgium  
**Fu, Weiling**, South-Western Hospital, Chongqing, China  
**Gaura, Elena**, Coventry University, UK  
**Geng, Yanfeng**, China University of Petroleum, China  
**Gole, James**, Georgia Institute of Technology, USA  
**Gong, Hao**, National University of Singapore, Singapore  
**Gonzalez de la Rosa, Juan Jose**, University of Cadiz, Spain  
**Granell, Annette**, Goteborg University, Sweden  
**Graff, Mason**, The University of Texas at Arlington, USA  
**Guan, Shan**, Eastman Kodak, USA  
**Guillet, Bruno**, University of Caen, France  
**Guo, Zhen**, New Jersey Institute of Technology, USA  
**Gupta, Narendra Kumar**, Napier University, UK  
**Hadjiloucas, Sillas**, The University of Reading, UK  
**Haider, Mohammad R.**, Sonoma State University, USA  
**Hashsham, Syed**, Michigan State University, USA  
**Hasni, Abdelhafid**, Bechar University, Algeria  
**Hernandez, Alvaro**, University of Alcalá, Spain  
**Hernandez, Wilmar**, Universidad Politecnica de Madrid, Spain  
**Homentcovschi, Dorel**, SUNY Binghamton, USA  
**Horstman, Tom**, U.S. Automation Group, LLC, USA  
**Hsiai, Tzung (John)**, University of Southern California, USA  
**Huang, Jeng-Sheng**, Chung Yuan Christian University, Taiwan  
**Huang, Star**, National Tsing Hua University, Taiwan  
**Huang, Wei**, PSG Design Center, USA  
**Hui, David**, University of New Orleans, USA  
**Jaffrezic-Renault, Nicole**, Ecole Centrale de Lyon, France  
**Jaime Calvo-Galleg, Jaime**, Universidad de Salamanca, Spain  
**James, Daniel**, Griffith University, Australia  
**Janting, Jakob**, DELTA Danish Electronics, Denmark  
**Jiang, Liudi**, University of Southampton, UK  
**Jiang, Wei**, University of Virginia, USA  
**Jiao, Zheng**, Shanghai University, China  
**John, Joachim**, IMEC, Belgium  
**Kalach, Andrew**, Voronezh Institute of Ministry of Interior, Russia  
**Kang, Moonho**, Sunmoon University, Korea South  
**Kaniusas, Eugenijus**, Vienna University of Technology, Austria  
**Katake, Anup**, Texas A&M University, USA  
**Kausel, Wilfried**, University of Music, Vienna, Austria  
**Kavasoglu, Nese**, Mugla University, Turkey  
**Ke, Cathy**, Tyndall National Institute, Ireland  
**Khan, Asif**, Aligarh Muslim University, Aligarh, India  
**Sapozhnikova, Ksenia**, D.I.Mendeleyev Institute for Metrology, Russia  
**Saxena, Vibha**, Bhabha Atomic Research Centre, Mumbai, India

**Ko, Sang Choon**, Electronics. and Telecom. Research Inst., Korea South  
**Kockar, Hakan**, Balikesir University, Turkey  
**Kotulska, Malgorzata**, Wroclaw University of Technology, Poland  
**Kratz, Henrik**, Uppsala University, Sweden  
**Kumar, Arun**, University of South Florida, USA  
**Kumar, Subodh**, National Physical Laboratory, India  
**Kung, Chih-Hsien**, Chang-Jung Christian University, Taiwan  
**Lacnjevac, Caslav**, University of Belgrade, Serbia  
**Lay-Ekuakille, Aime**, University of Lecce, Italy  
**Lee, Jang Myung**, Pusan National University, Korea South  
**Lee, Jun Su**, Amkor Technology, Inc. South Korea  
**Lei, Hua**, National Starch and Chemical Company, USA  
**Li, Genxi**, Nanjing University, China  
**Li, Hui**, Shanghai Jiaotong University, China  
**Li, Xian-Fang**, Central South University, China  
**Liang, Yuanchang**, University of Washington, USA  
**Liawruangrath, Saisunee**, Chiang Mai University, Thailand  
**Liew, Kim Meow**, City University of Hong Kong, Hong Kong  
**Lin, Hermann**, National Kaohsiung University, Taiwan  
**Lin, Paul**, Cleveland State University, USA  
**Linderholm, Pontus**, EPFL - Microsystems Laboratory, Switzerland  
**Liu, Aihua**, University of Oklahoma, USA  
**Liu Changgeng**, Louisiana State University, USA  
**Liu, Cheng-Hsien**, National Tsing Hua University, Taiwan  
**Liu, Songqin**, Southeast University, China  
**Lodeiro, Carlos**, University of Vigo, Spain  
**Lorenzo, Maria Encarnacio**, Universidad Autonoma de Madrid, Spain  
**Lukaszewicz, Jerzy Pawel**, Nicholas Copernicus University, Poland  
**Ma, Zhanfang**, Northeast Normal University, China  
**Majstorovic, Vidosav**, University of Belgrade, Serbia  
**Marquez, Alfredo**, Centro de Investigacion en Materiales Avanzados, Mexico  
**Matay, Ladislav**, Slovak Academy of Sciences, Slovakia  
**Mathur, Prafull**, National Physical Laboratory, India  
**Maurya, D.K.**, Institute of Materials Research and Engineering, Singapore  
**Mekid, Samir**, University of Manchester, UK  
**Melnyk, Ivan**, Photon Control Inc., Canada  
**Mendes, Paulo**, University of Minho, Portugal  
**Mennell, Julie**, Northumbria University, UK  
**Mi, Bin**, Boston Scientific Corporation, USA  
**Minas, Graca**, University of Minho, Portugal  
**Moghavvemi, Mahmoud**, University of Malaya, Malaysia  
**Mohammadi, Mohammad-Reza**, University of Cambridge, UK  
**Molina Flores, Esteban**, Benemérita Universidad Autónoma de Puebla, Mexico  
**Moradi, Majid**, University of Kerman, Iran  
**Morello, Rosario**, University "Mediterranea" of Reggio Calabria, Italy  
**Mounir, Ben Ali**, University of Sousse, Tunisia  
**Mulla, Imtiaz Sirajuddin**, National Chemical Laboratory, Pune, India  
**Neelamegam, Periasamy**, Sastra Deemed University, India  
**Neshkova, Milka**, Bulgarian Academy of Sciences, Bulgaria  
**Oberhammer, Joachim**, Royal Institute of Technology, Sweden  
**Ould Lahoucine, Cherif**, University of Guelma, Algeria  
**Pamidighanta, Sayanu**, Bharat Electronics Limited (BEL), India  
**Pan, Jisheng**, Institute of Materials Research & Engineering, Singapore  
**Park, Joon-Shik**, Korea Electronics Technology Institute, Korea South  
**Penza, Michele**, ENEA C.R., Italy  
**Pereira, Jose Miguel**, Instituto Politecnico de Setebal, Portugal  
**Petsev, Dimiter**, University of New Mexico, USA  
**Pogacnik, Lea**, University of Ljubljana, Slovenia  
**Post, Michael**, National Research Council, Canada  
**Prance, Robert**, University of Sussex, UK  
**Prasad, Ambika**, Gulbarga University, India  
**Prateepasen, Asa**, Kingmoungut's University of Technology, Thailand  
**Pullini, Daniele**, Centro Ricerche FIAT, Italy  
**Pumera, Martin**, National Institute for Materials Science, Japan  
**Radhakrishnan, S.**, National Chemical Laboratory, Pune, India  
**Rajanna, K.**, Indian Institute of Science, India  
**Ramadan, Qasem**, Institute of Microelectronics, Singapore  
**Rao, Basuthkar**, Tata Inst. of Fundamental Research, India  
**Raouf, Kosai**, Joseph Fourier University of Grenoble, France  
**Reig, Candid**, University of Valencia, Spain  
**Restivo, Maria Teresa**, University of Porto, Portugal  
**Robert, Michel**, University Henri Poincare, France  
**Rezazadeh, Ghader**, Urmia University, Iran  
**Royo, Santiago**, Universitat Politecnica de Catalunya, Spain  
**Rodriguez, Angel**, Universidad Politecnica de Cataluna, Spain  
**Rothberg, Steve**, Loughborough University, UK  
**Sadana, Ajit**, University of Mississippi, USA  
**Sadeghian Marnani, Hamed**, TU Delft, The Netherlands  
**Sandacci, Serghei**, Sensor Technology Ltd., UK  
**Schneider, John K.**, Ultra-Scan Corporation, USA  
**Seif, Selemeni**, Alabama A & M University, USA  
**Seifter, Achim**, Los Alamos National Laboratory, USA  
**Sengupta, Deepak**, Advance Bio-Photonics, India  
**Shearwood, Christopher**, Nanyang Technological University, Singapore  
**Shin, Kyuho**, Samsung Advanced Institute of Technology, Korea  
**Shmaliy, Yuriy**, Kharkiv National Univ. of Radio Electronics, Ukraine  
**Silva Girao, Pedro**, Technical University of Lisbon, Portugal  
**Singh, V. R.**, National Physical Laboratory, India  
**Slomovitz, Daniel**, UTE, Uruguay  
**Smith, Martin**, Open University, UK  
**Soleymampour, Ahmad**, Damghan Basic Science University, Iran  
**Somani, Prakash R.**, Centre for Materials for Electronics Technol., India  
**Srinivas, Talabattula**, Indian Institute of Science, Bangalore, India  
**Srivastava, Arvind K.**, Northwestern University, USA  
**Stefan-van Staden, Raluca-Ioana**, University of Pretoria, South Africa  
**Sumriddetchka, Sarun**, National Electronics and Computer Technology Center, Thailand  
**Sun, Chengliang**, Polytechnic University, Hong-Kong  
**Sun, Dongming**, Jilin University, China  
**Sun, Junhua**, Beijing University of Aeronautics and Astronautics, China  
**Sun, Zhiqiang**, Central South University, China  
**Suri, C. Raman**, Institute of Microbial Technology, India  
**Sysoev, Victor**, Saratov State Technical University, Russia  
**Szewczyk, Roman**, Industrial Research Inst. for Automation and Measurement, Poland  
**Tan, Ooi Kiang**, Nanyang Technological University, Singapore  
**Tang, Dianping**, Southwest University, China  
**Tang, Jaw-Luen**, National Chung Cheng University, Taiwan  
**Teker, Kasif**, Frostburg State University, USA  
**Thumbavanam Pad, Kartik**, Carnegie Mellon University, USA  
**Tian, Gui Yun**, University of Newcastle, UK  
**Tsiantos, Vassilios**, Technological Educational Institute of Kaval, Greece  
**Tsigara, Anna**, National Hellenic Research Foundation, Greece  
**Twomey, Karen**, University College Cork, Ireland  
**Valente, Antonio**, University, Vila Real, - U.T.A.D., Portugal  
**Vaseashta, Ashok**, Marshall University, USA  
**Vazquez, Carmen**, Carlos III University in Madrid, Spain  
**Vieira, Manuela**, Instituto Superior de Engenharia de Lisboa, Portugal  
**Vigna, Benedetto**, STMicroelectronics, Italy  
**Vrba, Radimir**, Brno University of Technology, Czech Republic  
**Wandelt, Barbara**, Technical University of Lodz, Poland  
**Wang, Jiangping**, Xi'an Shiyou University, China  
**Wang, Kedong**, Beihang University, China  
**Wang, Liang**, Advanced Micro Devices, USA  
**Wang, Mi**, University of Leeds, UK  
**Wang, Shinn-Fwu**, Ching Yun University, Taiwan  
**Wang, Wei-Chih**, University of Washington, USA  
**Wang, Wensheng**, University of Pennsylvania, USA  
**Watson, Steven**, Center for NanoSpace Technologies Inc., USA  
**Weiping, Yan**, Dalian University of Technology, China  
**Wells, Stephen**, Southern Company Services, USA  
**Wolkenberg, Andrzej**, Institute of Electron Technology, Poland  
**Woods, R. Clive**, Louisiana State University, USA  
**Wu, DerHo**, National Pingtung Univ. of Science and Technology, Taiwan  
**Wu, Zhaoyang**, Hunan University, China  
**Xiu Tao, Ge**, Chuzhou University, China  
**Xu, Lisheng**, The Chinese University of Hong Kong, Hong Kong  
**Xu, Tao**, University of California, Irvine, USA  
**Yang, Dongfang**, National Research Council, Canada  
**Yang, Wuqiang**, The University of Manchester, UK  
**Yang, Xiaoling**, University of Georgia, Athens, GA, USA  
**Yaping Dan**, Harvard University, USA  
**Ymeti, Aurel**, University of Twente, Netherland  
**Yong Zhao**, Northeastern University, China  
**Yu, Haihu**, Wuhan University of Technology, China  
**Yuan, Yong**, Massey University, New Zealand  
**Yufera Garcia, Alberto**, Seville University, Spain  
**Zakaria, Zulkarnay**, University Malaysia Perlis, Malaysia  
**Zagnoni, Michele**, University of Southampton, UK  
**Zamani, Cyrus**, Universitat de Barcelona, Spain  
**Zeni, Luigi**, Second University of Naples, Italy  
**Zhang, Minglong**, Shanghai University, China  
**Zhang, Quintao**, University of California at Berkeley, USA  
**Zhang, Weiping**, Shanghai Jiao Tong University, China  
**Zhang, Wenming**, Shanghai Jiao Tong University, China  
**Zhang, Xueji**, World Precision Instruments, Inc., USA  
**Zhong, Haoxiang**, Henan Normal University, China  
**Zhu, Qing**, Fujifilm Dimatix, Inc., USA  
**Zorzano, Luis**, Universidad de La Rioja, Spain  
**Zourab, Mohammed**, University of Cambridge, UK

# Contents

Volume 113  
Issue 2  
February 2010

www.sensorsportal.com

ISSN 1726-5479

## Research Articles

- Biosensors and Biochips for Nanomedical Applications: a Review**  
*Sarmishtha Ghoshal, Debasis Mitra, Sudip Roy, Dwijesh Dutta Majumder*..... 1
- Crossed-Optical-Fiber Oxygen Sensors with Intensity and Temperature Referencing for Use in High-Spatial-Resolution Sensor Arrays**  
*Maria Veronica Rigo, Robert Olsson and Peter Geissinger*..... 18
- Humidity Response of Polyaniline Based Sensor**  
*Mamta Pandey, Atul Srivastava, Anchal Srivastava, Rajesh Kumar Shukla* ..... 33
- Epoxy Resin Modified Quartz Crystal Microbalance Sensor for Chemical Warfare Agent Sulfur Mustard Vapor Detection**  
*Rajendra Bunkar, K. D. Vyas, V. K. Rao, Sunil Kumar, Beer Singh, M. P. Kaushik*..... 41
- Humidity Sensing Properties of CuO, ZnO and NiO Composites**  
*Vedhakkani Jeseentharani, Boniface Jeyaraj, John Pragasam, Arunachalam Dayalan, Karachalacheruvu Seetharamaiah Nagaraja* ..... 48
- Optical Behavior by Congo Red Doped in Polymer and Sol-Gel Film**  
*A. Kazemzadeh, R. Kashanaki and M. R. Hassanzadeh*..... 56
- Ammonia Gas Sensing Characteristics of Chemically Synthesized Polyaniline Matrix**  
*Ravindra G. Bavane, Mahendra D. Shirsat, and Ashok M. Mahajan*..... 63
- The Use of Calixarene Thin Films in the Sensor Array for VOCs Detection and Olfactory Navigation**  
*Alan F. Holloway, Alexei Nabok, Abbass A. Hashim, Jacques Penders* ..... 71
- Synthesis of WO<sub>3</sub>-Polyaniline Composites and their Gas Sensing Properties**  
*L. A. Patil, J. P. Talegaonkar* ..... 82
- Effect of Firing Temperature on the Composition and Micro Structural Parameters of Screen Printed SnO<sub>2</sub> Thick Films Resistors**  
*A. S. Garde and R. Y. Borse* ..... 95
- Influence of Firing Temperature on Compositional and Structural Characteristics of ZrO<sub>2</sub> Thick Films Gas Sensor**  
*S. J. Patil, C. G. Dighavkar, A. V. Patil, R. Y. Borse* ..... 107
- Development of Piezoelectric DNA-Based Biosensor for Direct Detection of *Mycobacterium Tuberculosis* in Clinical Specimens**  
*Thongchai Kaewphinit, Somchai Santiwatanakul, Chamras Promptmas and Kosum Chansiri*..... 115
- An Electrochemical Oxalate Biosensor Based on CA Membrane Bound Sorghum Oxalate Oxidase**  
*R. Chaudhary and C. S. Pundir*..... 127

<b>Detection of a BSA-Biotin-Conjugate by a Novel Immunosensor</b> <i>Lok Hang Mak, Meinhard Knoll, Nico Dankbar, Tanja Fisbeck, Andreas Gorschlüter.....</i>	140
<b>Heat Treatment of Nanocrystalline ZnO and AZO Films Grown by Pulsed Laser Deposition</b> <i>K. C. Dubey, Dharmendra Mishra, Anchal Srivastava and R. K. Shukla.....</i>	150
<b>A Model Linked to E. Coli Related to Electrostrictive Energy in Cancer Cell</b> <i>T. K. Basak, T. Ramanujam, Suman Halder, Poonam Goyal, Prachi Mohan Kulshrestha, Arpita Gupta, S. Jeybalan, V. Cyrilraj, Sudhir Patil, Narendra Mustare.....</i>	158
<b>Electrical and Dielectric Properties of New Natural Cellulosic Fabric Grewia Tilifolia</b> <i>Jayaramudu J., V. V. Ramana C.H. and Varadarajulu A... ..</i>	167

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com  
Please visit journal's webpage with preparation instructions: <http://www.sensorsportal.com/HTML/DIGEST/Submition.htm>

International Frequency Sensor Association (IFSA).

## SENSORDEVICES 2010:

**The First International Conference  
on Sensor Device Technologies and Applications**

**July 18 - 25, 2010 - Venice, Italy**



The inaugural event SENSORDEVICES 2010, The First International Conference on Sensor Device Technologies and Applications, initiates a series of events focusing on sensor devices themselves, the technology-capturing style of sensors, special technologies, signal control and interfaces, and particularly sensors-oriented applications. The evolution of the nano- and microtechnologies, nanomaterials, and the new business services make the sensor device industry and research on sensor-themselves very challenging.

### Conference tracks

Sensor devices  
Sensor device technologies  
Sensors signal conditioning and interfacing circuits

Medical devices and sensors applications  
Sensors domain-oriented devices, technologies, and applications  
Sensor-based localization and tracking technologies

### Important dates

**Submission (full paper):** February 20, 2010  
**Notification:** March 25, 2010  
**Registration:** April 15, 2010  
**Camera ready:** April 20, 2010



<http://www.aria.org/conferences2010/SENSORDEVICES10.html>

## A Model Linked to E. Coli Related to Electrostrictive Energy in Cancer Cell

**\*T. K. BASAK, T. RAMANUJAM, Suman HALDER, Poonam GOYAL,  
Prachi Mohan KULSHESTHA, Arpita GUPTA, \*\*S. JEYBALAN,  
\*\*\*V. CYRILRAJ, \*\*Sudhir PATIL, \*\*Narendra MUSTARE**

Krishna Engineering College, Ghaziabad, UP, India

Tel.: 0120-2899731, fax: 0120-2898413

E-mail: [tkb20042001@yahoo.co.in](mailto:tkb20042001@yahoo.co.in)

*Received: 18 December 2009 /Accepted: 19 February 2010 /Published: 26 February 2010*

---

**Abstract:** The paper has focused on a new concept in respect of the status of oxidant/antioxidant in cancer cell following radiation therapy. And in this respect a model has been developed linked with an environment of E.Coli in which TrpRS II is induced after radiation damage. It is interesting to note that Electrostrictive energy is the input to the model the output of which is the oxidant/antioxidant ratio. This ratio is related to the status of Electrostrictive energy derived from capacitance relaxation phenomenon (US patent No. US Patent No. TK Basak 5691178, 1997) in cancer cell. The oxidant/antioxidant ratio is linked to Electrostrictive energy with increasing pH. This paper discusses about the status of phosphorylation and dephosphorylation after radiation therapy linked to E.Coli environment against the pH gradient is indicative for the treatment of cancer. *Copyright © 2010 IFSA.*

**Keywords:** Oxidant/antioxidant, Electrostrictive energy of cancer cell, pH, TrpRS II, E.Coli

---

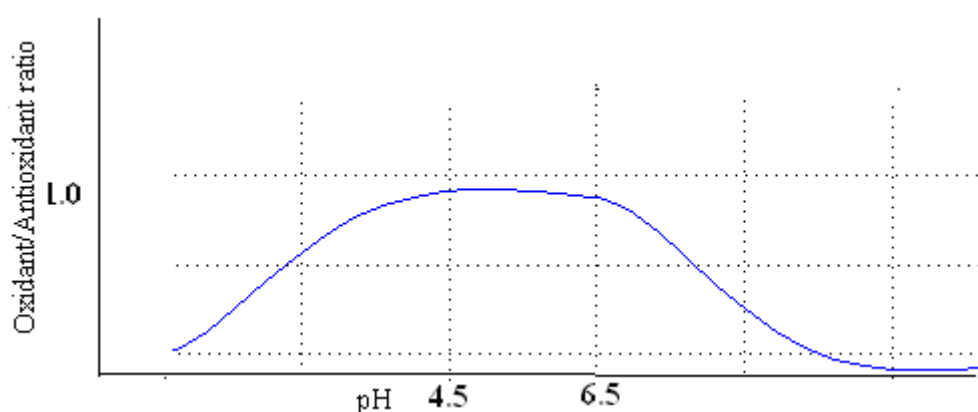
### 1. Introduction

Oxidant/antioxidant balance is an important factor related to initiation and progression of cancer. Clinical research shows that more the oxidant/antioxidant ratio more is the metastasis [1]. High urate at baseline may compensate against the oxidative stress caused by Lung Cancer. Radiation Therapy shifts the oxidant/ antioxidant balance towards lipid peroxidation (which may lead to more metastasis). However, the antioxidant defense mechanism of the body appears to counteract the increased oxidative stress rather effectively [2].

The antioxidant activity of the polysaccharide from *Ramulus mori* and its derivatives (sulfated, phosphorylated, acetylated and benzoylated polysaccharides) were determined, including scavenging activity against superoxide, hydroxyl and 1,1-diphenyl-2-picrylhydrazyl radicals. Although oxygen ion is a relatively weak oxidant, it decomposes to form stronger reactive oxidative species, such as singlet oxygen and  $\text{HO}^\cdot$ , which initiates Lipid peroxidation. Oxygen ion indirectly initiates lipid peroxidation as a result of hydrogen peroxide formation. Thus, polysaccharides initiate which, in turn, increases oxidant/antioxidant ratio [3].

The antioxidant activity of the polysaccharide from *Ramulus mori* and its derivatives (sulfated, phosphorylated, acetylated and benzoylated polysaccharides) were determined, including scavenging activity against superoxide, hydroxyl and 1,1-diphenyl-2-picrylhydrazyl radicals. Although oxygen ion is a relatively weak oxidant, it decomposes to form stronger reactive oxidative species, such as singlet oxygen and  $\text{HO}^\cdot$ , which initiates Lipid peroxidation. Oxygen ion indirectly initiates lipid peroxidation as a result of hydrogen peroxide formation. Thus, polysaccharides initiate which, in turn, increases oxidant/antioxidant ratio [3].

It has been investigated that antioxidant activity occurs at higher values of pH [4]. Referring to Fig. 1, we can say that as pH becomes more basic (increasing pH), less will be the oxidant/antioxidant ratio. It can be noted that the environment of survival of *E. Coli* over a wide pH range has been analyzed in relation to proliferation and inhibition of metastasis with cyclic genetic reform.



**Fig.1.** Status of Oxidant/antioxidant of *E. Coli* Trps II with Respect to the pH of its Environment.

During radiation therapy for suppression of metastasis, the antioxidant oscillation will grow up. But for a certain period of time after that, antioxidant oscillation will decay and this process continues with the application of successive phases of radiotherapy [2].

*E. Coli* related archaeobacteria in lipid peroxidation is influenced by the asymmetry of the lipid and the more the lipid peroxidation less is the relaxation time [5].

Asymmetry is linked with pH gradient mediated by lipid peroxidation. Relaxation of polar head is related archaeobacteria.  $\text{Na}^+/\text{H}^+$  antiporters cause enhancement of lipid peroxidation [6-7]. Antiporters maintain alkaline environment where as lipid peroxidation initiated by antiporters maintains acidic pH homeostasis of the fluid of the *E. Coli* archaeobacteria [8]. Antiporters initiate lipid peroxidation which sustains pH gradient in the environment of archaeobacteria. Thus the asymmetry of polar head of archeobacteria (*E. Coli*) is sustained in its pH environment mediated by the antiporters linked with the electrochemical gradient across its membrane [6, 7, 8].

DNA-binding proteins from starved cells (Dps proteins) protect archaeobacteria primarily from oxidative damage. They are composed of 12 identical subunits assembled with 23-symmetry to form a compact cage-like structure known to be stable at temperatures greater than 70°C and over a wide pH range. *Thermosynechococcus elongatus* Dps thermostability is increased dramatically relative to mesophilic Dps proteins. Hydrophobic interactions at the dimeric and trimeric interfaces called Dps-like are replaced by salt bridges and hydrogen bonds, a common strategy in thermophiles [9].

During the reduction of CO<sub>2</sub> to CH<sub>4</sub>, methanogenic bacteria appear to maintain their cytoplasmic pH slightly acidic (pH 6.6-6.8) and to generate an electrical potential (inside negative) of -120 to -200 mV. Growth is usually conducted in media buffered near pH value of 6.8 where the membrane potential is the predominant, or sole, component of the pmf explained. An ATP pool is maintained in the range of 1 to 23 nmol/mg, protein being especially large in *Msp. hungatei*. These factors may be relevant to the bioenergetics of K<sup>+</sup> movement, since activity of the low affinity, constitutive systems of *Escherichia coli* and *Streptococcus faecalis* requires both ATP and the pmf [7-9].

The *b*-glucoside utilization (*bgl*) genes of *Escherichia coli* are positively regulated by the product of the *bglG*, which functions as an anti terminator by binding to specific sequences present within the *bgl* mRNA. *BglG* is inactivated by phosphorylation in the absence of *b*-glucosides by *BglF*. Here, we present evidence for an additional function for *BglG*, namely the stabilization of the 5' end of the *bgl* mRNA.

The *bgl* operon in *Escherichia coli*, induced by an environmental signal (*b*-glucoside), is regulated by a sensory system which consists of a membrane-bound sensor, *BglF*, and a cytoplasmic response regulator, *BglG* which is a transcriptional antiterminator binds to the *bgl* RNA transcript to prevent the formation of transcriptional terminators.

The sensor *BglF* controls the activity of the response regulator *BglG* by phosphorylation and dephosphorylation, depending on *b*-glucoside availability. Reversible phosphorylation of *BglG* by *BglF* was shown to regulate its activity by controlling its dimeric state. Thus, *BglG* exists in the cell in two forms: an inactive, monomeric phosphorylated form and an active, dimeric nonphosphorylated form. Different organisms were reported to resemble the *bgl* system. Based on this similarity, the mechanism by which these systems induce the expression of particular carbohydrate-catabolic operons was suggested to involve PTS-mediated phosphorylation of transcriptional antiterminator proteins. To understand the rules of recognition and interaction between sensors and regulators of this new family, it is important to define the functional domains involved in transduction of a signal by the components which constitute systems of this family. It is to be noted that *BglG*, is the response regulator of the two-component systems which are phosphorylated on an aspartate [10].

Oxidative stress causes damage of DNA up to pH from 3 to 4.5 and the effect of antioxidant reduces the oxidative stress beyond pH 4.5. This particular phenomenon has been correlated with the pH for the status of oxidant to antioxidant ratio in cancer cell. Oxidant/antioxidant ratio in *E.Coli* with lower pH is linked to metastasis [1, 2, 11, 12].

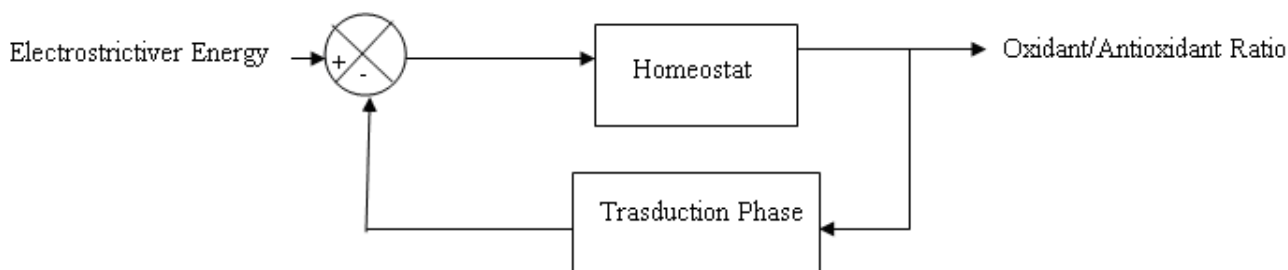
Identification of a number of unique tumor antigens in long-term survivors, has suggested that this class of antigens is immunogenic and relevant to tumor rejection. On the other hand, some of the mutant proteins that generate unique tumor antigens can be critical for tumor cell survival, due to their involvement in basic metabolic pathways, or in regulation of cell cycle and apoptosis. In these instances, immunogenicity and function of the mutant protein will likely act as opposing selective forces for the maintenance of expression of the antigen along tumor progression. In fact, immunogenicity may promote the T cell-mediated response leading to emergence of antigen loss variants, where the mutant protein is no longer expressed. However, neoplastic cells that will survive

in the host during tumor progression will attempt to maintain expression of the mutant protein due to its relevant cellular function [11]. Associated oxidative stress causes DNA damage with increase oxidant/antioxidant ratio in E.Coli for pH range 3-4.5. As DNA damage is correlated with increased oxidant/antioxidant ratio in E. Coli for tumor progression. Similarly DNA recovery is correlated to decreased oxidant/antioxidant ratio in E. Coli when the effect of antioxidant reduces the oxidative stress beyond pH 4.5. [1, 2, 11, 12].

It is to be noted that unusual tryptophanyl tRNA synthasase (TrpRS) interacts with nitric oxide in *D. radiodurans* present in the genes for TrpRS II identified as the NOS- interfacing protein in alkaline environment. TrpRS II is induced after radiation damage and contains an N-terminal extension similar to those of proteins involved in stress responses. Recombinantly expressed TrpRS II binds tryptophan (Trp), ATP, and *D. radiodurans* tRNA<sup>Trp</sup> and catalyzes the formation of 5' adenylyl-Trp and tRNA<sup>Trp</sup>. Upon coexpression in *Escherichia coli*, TrpRS II dramatically enhances the solubility of deiNOS in alkaline environment. It is interesting to note that the ability of TrpRS II and ATP to enhance the deiNOS nitration reaction underscores the functional coupling of these two enzymes in conformity with Lipid peroxidation in E.Coli [13, 14].

## 2. Modelling and Simulation

Fig. 2 shows a generalized model of metastasis and Apoptosis in cancer. As we are interested in the status of oxidant/antioxidant ratio with respect electrostrictive energy, the input to the model is electrostrictive energy [15-19] and output of the model is oxidant/antioxidant ratio. The homeostat and transduction phase [20] are linked with lipid peroxidation mediated by antiporters in E. Coli archaeabacteria. The incremental input electrostrictive energy is applied to the model on the basis of pH homeostasis linked with capacitance relaxation phenomenon.



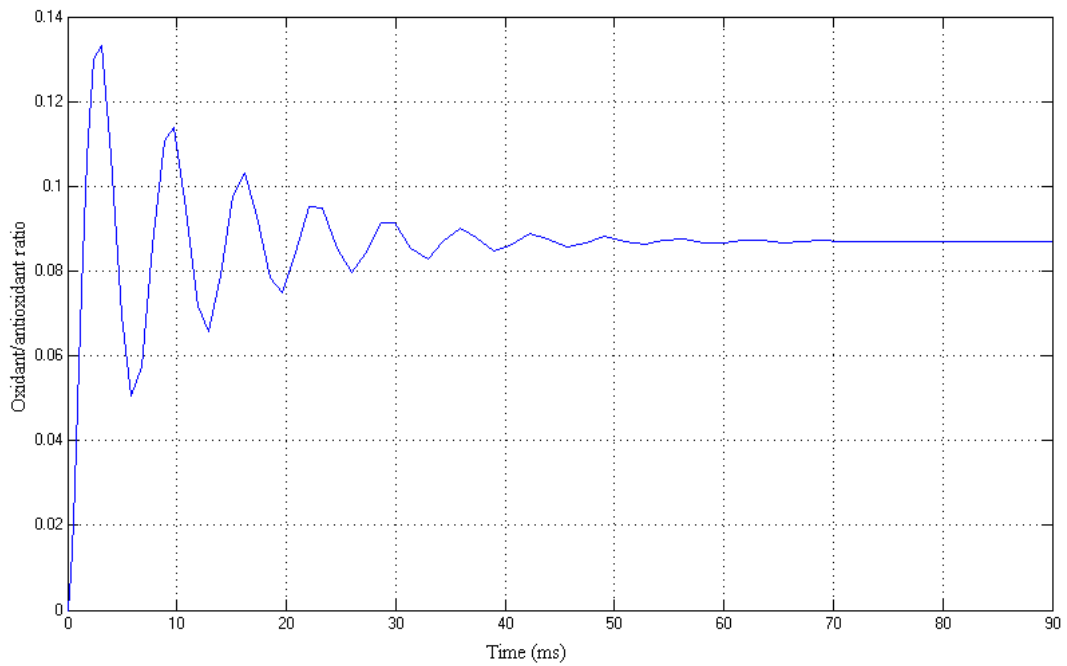
**Fig.2** Generalized Model of Metastasis at Apoptosis

Fig. 3 shows the 0.15 p.u. change in electrostrictive energy with the oxidant/antioxidant status. The Y-axis peak represents the ratio and we have considered only the first two peaks for calculation related to damping. For 0.15 PU change in Electrostrictive energy the oxidant/antioxidant ratio is (0.1331/0.114) 1.1675 corresponding to first two peaks and settling/relaxation time is 70ms at pH=7.5.

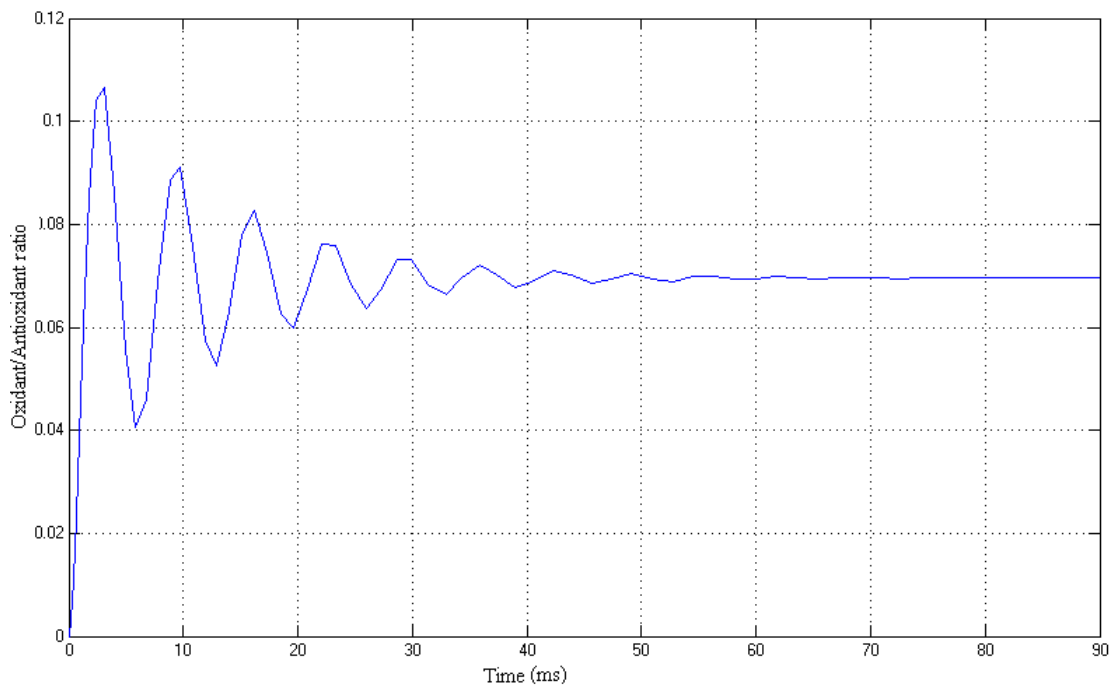
For 0.12 p.u. change in electrostrictive energy the oxidant/antioxidant response is plotted in Fig. 4.

Fig. 4 shows that for 0.12 p.u. change in electrostrictive energy, the oxidant/antioxidant ratio is (0.1065/0.0911) 1.169 and settling/relaxation time is 71 ms at pH =6.

For 0.06 p.u. change in electrostrictive energy the oxidant/antioxidant response is plotted in Fig. 5.



**Fig. 3** Oxidant/antioxidant response for 0.15PU changes in Electrostrictive Energy

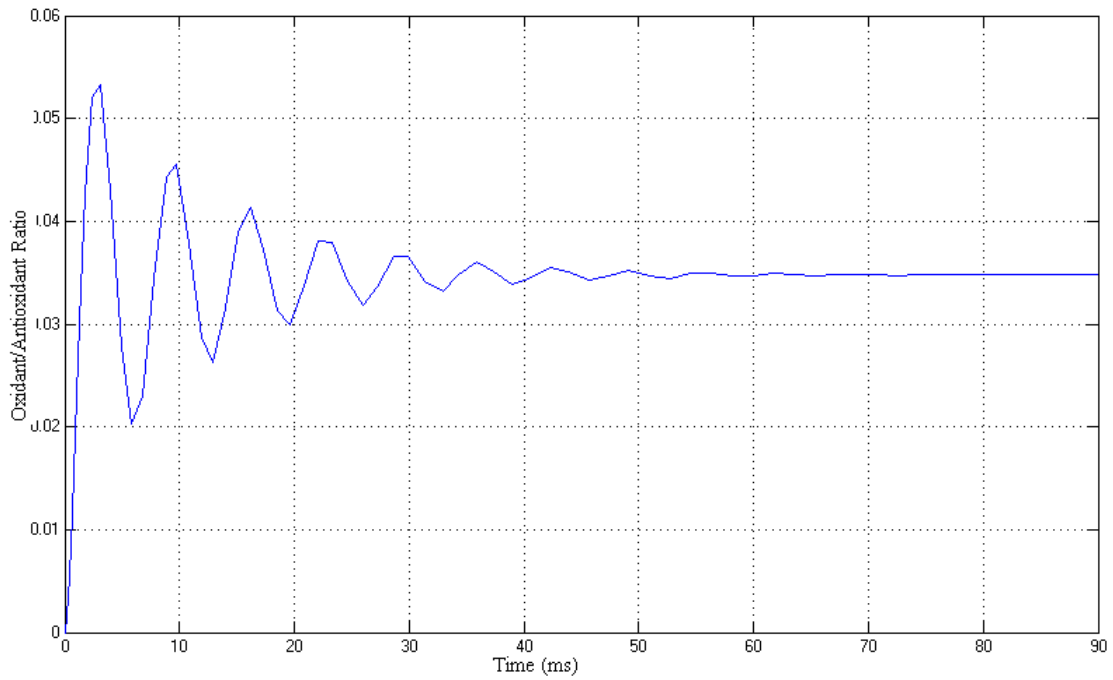


**Fig. 4** Oxidant/antioxidant response for 0.15PU changes in Electrostrictive Energy

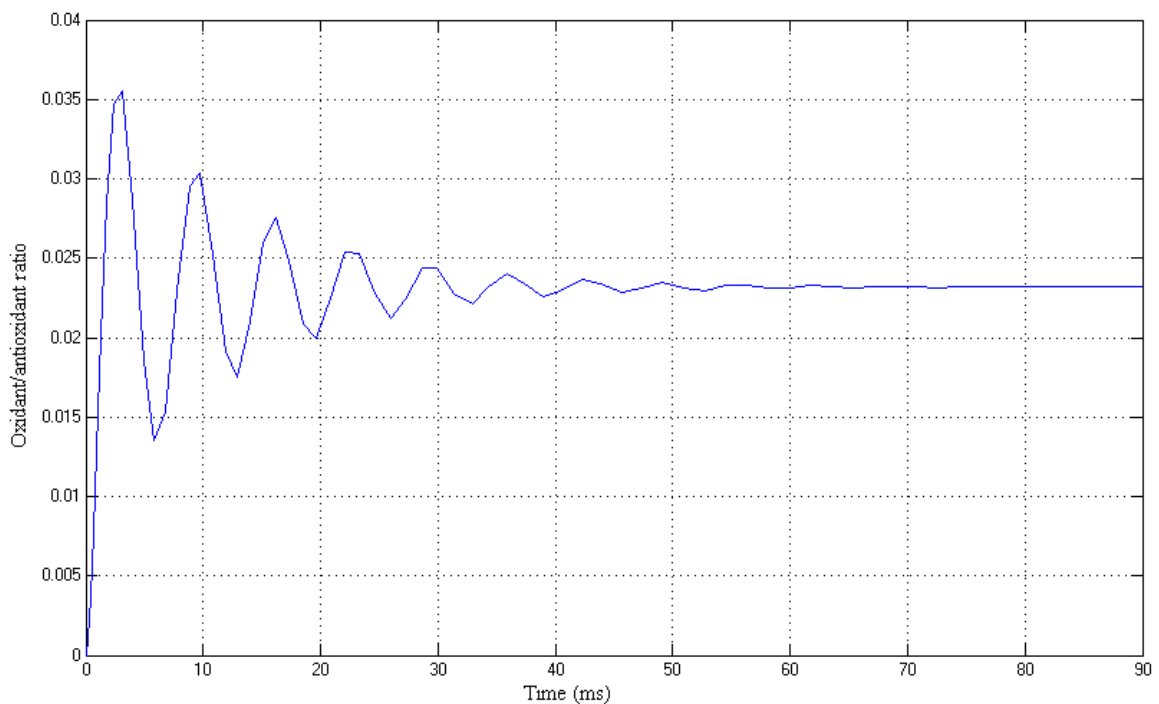
For 0.06 p.u. change in electrostrictive energy, the oxidant/antioxidant ratio is (0.0532/0.0455) 1.16932 and settling/relaxation time is 72 ms at pH=4.5.

For 0.04 p.u. change in electrostrictive energy the oxidant/antioxidant response is plotted in Fig. 6.

For 0.04 p.u. change in electrostrictive energy the oxidant/antioxidant ratio is (0.0355/0.0303) 1.1716 and settling/relaxation time is 73 ms at pH=3.



**Fig. 5** Oxidant/antioxidant response for 0.15PU changes in Electrostrictive Energy

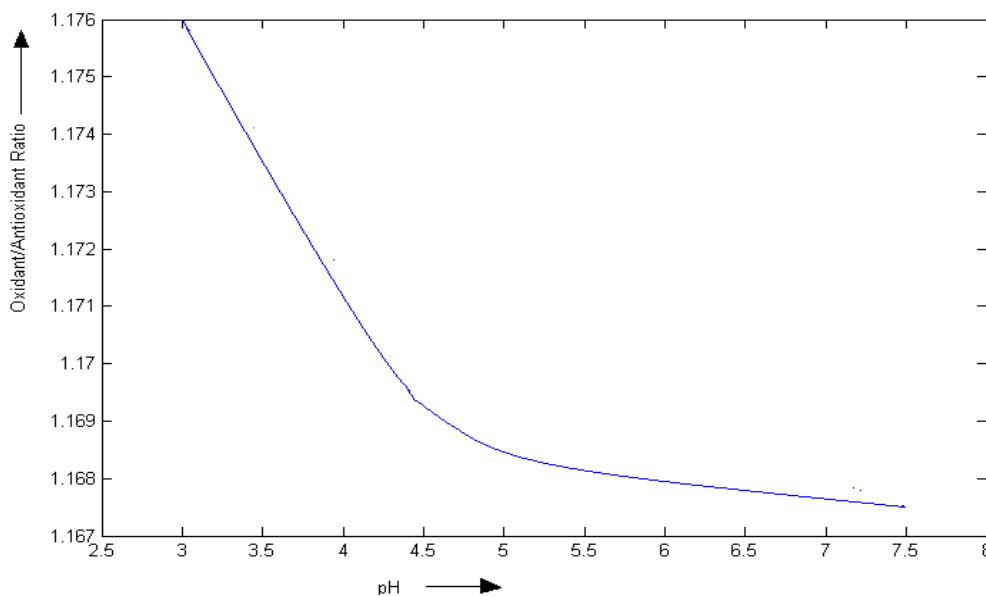


**Fig. 6** Oxidant/antioxidant response for 0.15PU changes in Electrostrictive Energy

From the figures Fig. 3 to Fig. 6, we observe that as electrostrictive energy increases, the ratio oxidant/antioxidant decreases and lipid peroxidation decreases. As oxidant/antioxidant ratio decreases metastasis decreases. It can also be seen that with increasing pH metastasis decays.

When electrostrictive energy decreases, ratio of oxidant/antioxidant increases, lipid peroxidation increases, relaxation time of lipid of E Coli increases and pH decreases leading to metastasis.

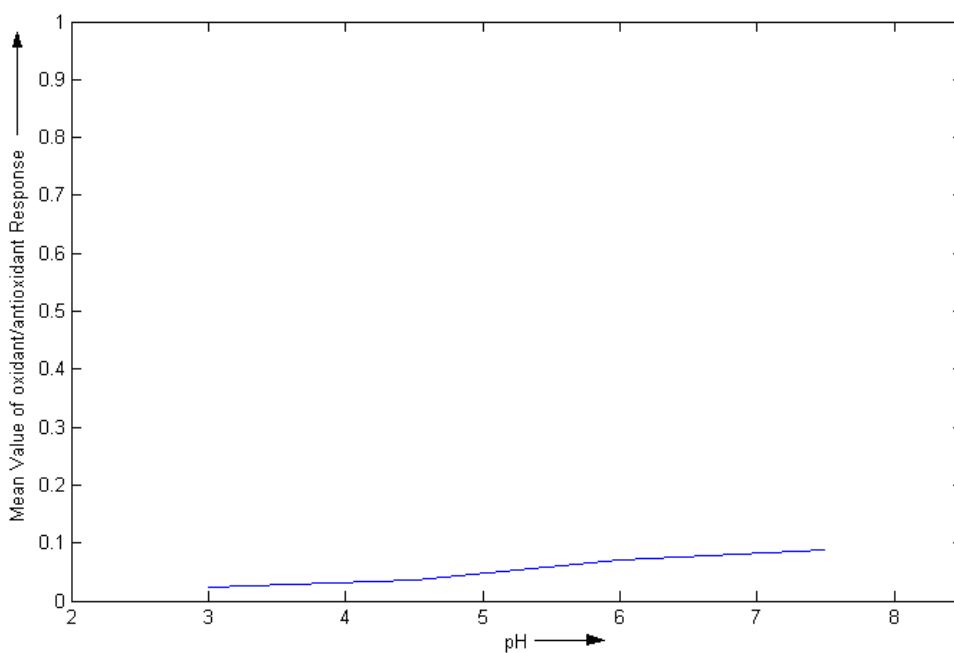
Fig. 7 shows graph of Oxidant/antioxidant ratio Vs pH from information obtained from Fig. 3 to Fig. 6.



**Fig. 7** Oxidant/Antioxidant Ratio Vs pH

From Fig. 7, it is clear that ratio of oxidant/antioxidant decreases with increment of pH. Thus we can conclude that oxidant/antioxidant ratio increases with decrease in pH value. With low acidic pH (pH=3.5), the relaxation time increases which initiates metastasis. Again metastasis can be retrorted with the increase of pH (pH=7.5) which causes decrement of oxidant/antioxidant ratio associated with decreased relaxation time. With more metastasis oxidant/antioxidant ratio will increase. With lower metastastasis oxidant/antioxidant ratio will decrease.

Fig. 8 represents mean value of oxidant/antioxidant response corresponding to Fig. 3-6 Vs pH representing dephosphorylation with almost a constant slope.



**Fig.8** Mean Value of oxidant/antioxidant response Vs pH

### **3. Conclusions**

This paper monitors the status of Oxidant/antioxidant ratio for incremental change in Electrostrictive energy linked to lipid peroxidation of cancer cell in the environment of E.Coli. From the oxidant/antioxidant response it is possible to focus on how TrpRS II is induced after radiation damage since it contains an N-terminal extension similar to those of protein involved in stress response. The Matlab Simulation shows the damped response after radiation therapy in cancer cell with the relevant relaxation time for asymmetrical bipolar lipid present in E.Coli . It is interesting to note that with increasing pH linked to electrostrictive energy oxidant/antioxidant ratio decreases.

The result about the status of phosphorylation and dephosphorylation with and after radiation therapy linked to E.Coli environment against the pH gradient can be an indicative for the treatment of cancer.

### **Acknowledgement**

The authors are grateful to the authorities of Krishna Engineering College, Ghaziabad. Prof. T. K. Basak is particularly indebted for inspiration received from his late wife, Mala Basak who is in the heavenly abode of Shree Shree Ramakrishna Paramhansa.

### **Author's Contribution**

Prof T. K. Basak received a third world scientist award from ICTP, Trieste, Italy and worked with Professor A. Gliozzi in the Dept of Biophysics, University of Genoa, Italy in 1985. Professor T. Ramanujam ,Jayabalan and Sudhir, Narendra is doing his Ph.D. work under the prof T K Basak, V. Cyrilraj and Suman Halder have completed his Ph.D. under Prof T.K. BASAK. Poonam Goyal, Arpita Gupta is involved in research activities under Professor T. K. Basak.

### **References**

- [1]. Himmetoglu Solen, Dincer Yildiz, Ersoy Yeliz E, Bayraktar Baris, Celik Varol, Akcay Tulay, *DNA Oxidation and Antioxidant Status in Breast Cancer, Journal of Investigative Medicine*, August 2009, Volume 57, Issue 6, pp. 720-723.
- [2]. Marika Crohns, Seppo Saarelainen, Hannu Kankaanranta, Eeva Moilanen, Hannu Alho, and Pirkko Kellokumpu-Lehtinen, Local and systemic oxidant/antioxidant status before and during lung cancer radiotherapy, *Free Radical Research*, 43, 7, 2009, pp. 646-57.
- [3]. Zuofa Z., Hang, Jie Jin and Liangen Shi, Antioxidant Activity of the Derivatives of Polysaccharide Extracted from a Chinese Medical Herb. *Ramulus mori*, *Food Sci. Technol. Res.*, 14, 2, 2008, pp. 160-168.
- [4]. Jing Zhou, Nan Hu, Ya-Lin Wu, Yuan-jiang Pan, Cuirong Sun. Preliminary studies on the chemical characterization and antioxidant properties of acidic polysaccharides from *Sargassum fusiforme*, *Journal of Zhejiang University SCIENCE B*, 9, 9, 2008, pp. 721-727.
- [5]. Gliozzi, A., Bruno, S., Basak, T. K., Rosa, M. D. and Gambacorta, Organization and dynamics of bipolar lipids from *Sulfolobus solfataricus* in bulk phases and in monolayer membranes, *System Appl. Microbiol.*, Vol. 7, 1986, pp. 266–27.
- [6]. S. Tajdoost, T. Farboodnia and R. Heidary. Amiloride inhibition of Vacuolar Na<sup>+</sup>/H<sup>+</sup> enhance salt stress in *Zea mays L.* Seedlings., *Pakistan Journal of Biological Sciences*, 10, 12, 2007, pp. 2020-2024.
- [7]. Priya C. Kadam and David R. Boone. Influence of pH on Ammonia Accumulation and Toxicity in Halophilic, Methylophilic Methanogens, *Applied and Environmental Microbiology*, Vol. 62, No. 12, 1996, p. 4486–4492.

- [8]. G. Dennis SprottS, Kathleen M. Shaw, and Ken F. Jarrellj, Methanogenesis and the K<sup>+</sup> Transport System Are Activated by Divalent Cations in Ammonia-treated Cells of Methanospirillum Hungatei, *The Journal of Biological Chemistry*, Vol. 260, No. 16, Issue 5, 1985, pp. 9244-9250.
- [9]. Stefano Franceschini, Pierpaolo Ceci, Flaminia Alaleona, Emilia Chiancone and Andrea Ilari. Antioxidant Dps protein from the thermophilic cyanobacterium Thermosynechococcus elongates An intrinsically stable cage-like structure endowed with enhanced stability, *FEBS Journal*, 273, 2006, pp. 4913–4928.
- [10].Orna Amster-Choder and Andrew Wright, BglG, the Response Regulator of the *Escherichia coli bgl* Operon, Is Phosphorylated on a Histidine Residue, *Journal of Bacteriology*, Vol. 179, No. 17, Sept. 1997, pp. 5621–5624.
- [11]. Marialuisa Sensi, Gabriella Nicolini, Marina Zanon, Chiara Colombo, Alessandra Molla, Ilaria Bersani, Raffaella Lupetti, Giorgio Parmiani, and Andrea Anichini, Immunogenicity without Immunoselection: A Mutant but Functional Antioxidant Enzyme Retained in a Human Metastatic Melanoma and Targeted by CD8<sup>+</sup> T Cells with a Memory Phenotype, *Cancer Res*, 65, 2, 2005.
- [12].T. K. Basak, T. Ramanujam, V. Cyrilraj, G. Gunshekharan, Asha Khanna, Deepali Garg, Poonam Goyal, Arpita Gupta, pH Homeostasis of a Biosensor in Renal Function Regulation Linked with UTI, *Sensors & Transducers*, Vol. 105, Issue 6, June 2009, pp. 127-134.
- [13].Madhavan R. Budha, Kim M. Keery and Brian R. Crane, An unusual tryptophanyl tRNA synthetase interacts with nitric oxide synthase in *Deinococcus radiodurans*, *PNAS*, Vol. 101, No. 45, 2004, pp. 15881-86.
- [14].Madhavan R. Buddha, Tao Tao, Ronald J. Parry, and Brian R. Crane. Regioselective Nitration of Tryptophan by a Complex between Bacterial Nitric-oxide Synthase and Tryptophanyl tRNA Synthetase, *The Journal of Biological Chemistry*, Vol. 279, No. 48, 2004, pp. 49567–49570.
- [15].T. K. Basak, T. Ramanujam, J. C. Kavitha, Poonam Goyal, Deepali Garg, Arpita Gupta, Suman Halder. pH Homeostasis Linked with Capacitance Relaxation Phenomena and Electrostrictive Energy in Cancer Cells, *Sensors & Transducers Journal*, Vol. 109, Issue 10, October 2009, pp. 147-153.
- [16].Tapas Kumar Basak, T. Ramanujam, Suman Halder, Poonam Goyal, Prachi, Mohan Kulshreshtha, Shweta Pandey, Himanshu Tripathi. Electrostrictive Effect in Cancer Cell Reflected in Capacitance Relaxation Phenomena, *Sensors & Transducers*, Vol. 99, Issue 12, December 2008, pp. 90-101.
- [17].Shivamurthy B., Basak T. K., Prabhuswamy M. S., Siddaramaiah, Tripathi Himangshu, Deopa S. S. Influence of Quartz Fillers in Dielectric Composites on Electrostrictive, *Sensors & Transducer*, Vol. 92, Issue 5, May 2008, pp. 32-42.
- [18].Basak T. K., Ramanujam T., Halder S., Cyrilraj V., Ravi T., Kulshreshtha Prachi Mohan. pH homeostasis and cell signaling pathway reflected in capacitance relaxation phenomena, *Int. J. Medical Engineering and Informatics*, Vol. 1, No. 1, 2008, pp. 85-90.
- [19].Basak T. K., *Electrical Engineering Materials, New Age International (India)*, 2007.
- [20].T. Apas K. Basak, Suman Halder, Madona Kumar, Renu Sharma and Bijoylaxmi Midya, A topological model of biofeedback based on catecholamine interactions, *Theoretical Biology and Medical Modelling*, 2, 2005, p. 11.
-

## Guide for Contributors

---

### Aims and Scope

*Sensors & Transducers Journal* (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In addition, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc.

### Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- 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;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

### Submission of papers

Articles should be written in English. Authors are invited to submit by e-mail [editor@sensorsportal.com](mailto:editor@sensorsportal.com) 8-14 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm> Authors must follow the instructions strictly when submitting their manuscripts.

### Advertising Information

Advertising orders and enquires may be sent to [sales@sensorsportal.com](mailto:sales@sensorsportal.com) Please download also our media kit: [http://www.sensorsportal.com/DOWNLOADS/Media\\_Kit\\_2009.pdf](http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2009.pdf)

# Subscription 2010 is open! SUBSCRIBE TODAY!

Sensors & Transducers Journal provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes reviews, regular research and application specific papers and short notes. This peer reviewed international journal is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List (ICV=6.31 at the end of 2008), Open J-Gate, Google Scholar, Scirus, etc.

## Topics of Interest

Include, but are not restricted to:

Physical, chemical and biosensors

Digital, frequency, period, duty-cycle, pulse number output sensors and transducers

Theory, principles, effects, design, standardization and modelling

Smart sensors and systems

Sensor instrumentation

Virtual instruments

Sensors interfaces, buses and networks

Signal processing

Technologies and materials

Nanosensors

Microsystems

Applications



2008

e-Impact Factor

205.767



[editor@sensorsportal.com](mailto:editor@sensorsportal.com)

[http://www.sensorsportal.com/HTML/DIGEST/Journal\\_Subscription\\_2010.htm](http://www.sensorsportal.com/HTML/DIGEST/Journal_Subscription_2010.htm)

[www.sensorsportal.com](http://www.sensorsportal.com)