

ISSN 1726-5479

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
Djordjevich, 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 WO₃-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 SnO₂ Thick Films Resistors**
A. S. Garde and R. Y. Borse 95
- Influence of Firing Temperature on Compositional and Structural Characteristics of ZrO₂ 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

Detection of a BSA-Biotin-Conjugate by a Novel Immunosensor <i>Lok Hang Mak, Meinhard Knoll, Nico Dankbar, Tanja Fisbeck, Andreas Gorschlüter.....</i>	140
Heat Treatment of Nanocrystalline ZnO and AZO Films Grown by Pulsed Laser Deposition <i>K. C. Dubey, Dharmendra Mishra, Anchal Srivastava and R. K. Shukla.....</i>	150
A Model Linked to E. Coli Related to Electrostrictive Energy in Cancer Cell <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
Electrical and Dielectric Properties of New Natural Cellulosic Fabric Grewia Tilifolia <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>

Optical Behavior by Congo Red Doped in Polymer and Sol-Gel Film

*A. Kazemzadeh, R. Kashanaki and M. R. Hassanzadeh

Materials & Energy Research center
P. O. Box 14155 – 4777 Tehran – Iran
Tel.: +98261-6204131-4, fax: +98261-6201888
E-mail: Asg642001@yahoo.com

Received: 20 October 2009 /Accepted: 19 February 2010 /Published: 26 February 2010

Abstract: A pH Chemical sensor with high sensitivity is achieved by direct attachment of Congo Red indicator over a Sol-Gel and polymeric film. This sensor is prepared by attaching Congo red over polymeric film or by adding indicator in tetra metoxysilan (TMOS) in order to determining hydrogen ion in solution with high concentration of hydrogen and producing strong signals and rapid response time.

Congo red is used over a Sol-Gel or polymeric film as a chemical-optical sensor. Sol-Gel layer and polymeric membrane have long lifetime as (>15 months) and (>12 months) and short response time as (>6 sec) and (>9 sec) respectively. It is a simple method and applied dye has low price and highly used.

In this paper, the purpose is investigation and optimizing condition for Sol-Gel layer and polymeric film. Finally morphology of polymeric film and Sol-Gel layer surfaces were investigated by AFM apparatus and subsequently Sol-Gel layer have been found to be a favorite base for chemical sensor a fabrication. *Copyright © 2010 IFSA.*

Keyword: Optical, pH, Congo Red, Polymer, Sol-Gel and Sensing Film.

1. Introduction

Optical pH detectors (optodes) are based on pH- dependent changes of the optical properties of thin and proton-permeable layers in which a pH indicator has been chemically or physically immobilized

[1]. Several authors have reported the immobilization of colorimetric reagents at various films as an effective approach to the construction of detectors for pH [2-6]. Although the properties desired of an immobilized indicator phase would vary depending on the intended application, in general the ideal immobilization techniques should produce a highly.

Stable assembly of molecules that remain sterically accessible to dissolved dye. Covalent attachment to a functionalized support [3] and physical entrapment, either in a porous polymer Matrix [4] or behind a selectively porous membrane [2]. There are two commonly employed techniques. Entrapment is the technically simpler technique, but the response is often relatively long.

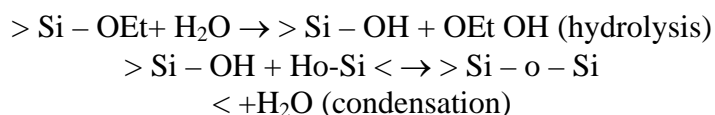
A method for covalent binding of enzyme to cellulose carrier, which includes activation of the cellulose by urea and formaldehyde, was described previously [3-7]. The purpose of this work was to investigate the possibility of developing a modification of the above methods for covalent immobilization of new indicators on optically transparent acetyl-cellulose membrane that has been previously hydrolyzed and activated using thiourea and poly vinyl alcohol. The characteristics of the membrane produced were investigated and the possibilities for its use in the design of optical pH detectors were evaluated. According to our knowledge, up to now, only dye molecules with amino groups on the ring cycle were used to construct optical pH detectors based on chemical modification of Sol-Gel films. In this paper, we used thiourea in linking every type of dye (with or without amino groups on the ring) to cellulose acetate film with satisfactory results. The Congo Red detector can be used for direct determination of pH in acidic media (pH 2.00-7.00) [8].

Sol-Gel films have been widely used during the past decade for the optical sensing of pH [9-17] and even bio molecules. The Sol-Gel process offers a very versatile method for the deposition of films on to various kinds of substrates such as Glasses, polymers or ceramics. The silica film is formed via the hydrolysis and condensation of silicon alcoxides [19].

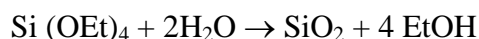
2. Experimental

Congo Red 0.020 % solution (Merck) was prepared by dissolving the dye in water. Polyvinyl alcohol solution was prepared by dissolving 0.70 g of the reagent (Merck) in 100 ml water. Thiourea solution was prepared by dissolving 0.65 g of the reagent (Merck) in 100 ml water. Solution of known pH was prepared using either analytical grade sodium borate or sodium citrate (Merck) or H₂PO₄, and with degassed doubly distilled water.

In order to prepare silica Sol-Gel layer we use tetraethyl ortho silica (TEOS) hydrolyses in an acidic environment, the reactions are as followed.



SiO₂ silica lattice is formed while reaction runs toward completion



Alcoxide is net soluble in water, therefore its special solvent is added. Two type of solution are prepared in an experiment:

- 1) The solution (A) is acidified by mixing 106.16 g of TEOS with to 26 g of pure ethanol and acidified water by adding 2.2 g of HCl (pH= 2.55) and then will be agitated 1 hour be for use.
- 2) Solution (B) is prepared by mixing acidified water (1.4 g and pH=1.26) and ethanol (15.10 g)

A little quantity mixture of a solution (B) (7.06 g) with high amount of solution (A) is agitated for an hour and a clear solution of silica- gel is provided and Congo-Red 5 % is added to so-called solution and agitated for 5 hours.

In order to optical measurements, a UV.Vis spectrophotometer in a water bath with $\pm 0/1$ controlled temperature was used measurements and experiment was carried out by locating prepared sensor on film in side the cell of a spectrophotometer for measuring absorption in constant wavelength and tungsten light source.

PH of buffer solutions was measured by applying pH meter (Schott, CG & 25) calibrated with standard buffer solutions with pH of 4.0; 7.0; 9.0 in 25°C.

A 0.1 molar solution of Sodium Nitrate, which prepared by solving 0/1 of its molecular mass. In a 1000 ml of water and cellulose acetate plates are made from slid polymeric film.

The treacetylcellulose was previously hydrolyzed in order to deesterify the acetyl groups and to increase the porosity of the membrane. A 2 g amounts of transparent film (separate pieces of size 33 X 10 X 0.2 mm) was treated in 0.10 mol /L KoH for 24 h. The film washed with water. The cellulose membrane were immediately treated with mixture of 0.65 % (W/V) thiourea and 0.70 % (W/V) polyvinyl alcohol solution for 48 h at 25°C. The cellulose membrane was separately treated with 0.20 % (W/V) solution of Congo Red at 25°C with magnetic stirring of the solution for 14h. After washing, the film was dried at 45°C for 20 min. Then the membrane was washed with distilled water until there was no absorption at the wavelength of the dye during rinsing. Then the film was dried at 45°C for 20 min.

In order to preparing Sol-Gel layer, TMOS was hydrolyzed in water or alcohol and then Congo-Red indicator was added to at (1/05 %) and was agitated for 5 hour. A little quantity of the solution was located over a layer of Quartz glass and produced a thin layer over glass slide by means of Spin Coating, and a piece with dimensions of (33 × 10 × 0/5 mm) was prepared and heated for one hour to became ready for measurement.

The measures with immobilized indicator were stretched vertically inside the cuvette using a special frame. The size of its opening was 7x30 mm. The control sample against which the measurement was performed consisted of triacetylcellulose film treated in the same way but without indicator. The control sample was stretched in the same way inside the cuvette using a frame of the same size. The spectral characteristics of Congo Red using (0.20 – 0.05- 0.10) M borate- citrate – phosphate buffer and in the pH range 2.00 – 7.50 in steps of 0.50.

3. Results and Discussion

In the experiments, it was found that a considerable amount of indicators with amino groups was linked to the activated membrane via covalent binding, whereas the indicators without amino groups such a phenol red [3] cannot be linked with cellulose membrane. The optical properties of Congo red solution and immobilized Congo red hydrolyzed cellulose membrane are as a function of pH. A blue shift of the transition interval from the acidic region to the neutral region occurred for the Congo Red, and a red shift of the absorption maxima at the hydrolyzed cellulose, in comparison with the free dye

in the solution, was observed. The shift of the transition interval for the Congo Red is about 0.50 absorbance units at 486 nm for the pH interval from 2.00 – 7.50, but the absorbance change is linear only for the pH ranges from 3.00 – 6.00. The absorption maxima of the immobilized Congo Red are located at 510 nm and that of the free dye at 486 nm.

The above result can be interpreted based on the influence of the immobilization procedure on the behavior of the indicator. Kresteva and co-workers [18] show that the condensation between the hydroxyl methyl groups of the carrier and the protein is accomplished through the transformation of the amino groups in the acidic pH range. In addition, the reactivity of the activated carrier is so high that it was considered that interaction is possible with low molecular weight compounds that have a free ortho position in the molecules. For the reason, indicators having amino groups or free ortho positions in their structure can be used.

This makes it possible to achieve covalent binding to the activated matrix. In the experiments, it was found that a considerable amount of indicators with amino groups was linked to the activated membrane via covalent binding. The fact that the immobilization changes the ratio of the heights and positions of the absorption maxima of the indicators shows that the amino groups are auxochrom elements of the molecule and the loss of the proton after the covalent binding influences the charge distribution during the dissociation of the immobilized dye. (Fig.1). The reason for the transition interval shift is possibly the new covalent binding and the influence of the nearby acetyl cellulose carrier.

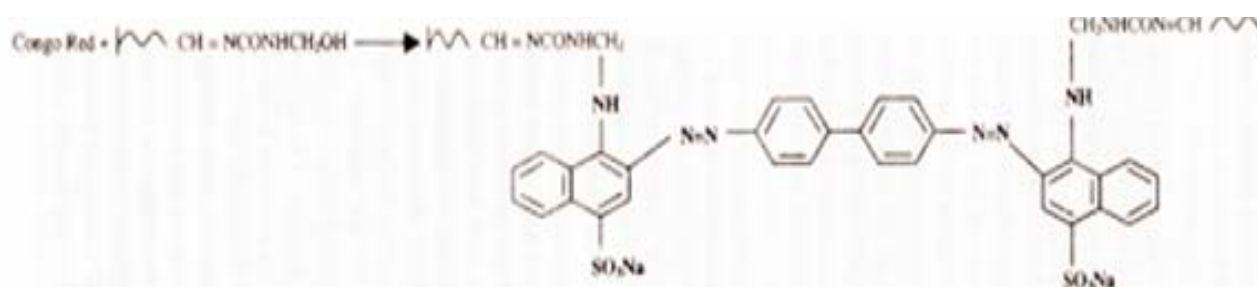


Fig. 1. Possible Scheme of reaction between activated membrane and Congo- Red.

Related to Sol-Gel layer, in addition to hydrogen and covalence bindings, locating Congo-Red inside silan lattice looks reasonable and amino groups act as Auxochrom elements in molecule, on the other hand interaction between electromagnetic waves and atoms, ions and molecules, results in counting their numbers. In this way, H⁺ concentration may be measured by fabricated membrane.

Measurement reiteration made by fabricated Sensors and variation in their absorption in maximal wave length in aqueous solution showed their stability to be less than 5 % for 1 month, that is, output signal has been varied 5% with stable state during month of measurement.

This stability, related to Sol-Gel membrane, is in higher level in proportion to polymer membrane in order to forming covalence binding between amino groups and also locating in Sol-Gel lattice.

Response time of fabricated sensors for polymer film and Sol-Gel film is <9 s and <6 s respectively and stability time of fabricated sensors for polymer film and Sol-Gel films are <12 months and <15 months respectively.

Table 1. pH measurement in aqueous condition.

Solution No.	HCl*solution		Achieved pH	
	Gel-sol layer	Polymer membrane	Gel-sol layer	Polymer membrane
1	3×10^{-3}	8×10^{-3}	2.52	2.09
2	9×10^{-3}	8×10^{-4}	2.04	3.09
3	11×10^{-4}	10×10^{-4}	2.95	4.00
4	12×10^{-5}	11×10^{-4}	3.42	2.95
5	15×10^{-5}	12×10^{-4}	3.82	2.92
6	1×10^{-5}	1×10^{-3}	5.00	3.00

*HCl has been diluted using distilled water

4. Conclusion

Spectrums for fixed Congo-Red on polymer film and Sol-Gel layer showed that dynamic rang for these sensors are higher than pH=2-7.5 and prepared of layer and membrane have some advantages for determining H^+ in aqueous environments.

- Sol-Gel layer have more transparency than polymer membrane.
- Response time of Sol-Gel layer is more than polymer membrane.
- Stability of Sol-Gel layer is more than polymer membrane.
- Polymer membrane and fixed Sol-Gel layer by Congo-Red consumption were investigated through AFM apparatus (Fig. 2-3) and showed the surface sliding of polymer membrane is more than of Sol-Gel lag, and it is concluded that Sol-Gel lager are more important than polymer membrane for making required sensors in order to measuring H^+ and other elements.

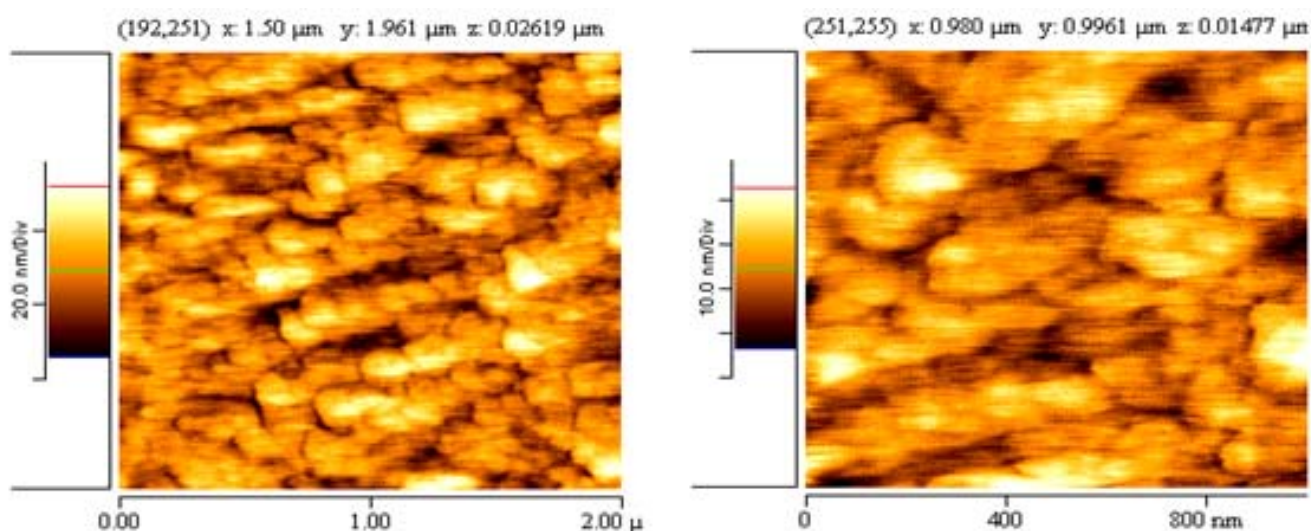


Fig. 2. AFM picture of polymer membrane surface fixed with Congo-Red.

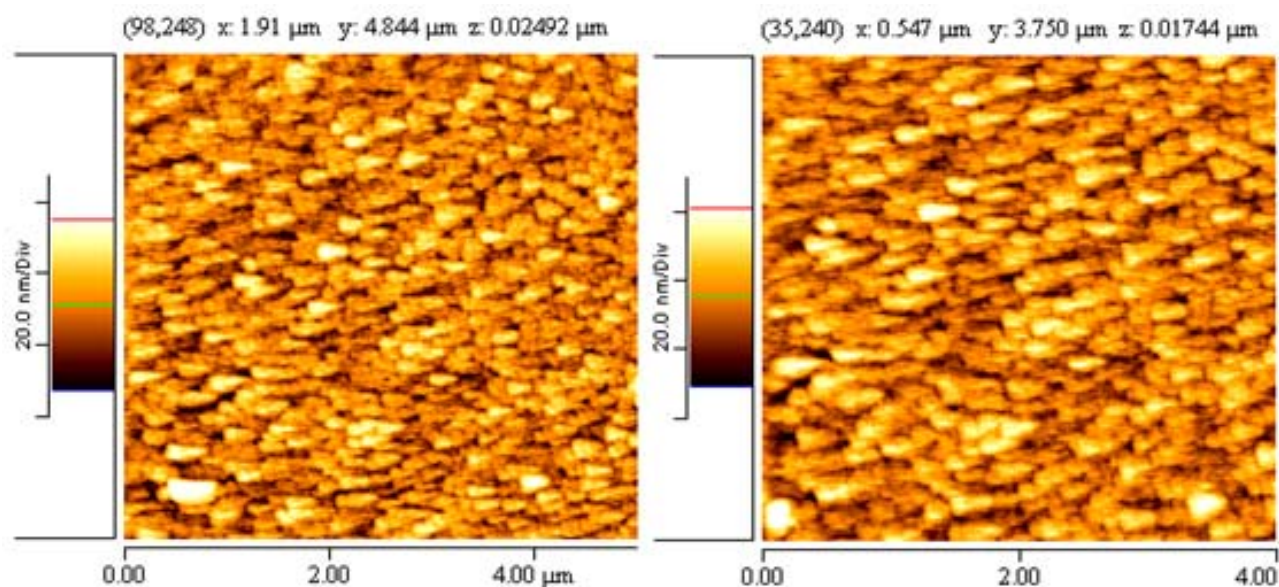


Fig. 3. AFM picture of Sol-Gel layer surface fixed with Congo-Red.

Acknowledgement

The author is grateful to the Materials Energy Research Center for the support of this work.

References

- [1]. E. Pringsheim, E. Terpetschnig, O. S. Wolfbeis, Optical Sensing of pH using thin films of substituted polyanilines, *Anal. Chem. Acta*, 357, 1997, pp. 247-252.
- [2]. L. K. Chau & M. D. Porter, Optical Sensor for calcium: performance, structure and reactivity of calcichrome immobilized at an anionic polymer film, *Anal. Chem.*, 62, 1990, pp. 1964-1971.
- [3]. A. Andrzejewski, H. Podbielska & A. Ulatowska, Sol gel protective layer for fiber optic chemical microsensors, *Opt. Appl. XXX*, 4, 2000, pp. 503-508.
- [4]. F. Kirkbir, S. R. Chaudhuri, Optical fibers from sol-gel derived Germania- silica glasses, *SPIE Proc.* 1758, 1992, pp. 160-172.
- [5]. N. E. Agbor, J. P. Cresswell, M. C. Petty, A. P. Monkman, An optical gas sensor based on polyaniline Langmuir-blodgett film, *Sens. Actuators*, B 41, 1997, pp. 137-141.
- [6]. M. E. H. Amrani, P. A. Payne, R. M. Dowdeswell & A. D. Hoffman, Frequency counting interrogation techniques applied to gas sensor arrays, *Sens. Actuators*, B, 57, 1999, pp. 75-82.
- [7]. M. A. Krysteva, B. I. Shopova, L. K. Yotova and M. I. Karasavova, *Biotechnol. Appl. Biochem*, 13, 1991, p. 106.
- [8]. A. Kazemzadeh, F. Moztafzadeh, Development of Low Cost pH Sensor, *Asian Journal of Chemistry*, 1, 18, 2006, pp. 325-330.
- [9]. S. S. Park, J. D. Mackenzie, Thickness and microstructure effects on alcohol sensing of tin oxide thin films, *Thin Solid Films*, 274, 1996, pp. 154-159.
- [10]. M. K. Krihak, M. R. Shahriari, Highly sensitive, all solid state fiber optic oxygen sensor based on the sol-gel coating technique, *Electron. Lett.* 32, 1996, pp. 240-242.
- [11]. O. S. Wolfbeis, A. Knierzinger & R. Shipfer, pH- dependent fluorescence spectroscopy XVII: first excited singlet state dissociation constants photoautomerism and dual fluorescence of flavonol, *J. Photochem.*, 21, 1983, pp. 67-79.
- [12]. C. J. Brinker, G. Scherer, Sol gel science, *The physics and chemistry of sol-gel processing*, San Diego, 1990, p. 818.

- [13].C Xu, J. N. Yamazoe, Grain Size effects on gas sensitivity of porous SnO₂-based elements, *Sensors and Actuators B*, 3, 1991, pp. 147-155.
- [14].S. K. Tripathy, J. Kumar, J. I. Chen, S. Marturunkakul, R. J. Jeng, L. Li & X. L. Jiang, nonlinear optical polymers derived from organic/inorganic composites, *Mater. Res. Soc. Symp. Proc.*, 346, 1994, pp. 531-540.
- [15].T. M. Butler, B. D. MacCraith & C. McDonagh, Leaching in sol-gel-derived silica films for optical pH sensing, *J. Non-Cryst. Solids*, 224, 1998, pp. 249-258.
- [16].O. Ben- David, E. Shafir, I. Gilat, Y. Prior & D. Avnir, long term renewable sol-gel fluorescent optical fiber pH sensor, *Sol-Gel Optics IV. Proc. of SPIE*, 3136, 1997, pp. 104-113.
- [17].C. Rottman, A. Turniansky & D. Avnir, Sol-gel physical and covalent entrapment of three methyl red indicators: a comparative study. *J. Sol-Gel Sci. Technol.*, 13, 1998, pp. 17-25
- [18].L. C. Klein (ed), Sol-gel Optic: Processing and Application, Boston, MA, 1994.
- [19].C. J. Brinker, G. W. Sherer, Sol-Gel Science, *Academic Press*, San Diego, 1990.

2010 Copyright ©, International Frequency Sensor Association (IFSA). All rights reserved.
(<http://www.sensorsportal.com>)

ISSN 1726-5479

Advertise in *Sensors & Transducers Journal* and *Sensors Web Portal*



http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2010.pdf
sales@sensorsportal.com

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 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 Please download also our media kit: 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

http://www.sensorsportal.com/HTML/DIGEST/Journal_Subscription_2010.htm

www.sensorsportal.com