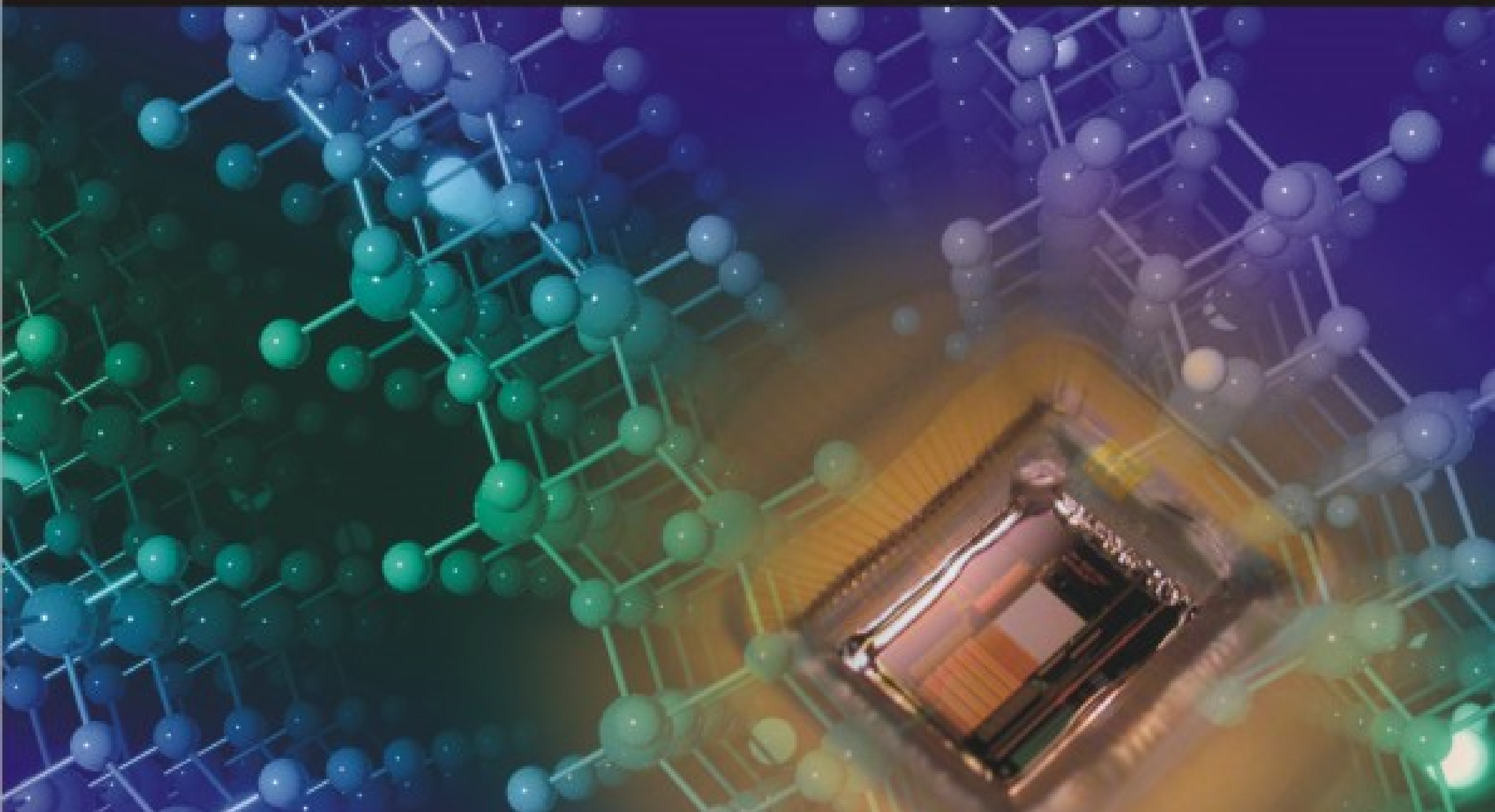
SENSORS & TRANSDUCERS

ISSN 1726-5479

vol. 149

2/13



International Frequency Sensor Association Publishing

IFSA

Printed in the USA.

Sensors & Transducers

Volume 149, Issue 2, February 2013 www.sensorsportal.com ISSN 1726-5479

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.

Sensors & Transducers Journal

Contents

Volume 149
Issue 2
February 2013

www.sensorsportal.com

ISSN 2306-8515
e-ISSN 1726-5479

Research Articles

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).

Sensors & Transducers, Vol. 149, Issue 2, February 2013, pp. 13-19

Sensors & Transducers

http://www.sensorsportal.com

Ethanol Gas Sensing Properties of Nano-Porous $LaFeO_3$ Thick Film

S. M. KHETRE
Dahiwadi College Dahiwadi, Tal. Man, Dist. Satara, (M. S.) 415508, India
Tel.: +91-2165-220231, fax: + 91-2165-220231
E-mail: sanjaykhetre@gmail.com

Received: 17 March 2012 /Accepted: 14 February 2013 /Published: 28 February 2013

Abstract. The characterization and ethanol gas sensing properties of nanoporous $LaFeO_3$ thick films were investigated. Thick films of $LaFeO_3$ were prepared by the screen printing technique. Thick films of nanoporous $LaFeO_3$ were observed to be highly sensitive to ethanol vapours at 300 °C. Upon exposure of ethanol vapours, the barrier height would decrease greatly leading to drastic increase in conductance. It is reported that the surface misfits and operating temperature can affect the microstructure and gas sensing performance of the sensor. The quick response and fast recovery are the main features of this sensor. The effects of microstructure and additive concentration on the gas response, selectivity, response time and recovery time of the sensor in the presence of ethanol vapours were studied and discussed.

Keywords: Nanoporous $LaFeO_3$, XRD, SEM, TEM, Gas response.

1. Introduction

There has been much interest in perovskite-structured compounds (of general formula ABO_3) because of their unique catalytic action [1], colossal magneto resistance effects [2, 3], and gas-sensing properties [4–12]. The materials are highly defective and have oxygen deficient structures, in which the valence state of metal ions may be controlled by temperature; oxygen partial pressure and dopants [13]. Actuators based on ABO_3-type oxide materials of rare-earth elements have an excellent stability.

Environmental safety is one of the serious concerns for the scientific community because of rapid increase in the use of organic pollutants in agriculture and various industries which caused severe adverse effects on the environment. Among various organic pollutants, ethanol, a colorless liquid, is one of the pollutants which is widely used as an industrial solvent for the preparation of various materials [14, 15]. It easily mixed with water and hence causes oxidative damage of brain, stomach, liver, erythrocyte, etc. [16, 17]. Due to its high-toxic nature, it is highly needed to detect efficiently the presence of ethanol in the environment. In this regard, various methods have been developed for the efficient detection of ethanol in environment and are reported in the literature [18–24]. Amongst various detection methods, the electro analytical technique is one of the most important methods for the detection of ethanol as it provides direct, sensitive and reliable analytical results just by utilizing conventional and easily available laboratory electrodes. For the fabrication of efficient electrochemical sensors, mostly artificial mediators are used which helps to transfer the electrons from the electrodes to the detection species. Recently, biocompatible nanomaterials, especially metal oxide nanomaterials, are utilized as artificial mediators for the fabrication of efficient electrochemical sensors [20–24]. $LaFeO_3$ is considered as one of the promising artificial mediators due to its own properties and functionalities [25, 26]. It is a p-type metal oxide semiconductor with narrow band gap (1.2 eV) and demonstrated a versatile range of applications. Due to the good electrical conductivity of $LaFeO_3$, it is widely used in the fabrication of various efficient electrical, optical, photovoltaic, sensing and other devices and is reported in the literature [25].

In this work, a successful synthesis of $LaFeO_3$ nano sheet via combustion process was done and characterized in terms of their structural and optical properties. Importantly, as-synthesized $LaFeO_3$ nanosheets were efficiently utilized as redox mediator for the fabrication of efficient ethanol chemi-sensor which exhibits good sensor performance, specifically in terms of its sensitivity and detection limit.

2. Experimental

Analytical grade $La(NO_3)_3{\cdot}6H_2O$, $Fe(NO_3)_3{\cdot}9H_2O$ and $C_2H_5NO_2$ were used as raw materials to prepare $LaCrO_3$. According to the stoichiometric preparation of the reactants, the specified amounts of $Fe(NO_3)_3{\cdot}9H_2O$ and $Fe(NO_3)_3{\cdot}6H_2O$ were first dissolved in glycine solution to form the sol. The molar amount of glycine was double to total molar amount of metal nitrates in the solution. A small amount of ammonia aqueous was slowly added to adjust the pH to 7. During this procedure, the solution was continuously stirred and kept at a temperature of 60-70 °C. Then, the stabilized nitrate–glycine sol was poured into a tray and heated slowly to 140-150 °C. Viscosity and color changed as the sol turned into a green, puffy, porous dry gel. When ignited at any point of the dried gel in air at room temperature, the dried gel simultaneously burnt in a self-propagating combustion manner until they were completely transformed into loose powders, known as as-synthesis powder. The entire combustion process would last a few seconds. The as-synthesis powder was the nanocrystalline $LaFeO_3$ with fine crystal structure.

2.1. Thick Film Preparation

The thixotropic paste was screen printed on a glass substrate in desired patterns [21]. The films prepared were fired at 550 °C for 24 h. These films were surface modified by dipping them into a 0.01 M aqueous solution of cupric chloride for different intervals of time and were dried at 80 °C followed by firing at 550 °C for 24 h in air ambient. The $CuCl_2$ dispersed on the films was oxidized in firing process, and sensor elements with different mass% of $LaCrO_3$ were obtained. Silver contacts were made by vacuum evaporation for electrical measurements. [13, 25]

2.2. Characterization

X-ray diffraction (CrK_α, Philips analytical XRD B.V.PW-1710) was used for confirming the phase and structural study. Infrared spectra (IR) for the synthesis powder were performed on a Perkin-Elmer 883 spectrophotometer from 450 to 4000 cm^{-1}. The surface morphological features were observed by using scanning electron microscopy (JSM-6360A). Transmission electron microscopy (TEM) of the powder was carried out by Make Philips CM-200 superwinster spectrometer at 200 kV. The specific surface area of the powders was measured by BET isotherm technique with nitrogen absorption. Thickness measurements were carried out using a Taylor- Hobson (Talystep, UK) system. Electrical and gas sensing characteristics were measured using a static gas sensing system. The I-V character and thermoelectric measurement of nanocrystalline $LaFeO_3$ re carried out. The dc resistivity was measured by the two probe method as a function of temperature (room temperature to 550 °C.)

2.3 Details of the Gas Sensing System

The sensing performance of the sensors was examined using a static gas sensing system. There were electrical feeds through the base plate. The heater was fixed on the base plate to heat the sample under test up to required operating temperatures. The current passing through the heating element was monitored using a relay with adjustable ON and OFF time intervals. A Cr–Al thermocouple was used to sense the operating temperature of the sensor. The output of the thermocouple was connected to a digital temperature indicator. A gas inlet valve was fitted at one of the ports of the base plate. The required gas concentration inside the static system was achieved by injecting a known volume of test gas using a gas-injecting syringe. A constant voltage was applied to the sensor, and current was measured by a digital picoammeter. Air was allowed to pass into the glass dome after every ethanol gas exposure cycle.

3. Results and Discussion

When reactants were heated at 180 °C the reaction proceeded by the mechanism indicated in equation number 1 and 2 give the final product $LaFeO_3$.

$$2C_2NH_5O_2 + (9/2)\, O_2 \rightarrow N_2 + 4CO_2\uparrow + 5H_2O\uparrow \quad (1)$$

$$La(NO_3)_3 + Fe(NO_3)_3 + 4\, C_2H_5NO_2 \rightarrow LaFeO_3 + + 8CO_2\uparrow + 10H_2O\uparrow + 5\, N_2\uparrow \quad (2)$$

The XRD measurement (Fig. 1) shows that the product is pure perovskite oxide $LaFeO_3$ with an orthorhombic structure, the diffraction data are in good agreement with JCPDS card of $LaFeO_3$ (JCPDS no: 15-0148). The average crystalline size of $LaFeO_3$ perovskite powder is determine with the help of Scherrer's equation $t=0.9\lambda/\beta cos\theta$, where t is the average size of the particles, λ is wavelength of X-ray radiation, β the full width at half maximum of the diffracted peak and θ is the angle of diffraction [27-28]. The average crystalline size obtained for nanocrystalline $LaFeO_3$ calcinated at 1000 °C is found to be 28-63 nm. $LaFeO_3$ nanocrystals are more attractive in the field of catalytic application. Glycine nitrate was used as organic fuel for combustion. Fig.1 shows desired and expected peaks of nanoporous $LaFeO_3$. No extra peaks are seen. Fuel plays an important role in the combustion of gel. At the combustion point organic fuel formed NO_x, CO_2, N_2 gases and they tried to come out from the gel by breaking the gel into nanoporous and nanosized particles of $LaFeO_3$.

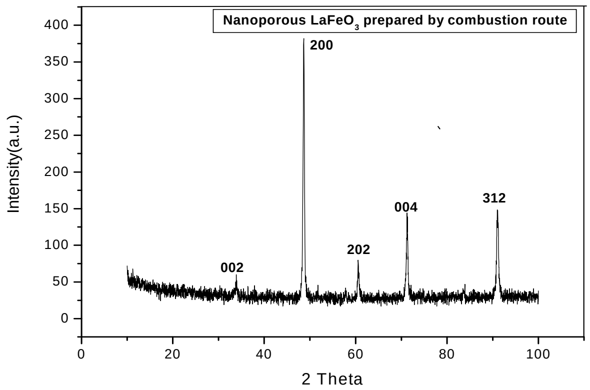
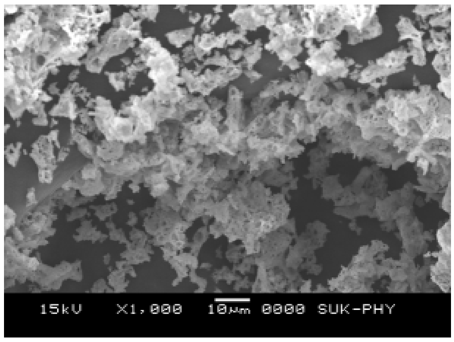


Fig. 1. XRD pattern of nanoporous $LaFeO_3$.

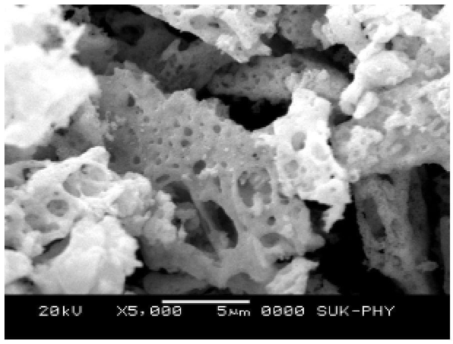
The SEM technique was employed for finding morphology of $LaFeO_3$ powder heated at 1000 °C Fig. 2 (a-d). One can notice the presence of macro-agglomerations of very fine particles having size less than 1 μm. The particle shapes are not well defined. Many large and small pores are present in the whole material. We assumed that the pores are mainly intergranular because intragranular pores are not seen on the SEM photograph.

3.1. TEM Analysis

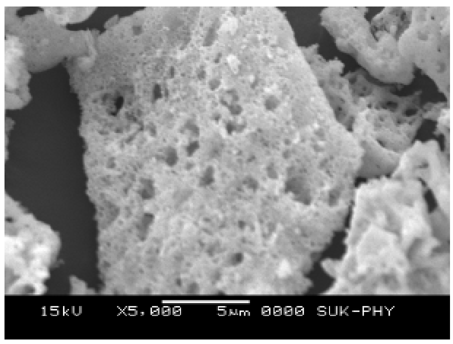
The TEM specimens were prepared by placing microdrops of colloid solutions on a carbon film supported by a copper grid. The TEM images of the nanocrystalline $LaFeO_3$ calcinated at 1000 °C in air for 5 h are shown in Fig. 3 (a) it indicates the presence of $LaFeO_3$ nanoparticles with 28-63 nm size which form spherical type of oriental aggregation, agglomeration and polymeric linkage throughout the region. The HRTEM image Fig. 3 (b-c) shows the porous nature of the material .The pores are well developed spherical shape with diameter from 9-13 nm size. The results are correlated with the XRD. The selected area diffraction (SAED) pattern Fig. 3 (d) shows the spot type pattern which is indicative of single crystalline particles. No evidence was found for more than one pattern, suggesting the single phase nature of the material. The BET surface area is measured on a Benchman coulter SA 3100 plus instrument using nitrogen adsorption at 200 °C. The surface area of the synthesized powder is 15.5 m^2/g.



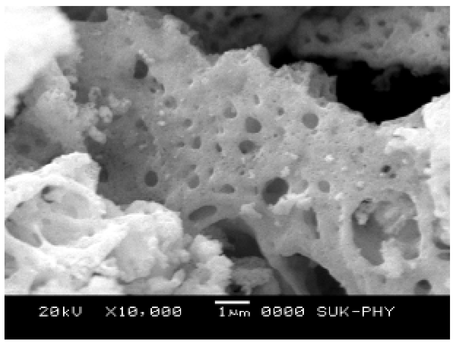
(a)



(b)



(c)



(d)

Fig. 2. SEM micrographs for $LaFeO_3$ at 1000 °C.

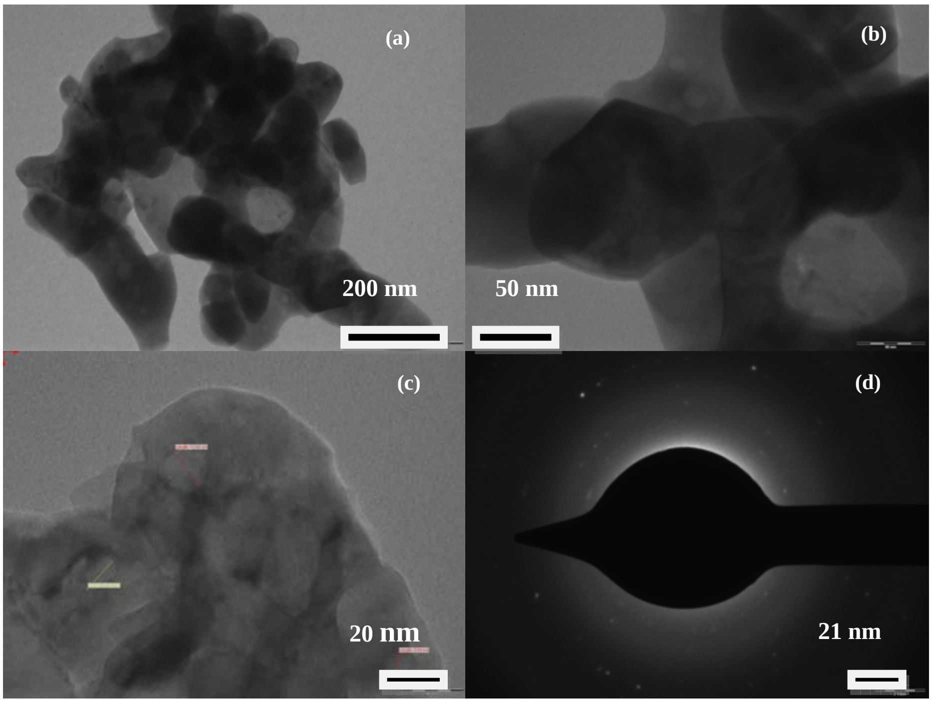


Fig. 3. TEM image of $LaFeO_3$ calcinated at 1000 °C (a), high resolution transmission electron microscopy image of nanocrystalline $LaFeO_3$ (b-c), selected area electron diffraction pattern (d).

3.2. Thickness Measurement

The thicknesses of the films were observed to be in the range from 30 to 40 µm. The reproducibility of the film thickness was achieved by maintaining the proper rheology and thixotropy of the paste.

3.3. Thermoelectric Power Measurements

The p-type semiconductivity of thick films of $LaFeO_3$ was confirmed by measuring thermoelectromotive force of the thick film samples. The $LaFeO_3$ was observed to be p-type material.

4. Electrical Properties

4.1. I-V characteristics

Fig. 4 depicts the I–V characteristics of the $LaFeO_3$ films at room temperature. It was clear from the I–V characteristics that the sliver contacts fabricated on the film were ohmic in nature. The voltage applied was in the range 1–30 V.

4.2 Electrical Conductivity

The semiconducting nature of $LaFeO_3$ is observed from the measurements of resistivity with temperature. The semiconductivity in $LaFeO_3$ must be due to large oxygen deficiency in it. The material would then adsorb the oxygen species at higher temperatures ($O_2^- \rightarrow 2O^- \rightarrow O^{2-}$). The increase in conductivity with increasing temperature could be attributed to negative temperature coefficient of resistance and semiconducting nature of the $LaFeO_3$. It is observed from Fig. 5 that the electrical conductivity of the $LaFeO_3$ in air is nearly linear in the temperature range from 300–575 °K in air ambient.

5. Sensing Performance

5.1. Sensing Characteristics

The relative response to a target gas is defined as the ratio of the change in conductance of a sample upon exposure of the gas to the original conductance in air. The gas response can be written as:

$$\text{Gas Response} = \frac{G_g - G_a}{G_a} = \frac{G}{G_a},$$

where G_a is the conductance in air and G_g is the conductance in a sample gas. Specificity or selectivity can be defined as the ability of a sensor to respond to a certain gas in the presence of different gases. Response time (RST) was defined as the time required for a sensor to a$LaFeO_3$ain the 90 % of the maximum increase in conductance after the exposure of test gas on the sensor surface, while recovery time (RCT) as the time taken to get back 90 % of the maximum conductance in air.

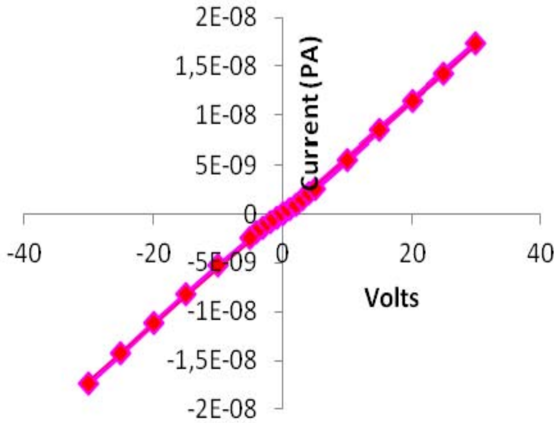


Fig. 4. I-V characteristics OF $LaFeO_3$.

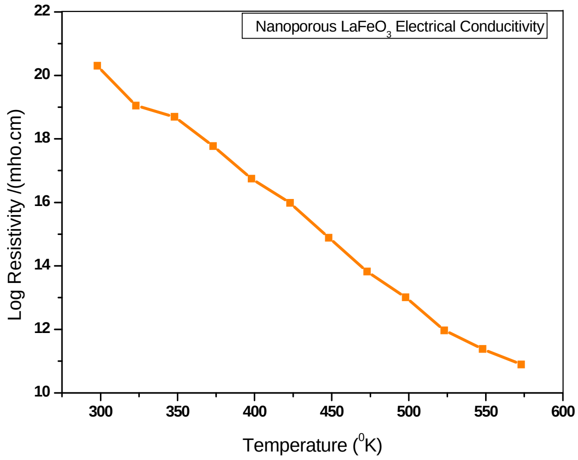


Fig. 5. Electrical conductivity of $LaFeO_3$ sample in air.

5.3. Gas Response of $LaFeO_3$ at Various Temperatures

5.3.1. Gas Response and Ethanol Gas Concentration

The variation of response of $LaFeO_3$ sample with ethanol gas concentration is represented in Fig. 6. It is clear from the figure that the gas response goes on increasing with gas concentration up to 100 ppm at 300 °C. The rate of increase in response was relatively larger up to 100 ppm and smaller beyond 100 ppm. Thus, the active region of the sensor would be up to 100 ppm.

5.3.2. Gas Response and Operating Temperature

Fig. 7 represents the variation of ethanol gas response with the operating temperature of the $LaFeO_3$ film. It is clear from the figure that the gas response increase with operating temperature reaches to the maximum (100 ppm) at 300 °C, and falls with further increasing the in operating temperature. The ethanol may burn before reaching the surface of the film at higher temperatures (>300 °C). Hence, the gas response would have been decreased above 300 °C. A larger amount of oxygen-adsorption would have occurred on the surface of the film at 300 °C and have facilitated the sensor to oxidize the ethanol gas immediately, giving faster and larger gas response.

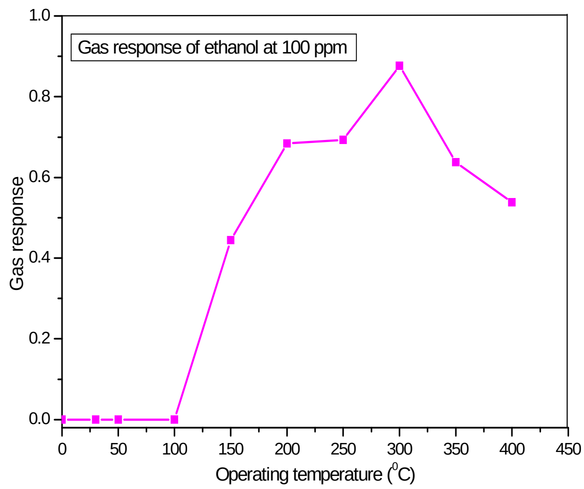


Fig. 6. Variation of response with operating temperature.

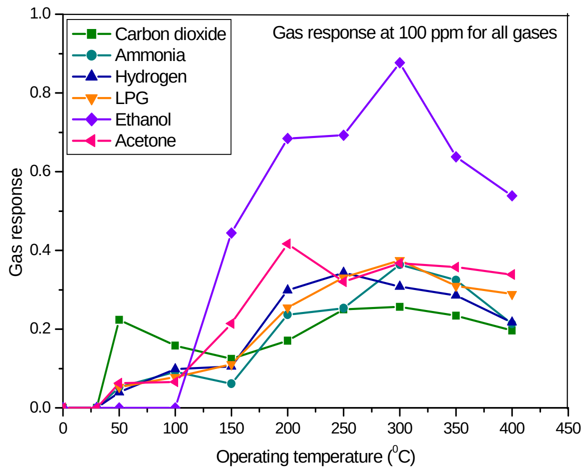


Fig. 7. Variation of gas response with operating temperature.

5.3.3. Ethanol Gas Response and Gas Concentration

Fig. 8 represents the variation of ethanol gas response with the gas concentration of $LaFeO_3$ film. For $LaFeO_3$ film, the response values were observed to increase continuously with increasing the gas concentration up to 100 ppm at 300 °C. The rate of increase in response was relatively larger up to 100 ppm, and then saturated after 100 ppm. Thus, the active region of the sensor would be between 50 and 100 ppm.

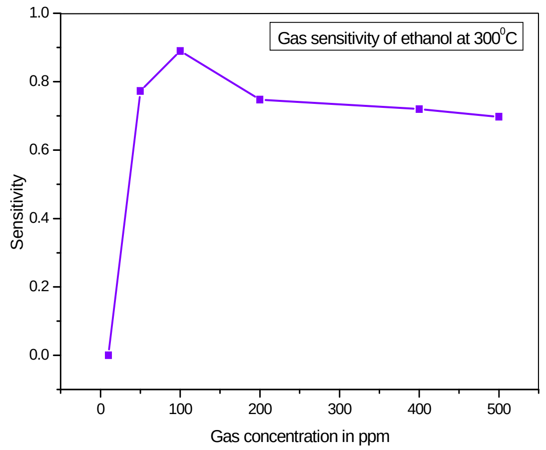


Fig. 8. Variation of gas response with gas concentration.

5.3.5. Selectivity for Ethanol Against Various Gases

Fig. 9 depicts the selectivity of $LaFeO_3$ to 100 ppm of ethanol gas against various gases at 300 °C. It is clear from Fig. 9 that, in contrast to pure $LaFeO_3$; the sample shows not only enhanced response towards ethanol but also very high selectivity.

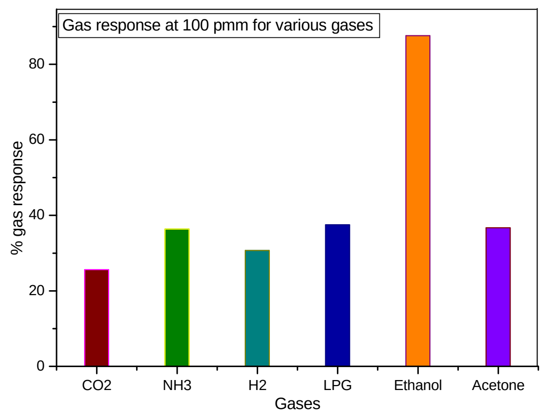


Fig. 9. Gas responses among various gases.

5.3.6. Response and Recovery of the Sensor

The response and recovery of the $LaFeO_3$ sensor are represented in Fig. 10. The response was quick (~5 s) to 100 ppm of ethanol. Recovery was also very fast (~35 s). The fast response may be due to the fast oxidation of ethanol into H_2O (gas). After sevaporating water molecules, the film recovery was obtained.

7. Summary

The following statements can be made for the sensing performance of $LaFeO_3$ sensors:

(1) Pure $LaFeO_3$ thick film is the most sensitive element to ethanol gas;
(2) The optimum operating temperature for ethanol gas sensing is 300 °C;
(3) $LaFeO_3$ has the potential of fabricating ethanol sensor;
(4) Surface properties of the films could be conveniently customized (without affecting the bulk properties) by the surface modification using dipping technique;
(5) The $LaFeO_3$ thick film sensor showed very rapid response and recovery to ethanol gas;
(6) The sensor showed good selectivity to ethanol gas against LPG, NH_3, CO_2 and H_2 gases.

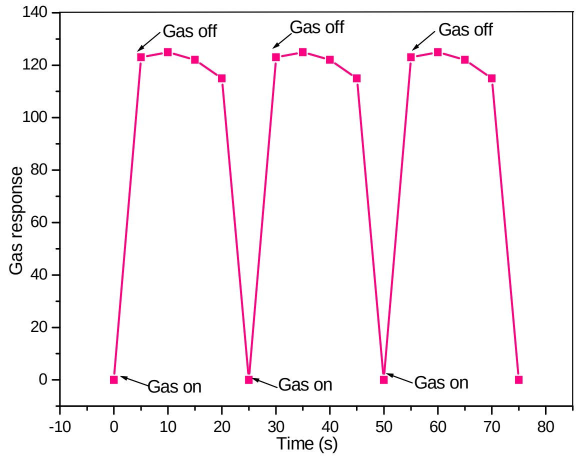


Fig.10. The response and recovery of the $LaFeO_3$ sensor.

Acknowledgements

Author is thankful to UGC (WRO) Pune for financial support to this research work under Minor Research Project (File No.47-2036/11(WRO) 22/2/2012). He is also grateful to the Principal, Dr. C. J. Khilare, Dahiwadi College Dahiwadi and Principal Dr. V. S. Shivankar Morden College Vashi (Navi-Mumbai) for their valuable guidance, inspiration and motivation.

References

[1]. L. Lisi, G. Bagnasco, P. Ciambelli, S. D. Rossi, A. P. Porta, A. G. Russo, M. Turco, Perovskite-type oxides II. Redox properties of $LaMn_{1-x}Cu_xO_3$ and $LaCo_{1-x}CuxO_3$ and ethane catalytic combustion, *Solid State Chem.*, 146, 1999, pp. 176–183.

[2]. J. F. Hu, C. J. Ji, H. W. Qin, J. Chen, Y. M. Hao, Y. X. Li, Enhancement of room temperature magnetoresistance in $La_{0.65}Sr_{0.35}Mn_{1-x}TxO_3$ (T = Fe, Ni) manganites, *J. Magn. Magn. Mater.*, 241, 2002, pp. 271–275.

[3]. H. W. Qin, J. F. Hu, C. J. Ji, H. D. Niu, L. M. Zhu, Room temperature magnetoresistance in $La_{0.67}Sr_{0.}$

$_{33}Mn_{1-x}Al_xO_3$ manganites, *J. Magn. Magn. Mater.*, 263, 2003, pp. 249– 252.

[4]. C. M. Chiu, Y. H. Chang, Characteristics and sensing properties of dipped $La_{0.8}Sr_{0.2}Co_{1-x}NixO_{3-d}$ film for CO gas sensors, *Thin Solid Films,* 342, 1999, pp. 15–19.

[5]. Z. Y. Peng, X. Li, M. Y. Zhao, H. Cai, S. Q. Zhao, G. D. Hu, Fabrication of $La_{1-x}Sr_xFe_{1-y}Co_yO_3$ sensitive ceramics, nanocrystalline thin films and the manufacture of the NCTF-OSFET gas sensing device, *Thin Solid Films*, 286, 1996, pp. 270–273.

[6]. C. M. Chiu, Y. H. Chang, The structure, electrical and sensing properties for CO of the $La_{0.8}Sr_{0.2}Co_{1-x}Ni_xO_{3-\delta}$ system, *Mater. Sci. Eng.*, A, 266, 1999, pp. 93–98.

[7]. C. M. Chiu, Y. H. Chang, The influence of microstructure and deposition methods on CO gas sensing properties of $La_{0.8}Sr_{0.2}Co_{1-x}Ni_xO_{3-\delta}$ perovskite films, *Sens. Actuators B,* 54, 1999, pp. 236– 242.

[8]. N. N. Toan, S. Saukko, V. Lantto, Gas sensing with semiconducting perovskite oxide $LaFeO_3$, *Physica B*, 327, 2003, pp. 279–282.

[9]. L. B. Kong, Y. S. Shen, Gas-sensing property and mechanism of $Ca_xLa_{1-x}FeO_3$, *Sens. Actuators B,* 30, 1996, pp. 217–221.

[10]. Y. D. Wang, J. B. Chen, X. H. Wu, Preparation and gas-sensing properties of perovskite-type $SrFeO_3$ oxide, *Mater. Lett*., 49, 2001, pp. 361–364.

[11]. S. M. Khetre, C. J. Khilare, V. S. Shivankar, S. R. Bamane preparation and study of gas sensing behavior of Nanocrystalline $LaCrO_3$ thick film, *Sensors & Transducers,* Vol. 137, Issue 2, February 2012, pp. 165-175.

[12]. S. M. Khetre., H. V. Jadhav, P. N. Jagadale, S. R. Kulal and S. R. Bamane., Studies on electrical and dielectric properties of $LaFeO_3$, *Advances in Applied Science Research*, 2, 4, 2011, pp. 503-511.

[13]. D. R. Patil, L. A. Patil, Cr_2O_3-modified ZnO thick film resistors as LPG sensors, *Talanta*, 77, 2009, pp. 1409–1414.

[14]. S. V. Bangale, S. M. Khetre, D. R. Patil, S. R. Bamane, Simple Synthesis of $ZnCo_2O_4$ Nanoparticles as Gas-sensing Materials, *Sensors & Transducers*, Vol. 134, Issue 11, November 2011, pp. 95-106.

[15]. L. Senf, F. Stapf, B. Dusedau, H. Frank, Atmospheric organic pollutants enriched on charcoal, *Journal of Thermal Analysis and Calorimetry*, 33, 371, 1988, pp.371-374

[16]. S. C. Bondy and S. X. Guo, Effect of ethanol treatment on indices of cumulative oxidative stress, European Journal of Pharmacology, 270, No. 4, pp. 349–355, 1994.

[17]. C. Lindi, G. Montorfano, P. Marciani. Rat erythrocyte susceptibility to lipid peroxidation after chronic ethanol intake. *Alcohol,* 16, 1998, pp.311–316.

[18]. N. Rastakhiz, A. Kariminik, V. Soltani-Nejad, S. Roodsaz, Simultaneous determination of phenyl hydrazine and sulphite using a modified carbon nanotube paste electrode, *Int. J. Electrochem. Sci*., 5, 2010, pp. 1203-1212.

[19]. A. Umar, M. M. Rahman, S. H. Kim, Y. B. Hahn, Zinc oxide nanonail based chemical sensor for hydrazine detection, *Chem. Commun.,* 2008, pp.166-169.

[20]. Y. Mo, Y. Okawa, M. Tajima, T. Nakai, N. Yoshiike, and K. Natukawa, Micro-machined gas sensor array based on metal film micro-heater, *Sensors and Actuators B: Chemical*, 79, 2001, pp. 175-181.

[21]. Z. Tianshua, P. Hinga, Z. Jiancheng and K. Lingbing, Ethanol-sensing characteristics of cadmium ferrite prepared by chemical coprecipitation. *Mater. Chem. Phys.,* 61, 1999, pp. 192–196.

[22]. W. Xing-Hui, W. Yu-De, L. Yan-Feng, Z. Zhen-Lai; Electrical and gas-sensing properties of perovskite-type $CdSnO_3$ semiconductor material. *Mater. Chem. Phys.,* 77, 2002, pp. 588–593.

[23]. W. Yude, S. Xiaodan, L. Yanfena, A. Zhenlai, W. Xinghni., Perovskite-type $NiSnO_3$ used as the ethanol sensitive material, *Solid State Electronic*, 44, 2000, pp.2009-2014.

[24]. A Umar, Y. B. Hahn, Metal oxide nanostructures and their applications, *American Scientific Publishers,* LA, USA, 2010.

[25]. Y. Mu, J. Yang, S. Han, H. Hou, Y. Fan; Syntheses and gas-sensing properties of CuO nanostructures by using $[Cu(pbbt)Cl_2]_2{\cdot}CH_3OH$ as a precursor. *Mater Lett*, 64, 2010, pp. 1287–1290

[26]. L. Chen, C. Zhao, ZI Wei, S. Wang, Chen Y. G. L., C. Zhao, Z. Wei, S. Wang, Gu Y., Direct synthesis and characterization of spongy CuO with nanosheets from $Cu_3(btc)_2$ microporous metal-organic framework, *Material Lett.* , 65, 3, 2011, pp. 446-449

[27]. S. M. Khetre, H. V. Jadhav, S. V. Bangale, P. N. Jagdale, S. R. Bamane, Use of mixed metal oxide as a catalyst in the decomposition of hydrogen peroxide, *Advances in Applied Science Research*, 2, 2, 2011, pp. 252-259.

[28]. S. M. Khetre, H. V. Jadhav, P. N. Jagadale, S. V. Bangale, S. R. Kulal, S. R. Bamane, Solar photodegradation of methylene blue by $LaMnO_3$ nanorods as a heterogeneous catalyst, *Archives of Applied Science Research*, 3, 4, 2011, pp. 450-462.

[29]. S. M. Khetre, A. U. Chopade, H. V. Jadhav, S. R. Kulal, P. N. Jagadale, S. V. Bangale, S. R. Bamane, Auto- Combustion Synthesis of Nanocrystalline $FeCrO_3$, in *Proceedings of the IEEE International Conference on Nanoscience, Technology and Societal Implications (NSTSI' 2011),* 8-10 December 2011, pp. 1-6.


IARIA
The Fourth International Conference on Sensor Device Technologies and Applications
SENSORDEVICES 2013
25 - 31 August 2013 - Barcelona, Spain
Tracks: Sensor devices - Ultrasonic and Piezosensors - Photonics - Infrared - Gas Sensors - Geosensors - 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 - Sensors and Transducers for Non-Destructive Testing
Deadline for papers: 30 March 2013
http://www.iaria.org/conferences2013/SENSORDEVICES13.html


IARIA
The Seventh International Conference on Sensor Technologies and Applications
Deadline for papers: 30 March 2013
SENSORCOMM 2013
25 - 31 August 2013 - Barcelona, Spain
Tracks: Architectures, protocols and algorithms of sensor networks - Energy, management and control of sensor networks - Resource allocation, services, QoS and fault tolerance in sensor networks - Performance, simulation and modelling of sensor networks - Security and monitoring of sensor networks - Sensor circuits and sensor devices - Radio issues in wireless sensor networks - Software, applications and programming of sensor networks - Data allocation and information in sensor networks - Deployments and implementations of sensor networks - Under water sensors and systems - Energy optimization in wireless sensor networks
http://www.iaria.org/conferences2013/SENSORCOMM13.html


IARIA
The Sixth International Conference on Advances in Circuits, Electronics and Micro-electronics
CENICS 2013
25 - 31 August 2013 - Barcelona, Spain
Deadline for papers: 30 March 2013
Tracks: Semiconductors and applications - Design, models and languages - Signal processing circuits - Arithmetic computational circuits - Microelectronics - Electronics technologies - Special circuits - Consumer electronics - Application-oriented electronics
http://www.iaria.org/conferences2013/CENICS13.html

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 by EI Compendex index (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