Document type
Article

Source type
Journal

ISSN
1511788X

DOI
10.31436/iiumej.v22i2.1612

View more

IIUM Engineering Journal • Open Access • Volume 22, Issue 2, Pages 168 - 177 • 2021

An Investigation of The Sensitivity of Polymer - coated Surface Acoustic Wavebased Gas Sensors in the Detection of Volatile Organic Compounds

Ralib A.A.M., Omar A.S.S.

Save all to author list

Department of Electrical and Computer Engineering, Kulliyyah of Engineering, International Islamic University of Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia

Abstract

Author keywords

Funding details

Abstract

Surface acoustic wave sensors (SAWs) are excellent at detecting volatile organic compounds (VOCs) since a sensing layer can be created by spreading a thin film of material across the delay line. This critically enhances performance as it is sensitive to the physical phenomena of interest. This study aims to provide a thorough investigation of the sensitivity of polymer - coated SAW-based gas sensors to VOCs using simulations via the finite element method (FEM). As such, quartz was chosen as the piezoelectric substrate while polymeric materials were chosen as the sensing layers due to their high sensitivity , low energy consumption, short response time, performance at room temperature, and reversibility after exposure to an analyte. The polymeric materials chosen were: (1) polyisobutylene (PIB), (2) polydimethylsiloxane (PDMS), (3) polyisoprene (PIP), (4) polyimide (PI), and (5) phenylmethyldiphenylsilicone (OV25). The VOCs chosen for investigation were: (1) dichloromethane (DCM), (2) trichloroethylene (TCE), (3) 1,2- dichloroethylene (DCE), and (4) carbon tetrachloride (CCl4). The performance of each polymer - coated SAW sensor was evaluated in terms of frequency shift and sensitivity to each VOC in FEM simulations. Our study found that the PIB- coated sensor had the highest sensitivity (4.0571 kHz/ppm) to DCM vapor and good sensitivity (45.257 kHz/ppm) to TCE vapor. However, the performance of each polymer - coated sensor varied depending on the type of VOC being tested. As an example, while the OV25- coated sensor was more sensitive (52.57 kHz/ppm) than the PIB- coated sensor (53.54 kHz/ppm) to TCE vapor regardless of the concentration, the PIB- coated sensor was more sensitive to DCM vapor at both low (4.06 kHz/ppm) and high (3.54 kHz/ppm) concentrations than the OV25- coated sensor . Therefore, the results of our FEM simulations indicate that polymer - coated SAW-based gas sensors are highly capable of self-powered VOC detection .

Author keywords

frequency shift; gas sensor ; polymer sensing layer; sensitivity ; surface acoustic wave

Funding sponsor	Funding number	Acronym
Ministry of Higher Education, Malaysia	FRGS 17-032-0598	MOHE

See opportunities by MOHE

Funding text
This work was supported by the Ministry of Higher Education (MOHE) Malaysia under the Fundamental Research Grant Scheme (FRGS) (Grant No.: FRGS 17-032-0598).

References (17)

View in search results format

All Export Print E-mail Save to PDF Create bibliography

Cited by 0 documents

Inform me when this document is cited in Scopus:

Set citation alert

Related documents

Analysis of propagation characteristics of AlN/diamond/Si layered SAW resonator
Wang, L. , Wang, H.
(2020) Microsystem Technologies

Systematic Review on Design and Development of Efficient Semiconductor Based Surface Acoustic Wave Gas Sensor
Patial, P. , Deshwal, M.
(2021) Transactions on Electrical and Electronic Materials

A proposition and an evaluation for compact multiple odor scan system
Araki, H. , Omatu, S.
(2015) 2015 10th Asian Control Conference: Emerging Control Techniques for a Sustainable World, ASCC 2015

View all related documents based on references

Find more related documents in Scopus based on:

Authors Keywords

1 Kim, ID, Choi, SJ, Kim, SJ, Jang, JS.
Exhaled Breath Sensors
(2015) *Smart Sensors for Health and Environment Monitoring*. Cited 33 times.
[1] in: Kyung CM. (eds) KAIST Research Series. Springer, Dordrecht
https://doi-org.ezlib.iium.edu.my/10.1007/978-94-017-9981-2_2

2 Lee, B.C., Tward, D.J., Mitra, P.P., Miller, M.I.
On variational solutions for whole brain serial-section histology using a Sobolev prior in the computational anatomy random orbit model (Open Access)

(2018) *PLoS Computational Biology*, 14 (12), art. no. e1006610. Cited 7 times.
http://www.ploscompbiol.org/article/browseVolume.action?field=volume
doi: 10.1371/journal.pcbi.1006610

View at Publisher

3 Wang, C., Sahay, P.
Breath analysis using laser spectroscopic techniques: Breath biomarkers, spectral fingerprints, and detection limits (Open Access)

(2009) *Sensors*, 9 (10), pp. 8230-8262. Cited 388 times.
http://www.mdpi.com/1424-8220/9/10/8230/pdf
doi: 10.3390/s91008230

View at Publisher

4 Kim, K.-H., Jahan, S.A., Kabir, E.
A review of breath analysis for diagnosis of human health

(2012) *TrAC - Trends in Analytical Chemistry*, 33, pp. 1-8. Cited 188 times.
doi: 10.1016/j.trac.2011.09.013

View at Publisher

5 Afzal, A., Iqbal, N., Mujahid, A., Schirhagl, R.
Advanced vapor recognition materials for selective and fast responsive surface acoustic wave sensors: A review

(2013) *Analytica Chimica Acta*, 787, pp. 36-49. Cited 101 times.
doi: 10.1016/j.aca.2013.05.005

View at Publisher

6 Aslam, M.Z., Jeoti, V., Karuppanan, S., Malik, A.F., Iqbal, A.
FEM analysis of sezawa mode SAW sensor for VOC based on CMOS compatible AlN/SiO_2/Si multilayer structure (Open Access)

(2018) *Sensors (Switzerland)*, 18 (6), art. no. 1687. Cited 11 times.
http://www.mdpi.com/1424-8220/18/6/1687/pdf
doi: 10.3390/s18061687

View at Publisher

7 Ralib, A.A.M., Nordin, A.N., Salleh, H.
A comparative study on MEMS piezoelectric microgenerators

(2010) *Microsystem Technologies*, 16 (10), pp. 1673-1681. Cited 20 times.
doi: 10.1007/s00542-010-1086-9

View at Publisher

8 Arshak, K., Moore, E., Lyons, G.M., Harris, J., Clifford, S.
A review of gas sensors employed in electronic nose applications (Open Access)

(2004) *Sensor Review*, 24 (2), pp. 181-198. Cited 539 times.
doi: 10.1108/02602280410525977

View at Publisher

9 Hazadi, A.H.F., Ralib, A.A.M., Saidin, N.

Design and Simulation of Electroacoustic Sensor for exhaled breath analysis

(2018) *Proceedings of the 2018 7th International Conference on Computer and Communication Engineering, ICCCE 2018*, art. no. 8539332, pp. 388-391. Cited 2 times.
http://ieeexplore.ieee.org.ezlib.iium.edu.my/xpl/mostRecentIssue.jsp?punumber=8510540
ISBN: 978-153866991-4
doi: 10.1109/ICCCE.2018.8539332

View at Publisher

10 Mujahid, A., Dickert, F.L.

Surface acousticwave (SAW) for chemical sensing applications of recognition layers (Open Access)

(2017) *Sensors (Switzerland)*, 17 (12), art. no. 2716. Cited 66 times.
http://www.mdpi.com/1424-8220/17/12/2716/pdf
doi: 10.3390/s17122716

View at Publisher

11 Choi, K.H., Kim, H.B., Ali, K., Sajid, M., Siddiqui, G.U., Chang, D.E., Kim, H.C., (...), Doh, Y.H.

Hybrid Surface Acoustic Wave- Electrohydrodynamic Atomization (SAW-EHDA) for the Development of Functional Thin Films (Open Access)

(2015) *Scientific Reports*, 5, art. no. 15178. Cited 24 times.
www.nature.com/srep/index.html
doi: 10.1038/srep15178

View at Publisher

12 Lukose, V., Nemade, H.B.

Finite element simulation of one-port surface acoustic wave resonator with thick interdigital transducer for gas sensing

(2019) *Microsystem Technologies*, 25 (2), pp. 441-446. Cited 3 times.
http://www.springerlink.com.ezlib.iium.edu.my/content/0946-7076
doi: 10.1007/s00542-018-4015-y

View at Publisher

13 Haresh, M., Pandya
(2010) *Design and Modelling of Surface Acoustic Wave (SAW) Devices and Sensors*, p. 8. Cited 2 times.
[13] Ph.D. Thesis, Bharathiar University, Coimbatore

14 Liu, X., Cheng, S., Liu, H., Hu, S., Zhang, D., Ning, H.

A survey on gas sensing technology (Open Access)

(2012) *Sensors (Switzerland)*, 12 (7), pp. 9635-9665. Cited 752 times.
http://www.mdpi.com/1424-8220/12/7/9635/pdf
doi: 10.3390/s120709635

View at Publisher

15 Zhao, Y.-G., Liu, M., Li, D.-M., Li, J.-J., Niu, J.-B.

FEM modeling of SAW organic vapor sensors

(2009) *Sensors and Actuators, A: Physical*, 154 (1), pp. 30-34. Cited 15 times.
doi: 10.1016/j.sna.2009.07.014

View at Publisher

16 Johnson, S, Shanmugananthan, T.
Design and analysis of SAW based MEMS gas sensor for the detection of volatile organic gases
(2014) *Carbon*, 119 (5), pp. 0-041316. Cited 11 times.
[16]

17 Sayago, I., Fernández, M.J., Fontecha, J.L., Horrillo, M.C., Vera, C., Obieta, I., Bustero, I.

New sensitive layers for surface acoustic wave gas sensors based on polymer and carbon nanotube composites

(2012) *Sensors and Actuators, B: Chemical*, 175, pp. 67-72. Cited 55 times.
doi: 10.1016/j.snb.2011.12.031

View at Publisher

Ralib, A.A.M.; Department of Electrical and Computer Engineering, Kulliyyah of Engineering, International Islamic University of Malaysia, Jalan Gombak, Kuala Lumpur, Malaysia;
email:alizaaini@iium.edu.my

Back to results | 1 of 1

Top of page