Document details

Proceedings of the 2018 7th International Conference on Computer and Communication Engineering, ICCCE 2018
16 November 2018, Article number 8539280, Pages 62-67
7th International Conference on Computer and Communication Engineering, ICCCE 2018; Kuala Lumpur; Malaysia; 19 September 2018 through 20 September 2018; Category numberCFP1839D-USB; Code 142740

Theoretical Modelling of Interdigitated Electrode Sensor for Mammalian Cell Characterization (Conference Paper)

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Abstract

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Interdigitated Electrodes (IDEs) have been widely used in biological cellular characterization such as the Electrical Cell -Substrate Impedance Sensing (ECIS). Optimization of IDEs are crucial to obtain high accuracy of measurement that associates with the biological cell activities. However, not much research studies the generation of electric field by the IDEs geometry especially in cellular application. In this work, theoretical modelling of IDEs was done by modelling the IDEs equivalent circuit consisting of 3 major components; double layer capacitance, C_{DL}, solution capacitance, C_{SOL} and solution resistance, R_{SOL}. Simulation using MATLAB and COMSOL Multiphysics was done to study the effect of geometrical parameters (width of electrodes (W), spacing between electrodes (S) and total number of electrodes (N)) on the cut-off frequency (F_{LOW}), solution resistance (R_{SOL}) and the average electric field magnitude based on the equivalent circuit model. The simulation results show three main findings; lowest F_{LOW} to be at the ratio of a =0.54 and textbfN le 16, lowest R_{SOL} at smaller a and higher N, and saturated electric field at textbfN ge 18. The results suggested that the optimal configuration of IDEs with a fixed length of electrode of 7000 mu mathrm m is to have the ratio of (S/W) as 0.54 and N as 18. © 2018 IEEE.

SciVal Topic Prominence

Topic: Electric Impedance | Biosensors | electric cell-substrate

Prominence percentile: 89.891

Author keywords

Cellbased biosensor | IDEs | Interdigitated electrodes | Optimization

Indexed keywords

Engineering controlled terms: Capacitance | Chemical sensors | Electric fields | Electrochemical electrodes | Geometry | Mammals | MATLAB | Optimization | Transport properties

Engineering uncontrolled terms: Cell -based biosensor | Cellular applications | Double-layer capacitance | Electric field magnitude | Equivalent circuit model | IDEs | Inter-digitated electrodes | Theoretical modelling

Engineering main heading: Equivalent circuits

Funding details

Funding sponsor	Funding number	Acronym
Kementerian Sains, Teknologi dan Inovasi	06-01-08-SF0376	MOSTI
Ministry of Education, Science and Technology		MEST

Funding text

ACKNOWLEDGMENT This work is supported by Malaysia Ministry of Science and Technology (MOSTI) under the grant of e-Science Research Grant (06-01-08-SF0376).

ISBN: 978-153866991-4
Source Type: Conference Proceeding
Original language: English
DOI: 10.1109/ICCCE.2018.8539280
Document Type: Conference Paper
Publisher: Institute of Electrical and Electronics Engineers Inc.

References (23)

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1 Xiao, C., Luong, J.H.T.

On-line monitoring of cell growth and cytotoxicity using electric cell-substrate impedance sensing (ECIS)

(2003) *Biotechnology Progress*, 19 (3), pp. 1000-1005. Cited 154 times.
doi: 10.1021/bp025733x

View at Publisher

2 Giaever, I., Keese, C.R.

Monitoring fibroblast behavior in tissue culture with an applied electric field (Open Access)

(1984) *Proceedings of the National Academy of Sciences of the United States of America*, 81 (12 I), pp. 3761-3764. Cited 419 times.
doi: 10.1073/pnas.81.12.3761

View at Publisher

3 Giaever, I., Keese, C.R.

Use of Electric Fields to Monitor the Dynamical Aspect of Cell Behavior in Tissue Culture

(1986) *IEEE Transactions on Biomedical Engineering*, BME-33 (2), pp. 242-247. Cited 200 times.
doi: 10.1109/TBME.1986.325896

View at Publisher

4 Giaever, I., Keese, C.R.

Micromotion of mammalian cells measured electrically (Open Access)

(1991) *Proceedings of the National Academy of Sciences of the United States of America*, 88 (17), pp. 7896-7900. Cited 581 times.
doi: 10.1073/pnas.88.17.7896

View at Publisher

5 Lo, C.-M., Keese, C.R., Giaever, I.

Cell-substrate contact: Another factor may influence transepithelial electrical resistance of cell layers cultured on permeable filters

(1999) *Experimental Cell Research*, 250 (2), pp. 576-580. Cited 69 times.
http://www.journals.elsevier.com/experimental-cell-research/
doi: 10.1006/excr.1999.4538

View at Publisher

6 Keese, C.R., Bhawe, K., Wegener, J., Giaever, I.
Real-time impedance assay to follow the invasive activities of metastatic cells in culture

(2002) *BioTechniques*, 33 (4), pp. 842-850. Cited 121 times.

View at Publisher

7 Lu, Y., Huang, Y., Li, S., Zhang, Q., Wu, J., Xiong, Z., Xiong, L., (...), Liu, Q.
Fat taste detection with odorant-binding proteins (OBPs) on screen-printed electrodes modified by reduced graphene oxide

(2017) *Sensors and Actuators, B: Chemical*, 252, pp. 973-982. Cited 6 times.
doi: 10.1016/j.snb.2017.06.100

View at Publisher

8 Martinez, J., Montalibet, A., McAdams, E., Faivre, M., Ferrigno, R.
Comparison of ito and irox-modified ITO interdigitated electrodes for electrical cell-substrate impedance sensing (ecis) applications
(2017) *Multidisciplinary Digital Publishing Institute Proceedings*, p. 532.

9 Mansor, A.F.M., Ibrahim, I., Zainuddin, A.A., Voiculescu, I., Nordin, A.N.
Modeling and development of screen-printed impedance biosensor for cytotoxicity studies of lung carcinoma cells

(2018) *Medical and Biological Engineering and Computing*, 56 (1), pp. 173-181.
http://link.springer.com/journal/11517
doi: 10.1007/s11517-017-1756-1

View at Publisher

10 Price, D.T., Rahman, A.R.A., Bhansali, S.
Design rule for optimization of microelectrodes used in electric cell-substrate impedance sensing (ECIS)

(2009) *Biosensors and Bioelectronics*, 24 (7), pp. 2071-2076. Cited 25 times.
doi: 10.1016/j.bios.2008.10.026

View at Publisher

11 Yang, G., Long, H., Tian, H., Luo, S., Huang, H.
Bioimpedance measurement: Modeling of coplanar electrodes and impedance characterization

(2008) *2nd International Conference on Bioinformatics and Biomedical Engineering, iCBBE 2008*, art. no. 4535520, pp. 1248-1251. Cited 2 times.
ISBN: 978-142441748-3
doi: 10.1109/ICBBE.2008.640

View at Publisher

12 Alexander Jr., F., Price, D.T., Bhansali, S.
Optimization of interdigitated electrode (IDE) arrays for impedance based evaluation of Hs 578T cancer cells (Open Access)

(2010) *Journal of Physics: Conference Series*, 224 (1), art. no. 012134. Cited 24 times.
http://www.iop.org/EJ/journal/conf
doi: 10.1088/1742-6596/224/1/012134

View at Publisher

13 Varshney, M., Li, Y.
Interdigitated array microelectrodes based impedance biosensors for detection of bacterial cells

(2009) *Biosensors and Bioelectronics*, 24 (10), pp. 2951-2960. Cited 228 times.
doi: 10.1016/j.bios.2008.10.001

View at Publisher

14 Narakathu, B.B., Atashbar, M.Z., Bejcek, B.E.
Improved detection limits of toxic biochemical species based on impedance measurements in electrochemical biosensors

(2010) *Biosensors and Bioelectronics*, 26 (2), pp. 923-928. Cited 35 times.
doi: 10.1016/j.bios.2010.06.051

View at Publisher

15 Ibrahim, M., Claudel, J., Kourtiche, D., Nadi, M.
Geometric parameters optimization of planar interdigitated electrodes for bioimpedance spectroscopy
(2013) *Journal of Electrical Bioimpedance*, 4, pp. 13-22. Cited 40 times.

16 Zhang, X., Li, F., Lee, K., Voiculescu, I.
Lab-on-chip stretchable impedance spectroscopy device for mammalian cells studies

(2017) *TRANSDUCERS 2017 - 19th International Conference on Solid-State Sensors, Actuators and Microsystems*, art. no. 7994359, pp. 1563-1566.
ISBN: 978-153862731-0
doi: 10.1109/TRANSDUCERS.2017.7994359

View at Publisher

17 Ngo, T.-T., Bourjilat, A., Claudel, J., Kourtiche, D., Nadi, M.
Design and realization of a planar interdigital microsensor for biological medium characterization

(2016) *Smart Sensors, Measurement and Instrumentation*, 16, pp. 23-54. Cited 7 times.
http://www.springer.com/series/10617
doi: 10.1007/978-3-319-21671-3_1

View at Publisher

18 Wang, H., Pilon, L.
Accurate simulations of electric double layer capacitance of ultramicroelectrodes

(2011) *Journal of Physical Chemistry C*, 115 (33), pp. 16711-16719. Cited 112 times.
doi: 10.1021/jp204498e

View at Publisher

19 Bard, A.J., Faulkner, L.R., Leddy, J., Zoski, C.G.
(1980) *Electrochemical Methods: Fundamentals and Applications*, 2. Cited 23312 times.
wiley New York

20 Olthuis, W., Streekstra, W., Bergveld, P.
Theoretical and experimental determination of cell constants of planar-interdigitated electrolyte conductivity sensors

(1995) *Sensors and Actuators: B. Chemical*, 24 (1-3), pp. 252-256. Cited 123 times.
doi: 10.1016/0925-4005(95)85053-8

View at Publisher

21 SCHWAN, H.P.

Electrical properties of tissue and cell suspensions.

(1957) *Advances in biological and medical physics*, 5, pp. 147-209. Cited 1020 times.

22 Kuang, W., Nelson, S.O.

Low-frequency dielectric properties of biological tissues: A review with some new insights

(1998) *Transactions of the American Society of Agricultural Engineers*, 41 (1), pp. 173-184. Cited 90 times.

23 Arnold, W.Michael, Fuhr, Guenter

Increasing the permittivity and conductivity of cellular electromanipulation media

(1994) *Conference Record - IAS Annual Meeting (IEEE Industry Applications Society)*, 2, pp. 1470-1476. Cited 5 times.

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