# Design and fabrication of different platinum microelectrodes morphologies for electrical impedance tomography in biomedical applications

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## Introduction

3D cells exhibit more physiological relevance to cancerous tumour *in vivo* and represent great potential in pharmaceutical drug testing

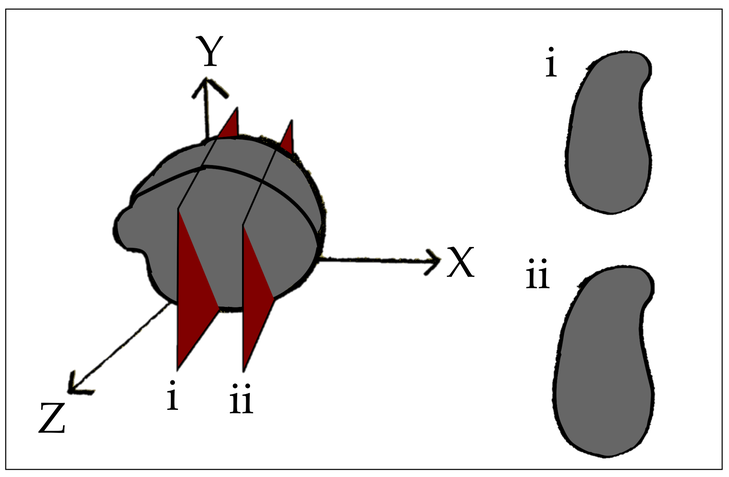


Fig. 1 Illustration of a 3D cell, slices of the cell for optical imaging and location of the slices

Conventional method: Optical microscope inspection

Fig. 2 Inverted microscope

Proposed method: Electrical impedance tomography (EIT) system that is fast, non-invasive and label free. It does not damage the cell spheroids

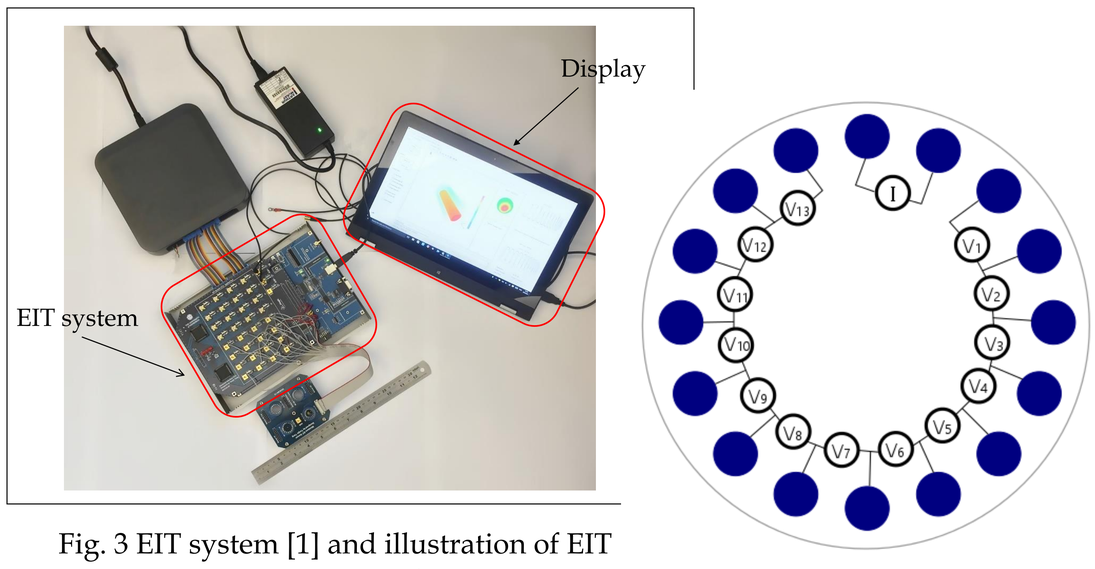


Fig. 3 EIT system [1] and illustration of EIT measurement

## Research methodology

Spheroids size requires the electrodes dimension to be scaled down. Platinum (Pt) microelectrodes are designed on a glass substrate with different morphologies. 250 µL fluid reservoir contains phosphate buffered saline (PBS) as the reference solution in the experiments as its salinity matches the salinity of human body.

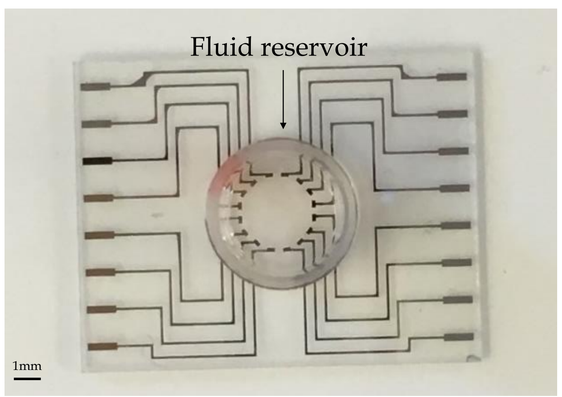


Fig. 5 Fabricated Pt microelectrodes


Cancer cells have lower electrical membrane potentials and electrical impedance than healthy cells [2] and [3].

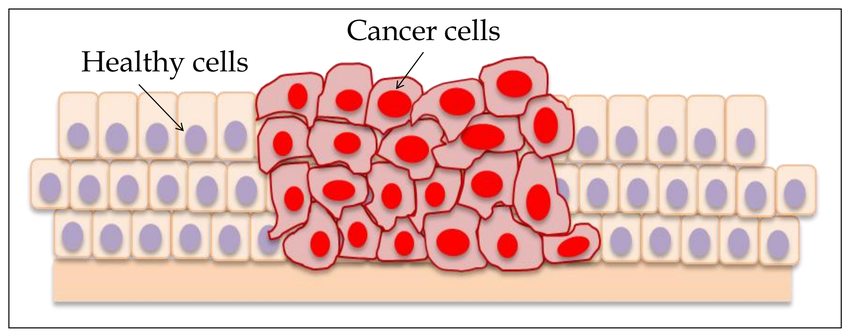


Fig. 6 Healthy cells versus cancer cells

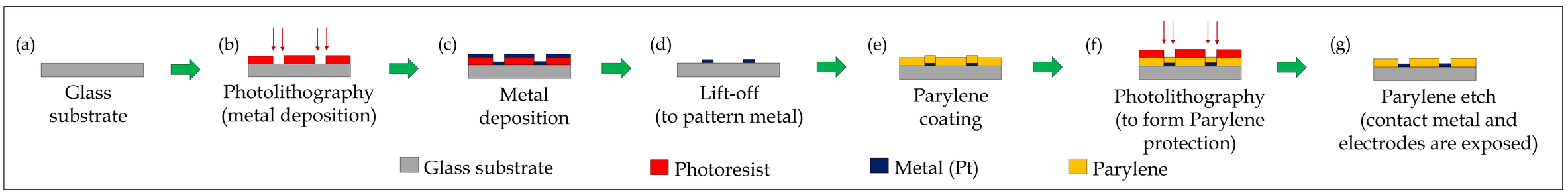


Fig. 7 Microfabrication process [4]

## Experiment results

**Test samples in the experiment:**
1) 0.8 mm (diameter) conductive material
2) 0.8 mm (diameter) less conductive material

**Resistivity colour scale**
High resistivity (less-conductive) — Low resistivity (conductive)

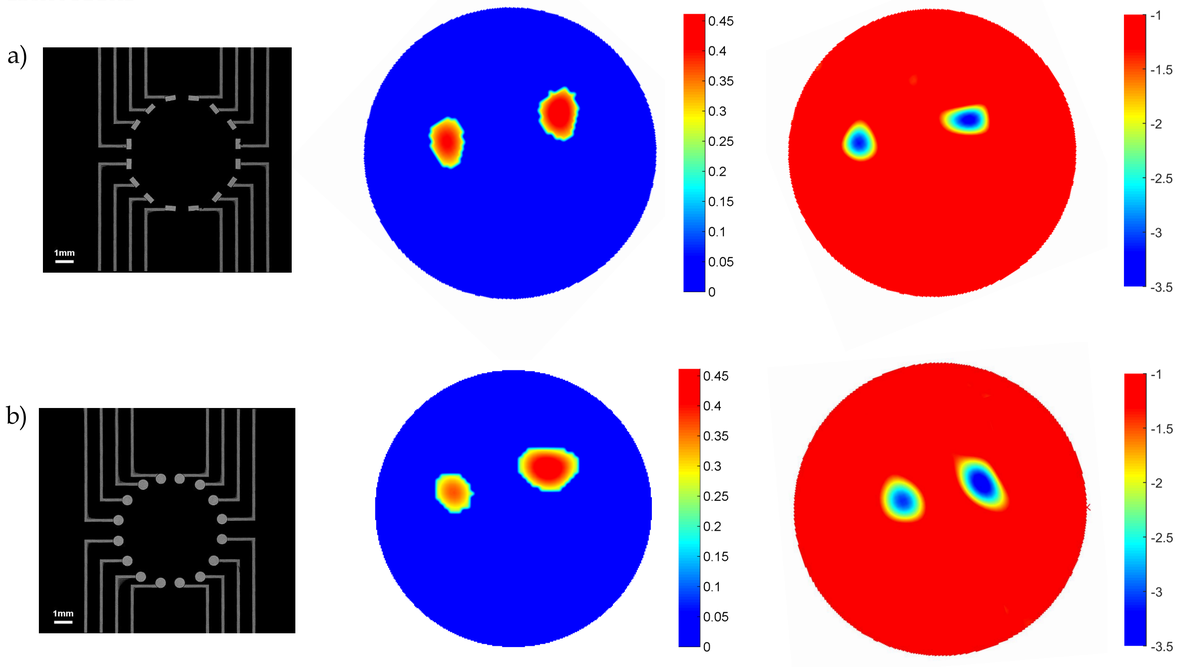


Fig. 8 (Left) Images under microscope a) 500 µm x 250 µm rectangular, b) 500 µm diameter circular, c) 350 µm diameter circular microelectrodes and d) 500 µm x 500 µm square. (Centre) Image reconstruction of two less conductive test samples and (Right) Image reconstruction of two conductive test samples respective to the microelectrodes morphologies

## Conclusion

Platinum (Pt) microelectrodes are able to differentiate the test samples conductivity with respect to the reference solution, PBS. Hence, platinum microelectrodes can effectively be used in biomedical applications for real-time drug effect monitoring on cancer spheroids

**Pt microelectrodes** + **EIT** = **Anti-cancer drug monitoring**

**Acknowledgements**

## References

[1] Yang, Y., Jia , J., Smith, S., Jamil, N., Gamal, W. & Bagnaninchi, P. O. (2017) A Miniature Electrical Impedance Tomography Sensor and 3-D Image Reconstruction for Cell Imaging. *IEEE Sensors Journal*. 17(2), 514-523.
[3] Blad, B. & Baldetorp, B. (1996) Impedance spectra of tumour tissue in comparison with normal tissue: A possible clinical application for electrical impedance tomography. *Physiological Measurement*. 17, 105-115.
[4] Stern, R. G., Milestone, B. N. & Gatenby, R. A. (1999 ) Carcinogenesis and the plasma membrane. *Medical Hypotheses*. 52(5), 367-372.
[4] Jamil, N., Smith, S., Yang, Y., Jia, J., Bagnaninchi, P. & González-Fernández, E. (2016) Design and fabrication of microelectrodes for electrical impedance tomography of cell spheroids. *IEEE EMBS Conference on Biomedical Engineering and Sciences (IECBES 2016). Kuala Lumpur, Malaysia.* pp426-431.