Characterisation of an electrical impedance tomography sensor for imaging cells in culture

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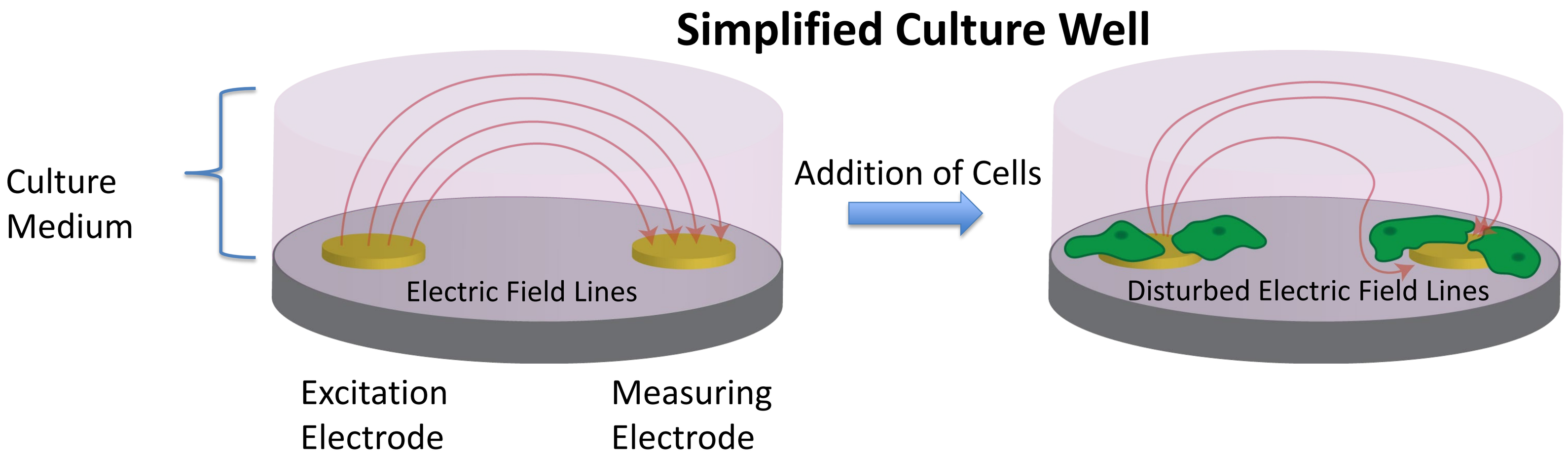
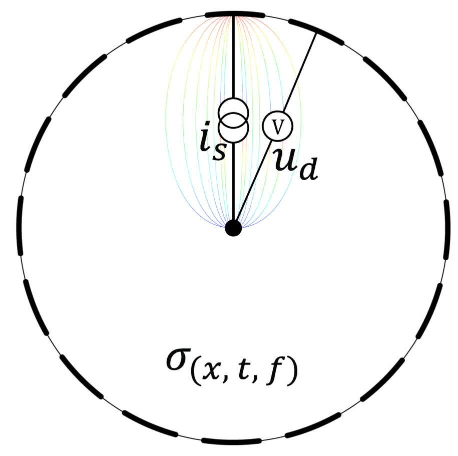
Introduction

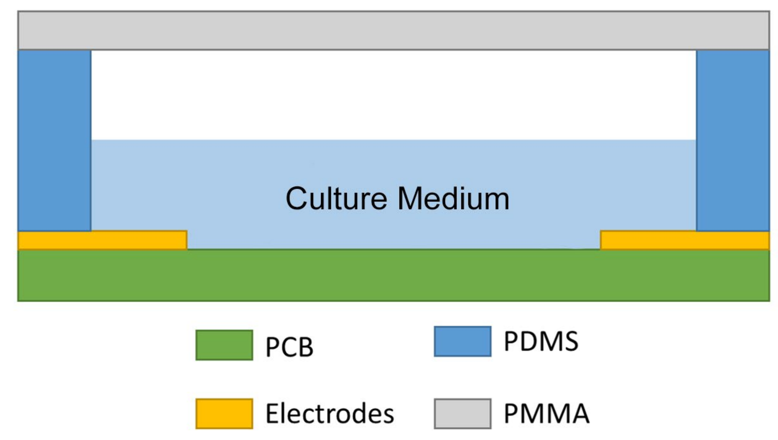
Electrical Impedance Tomography (EIT) is a non-invasive, non-ionizing and inexpensive imaging modality that is used to image the conductivity distribution inside the subject under test.

Simplified Culture Well



In (bio)medical and medical applications, the different **conductivity distributions** can show the structural and functional properties of the subject, this due to the inhomogeneous bioelectrical properties of tissue. Having this knowledge, a **sensor** is developed to monitor the **cell growth** in the **spatial domain**.



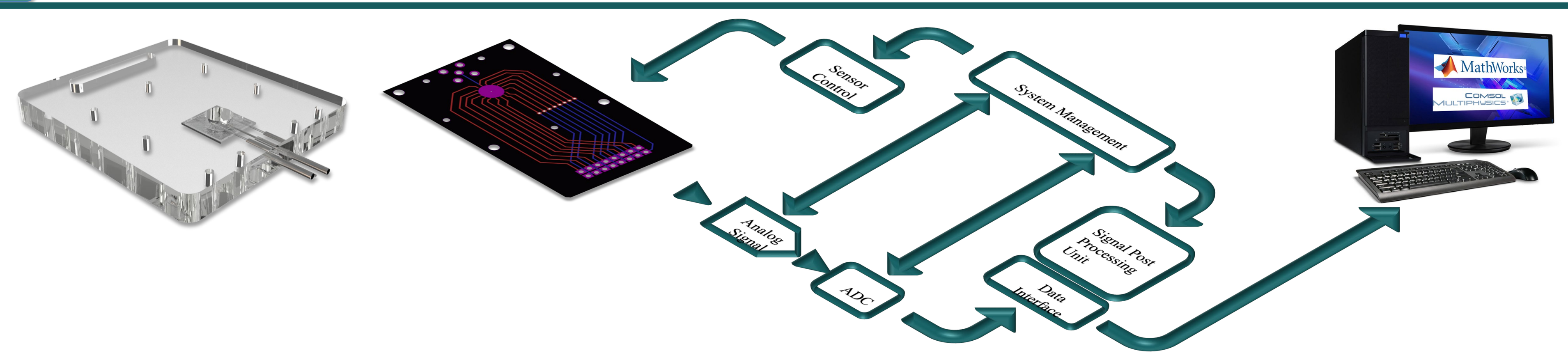


i_s ⇒ Constant AC

u_d ⇒ Measured potential

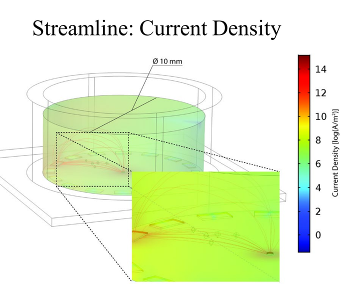
$\sigma_{(l,t,f)}$ ⇒ l Conductivity depending on spatial conditions
t Conductivity depending on time conditions
f Conductivity depending on frequency conditions

Materials & Methods



1 Flow Cell → 2 Retrieve the signal → 3 Converting analog signal to digital signal → 4 Computing The Conductivity Map

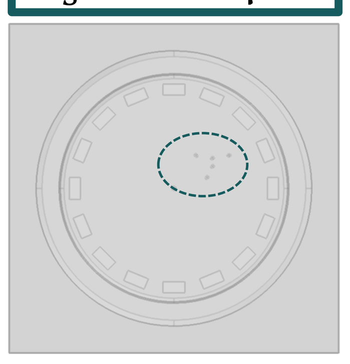
1	2	3	4
Constant flow	16 Electrode PCB	16 Parallel measurements	COMSOL Simulation
High throughput	10 mm Cell Well	Increased Framerate	Parameter Optimisation
Real-time Monitoring	Gold Plated	Compact Hardware	Reconstruction in MATLAB

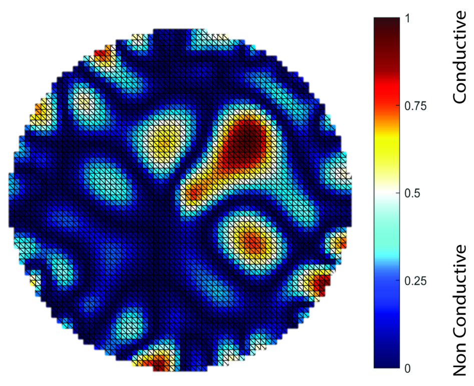


Results

$f = 250$ Hz
$i_s = 100$ μA

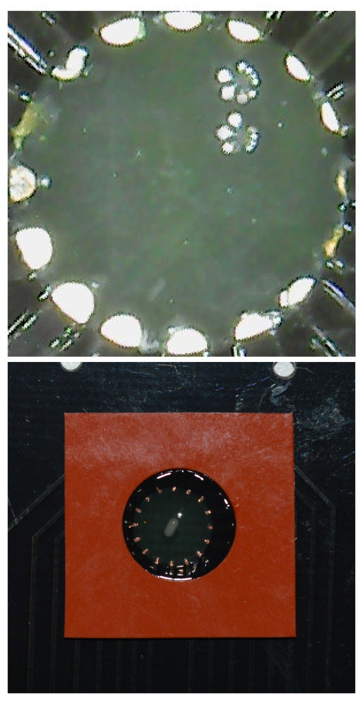
Simulation

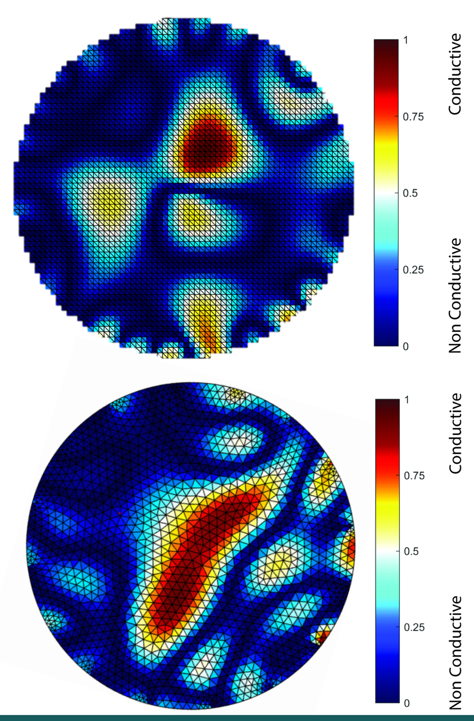




In both theoretical and experimental study the SiO_2 with a size of ±200 μm.

Experimental

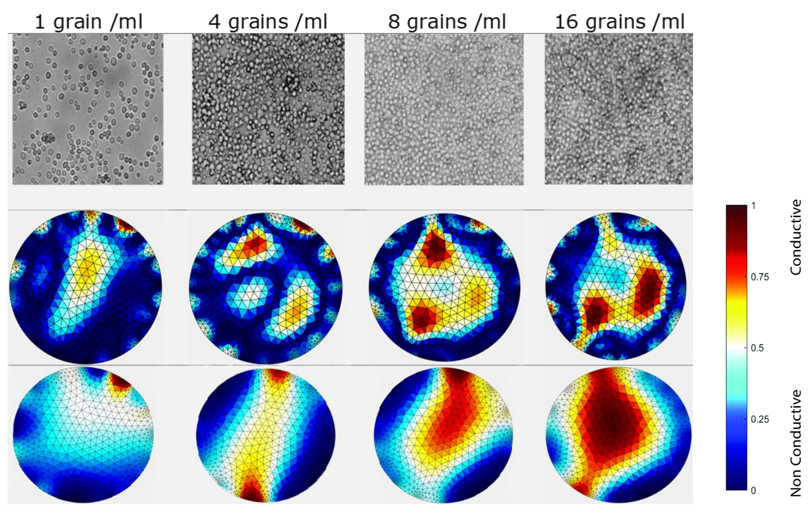




Cell colony is detectable when reconstructing the tomographical image.

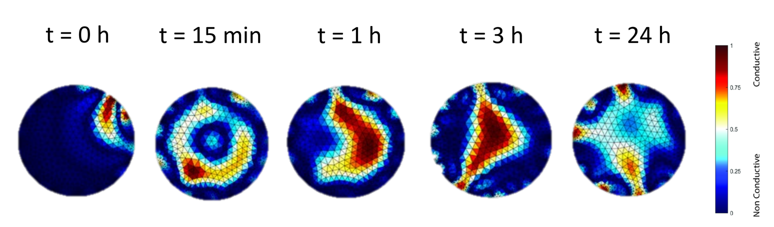
Size

Concentration



Tomography images of different concentration of yeast cells dissolved in 10% glucose **(First row)** Microscopy images of yeast cells. **(Second row)** Reconstructed EIT images of two different sensors (6 mm). Differential images, the higher the yeast concentration, the higher the conductivity distribution. **(Third row)** sensor with (2 mm) gives clear expected results. Data was taken @ 1 kHz.

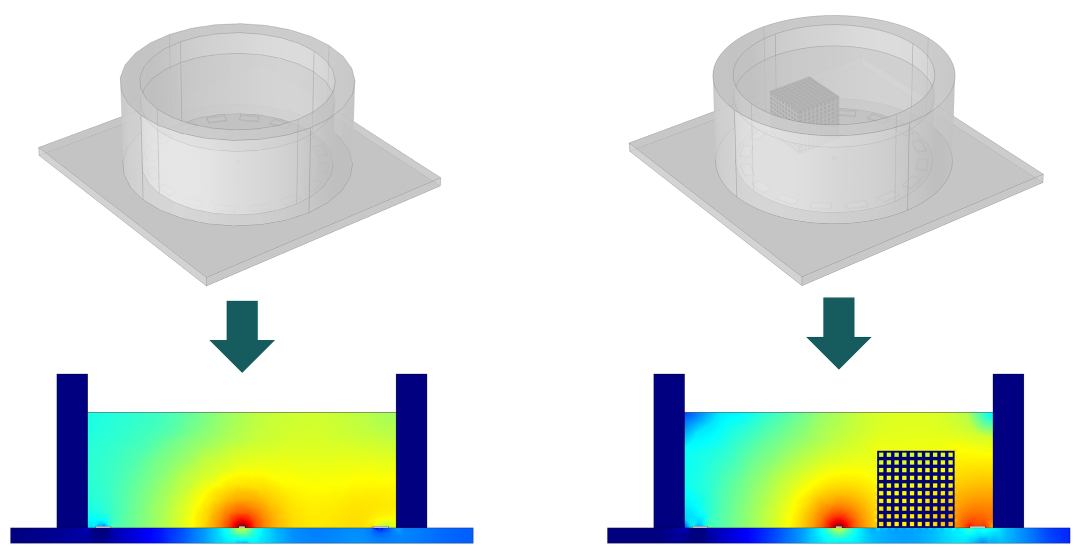
Time



Reconstructed tomography images of yeast cells in function of time. The yeast cell **proliferation** induce a **higher conductivity**, thus there is more red region obtained in the reconstructed images. Note that after 24 h the cells are death, and that more blue is noticed in the image. Data was taken @ 1 kHz. (sensor 6 mm)

Future Work

The preliminary results show the penetration of the current into the scaffold. The next step is to transfer this setup into an experimental setup and perform the previous mentioned reconstruction technique onto it. It will result into the possibility of conductivity imaging within the cavities of the scaffold.



Acknowledgements

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