Electrochemical Study of Potential Materials for CI Electrode Array

Smart Cochlear Implants. (Smac *it*)

N. S. Lawand, V. Lopez and P. J. French

Email: n.s.lawand@tudelft.nl, p.j.french@tudelft.nl

COMSOL CONFERENCE ROTTERDAM2013

Delft University of Technology

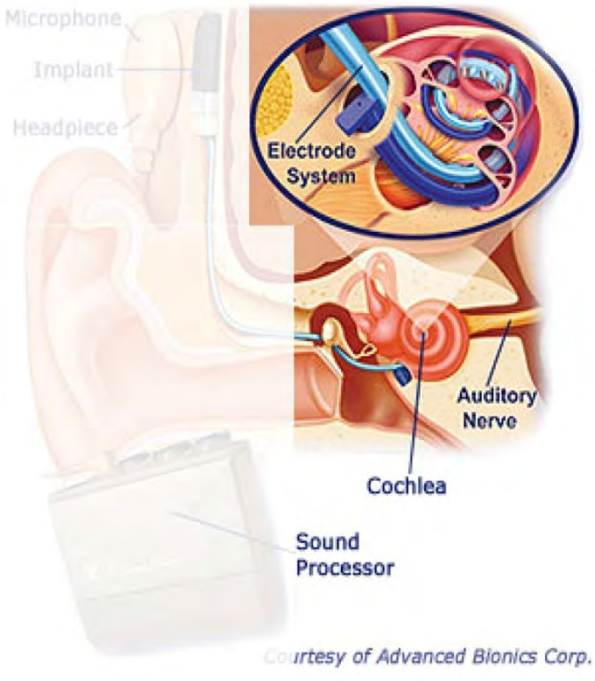
Challenge the future

Overview.

1. SMAC-it project.
2. Main highlights under microelectrode array development.
3. bi-phasic stimulator.
4. Electrochemical Study and experimental setup.
5. COMSOL study.

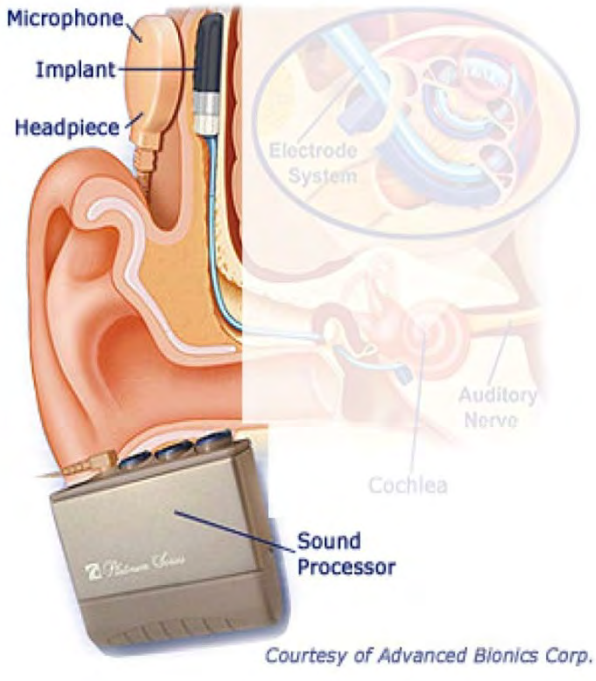
Framework of Smac *it* project.

Electrode design, fabrication & biological interface



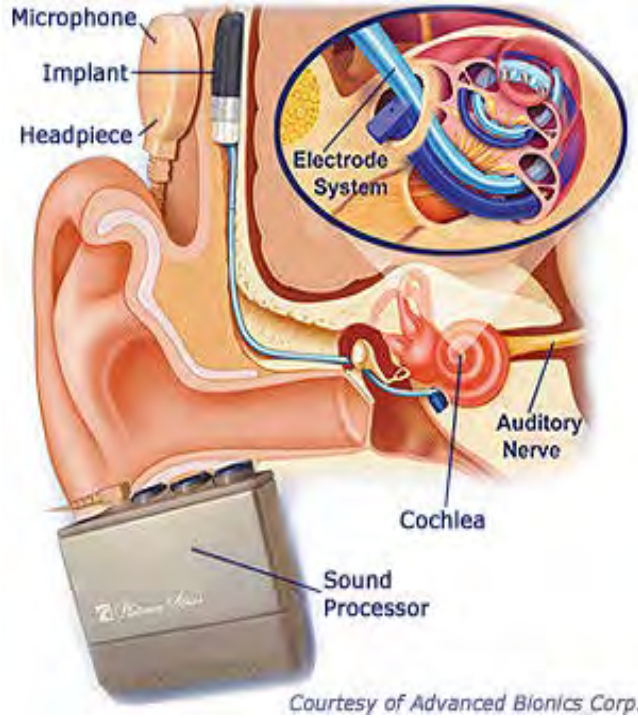
Nishant Lawand
Supervisors : Prof. Dr. P J. French
Prof. Dr. ir. J H M. Frijns
Dr. J. J. Briaire

Low power read out electronics & integration



Wannaya Ngamkham
Supervisor : Dr. ir. W A. Serdijn

Complete System level Optimizations



Ghazaleh Nazarian
Supervisor: Dr. G N. Gaydadjiev

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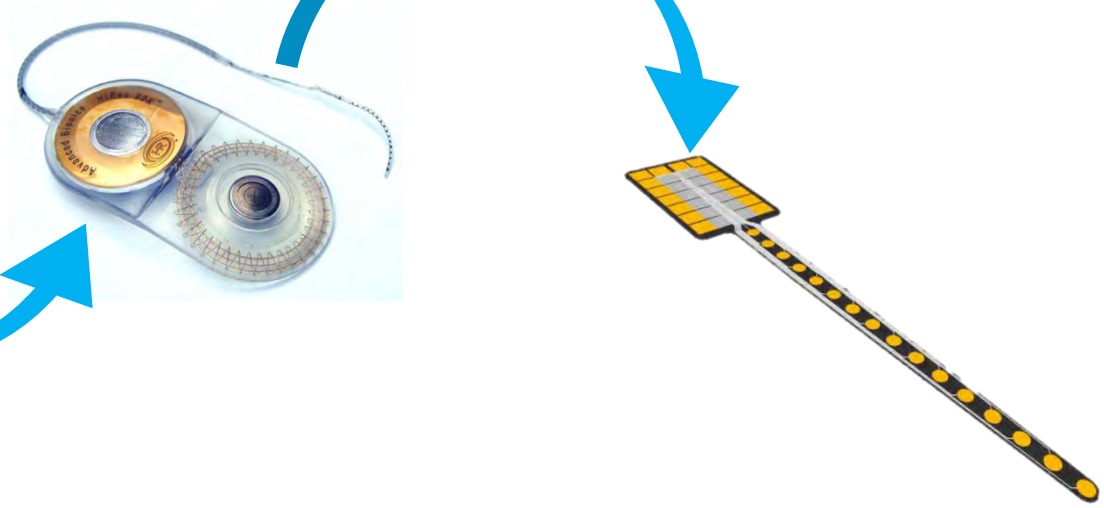
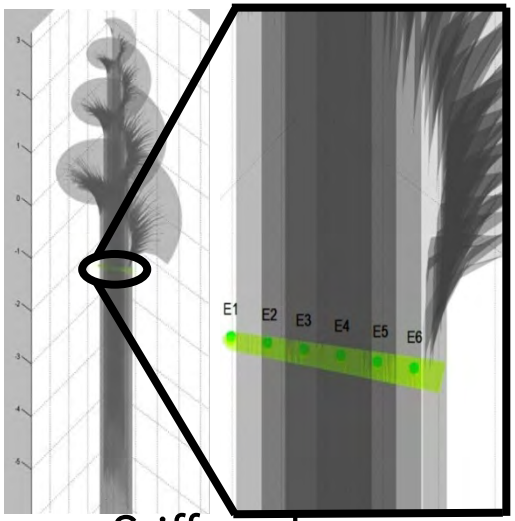
Electrode array Development.



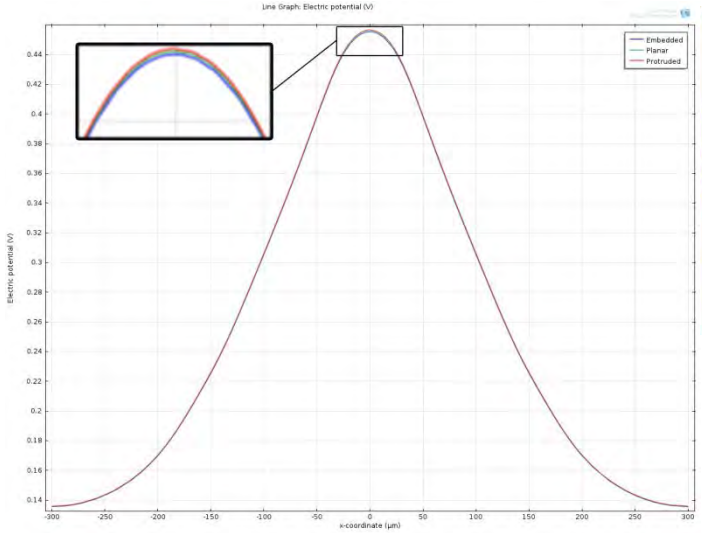
Nishant S. Lawand, P. J. French, J. H. M. Frijns and J. J. Briaire

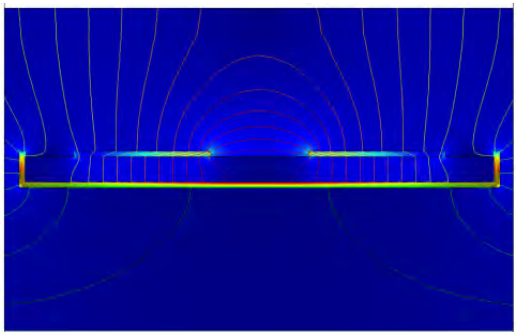
Electronic Instrumentation Laboratory (EI Lab), Department of ORL-HNS
Delft University of Technology
and Leiden University Medical Center

Main highlights under MEA work.

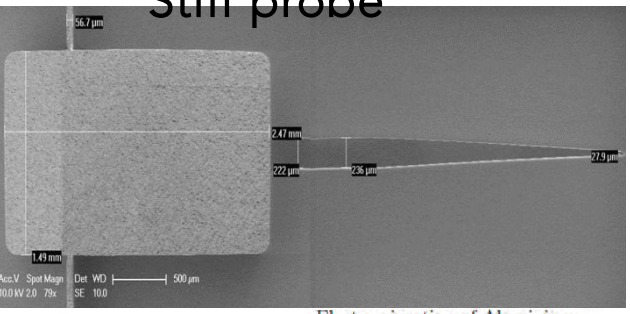


Stiff probe

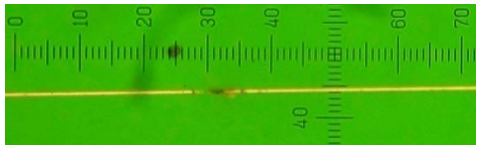


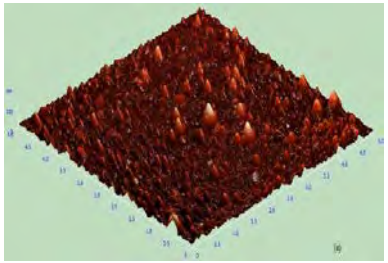


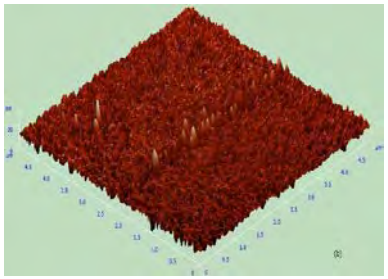
COMSOL simulations to study the current density distribution.

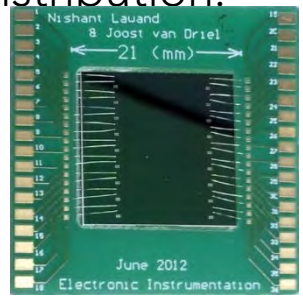


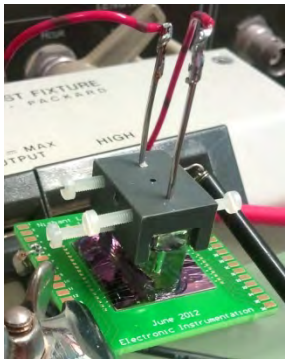
Titanium Nitride material investigation.



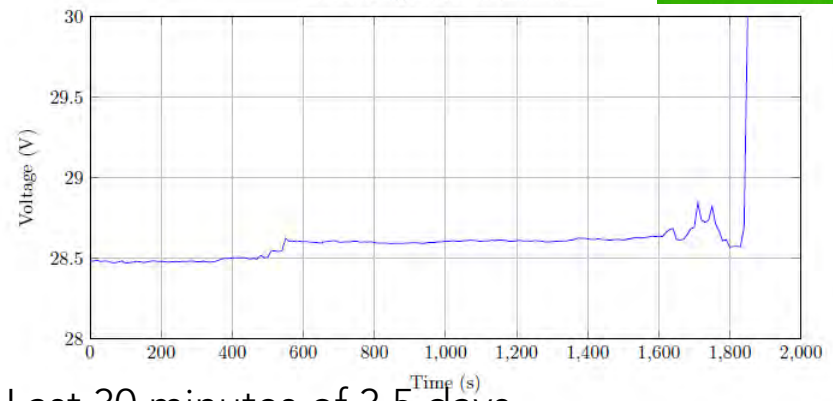








Electromigration of Aluminium

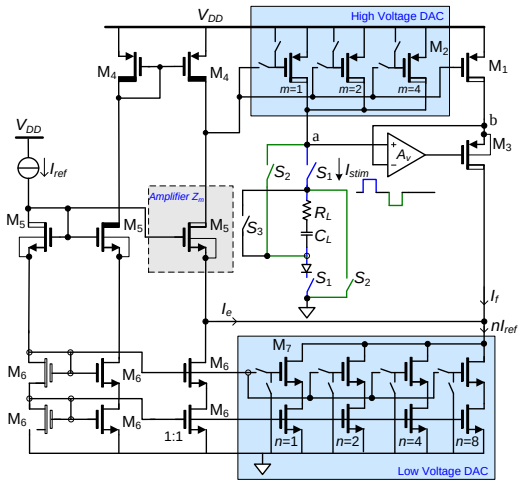


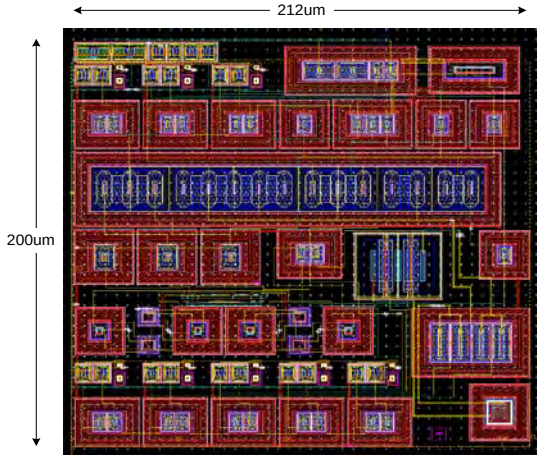
Sputtered TiN better than flat Pt surface.

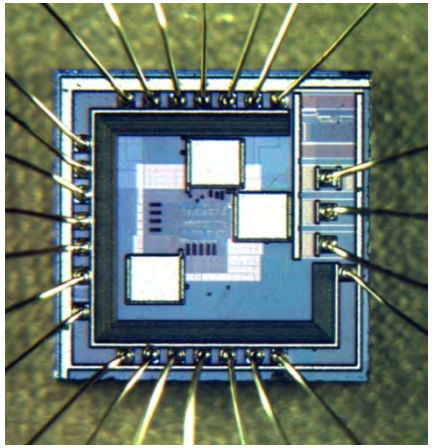
Last 30 minutes of 3,5 days

A programmable bi-phasic stimulator for cochlear implants

- 0.18μm AMS High-voltage process





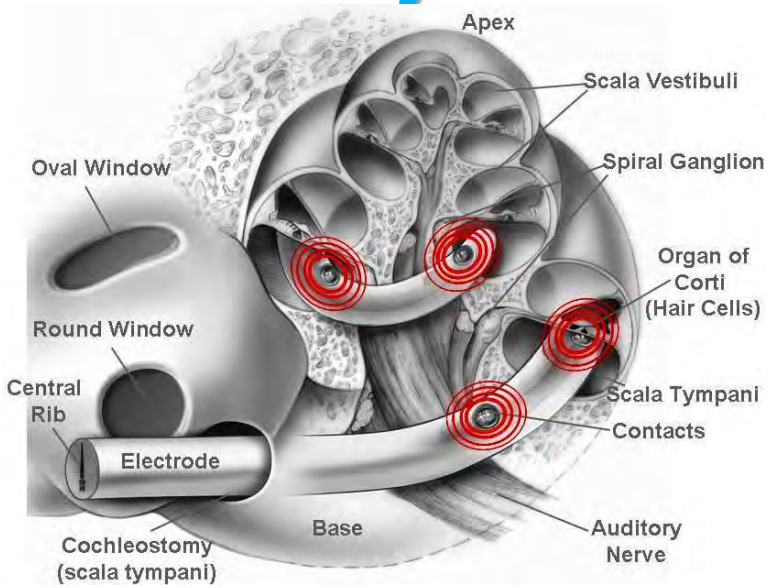


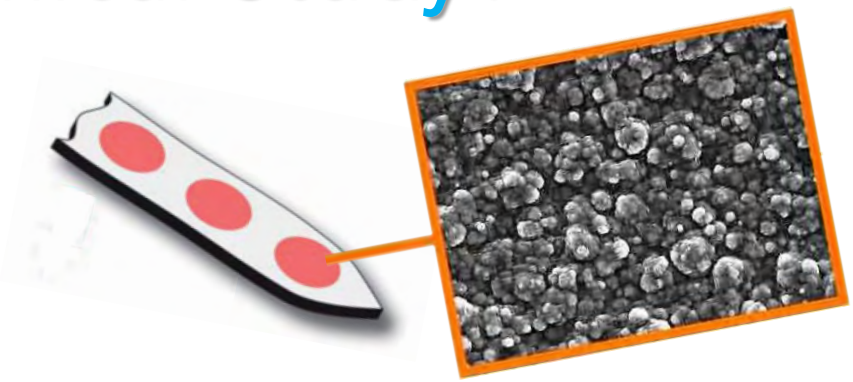
- 7 bit resolution with 10μA each step
- Current range : 10μA – 1.05mA
- Range of electrode- tissue impedances,
  R_L=1kΩ~10kΩ, C_L=1nF~10nF.

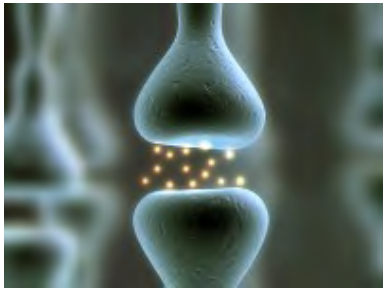
- Chip area: 0.04mm^2
- Stimulation current different : 0.6μA
- Residual voltage: < 19 mV

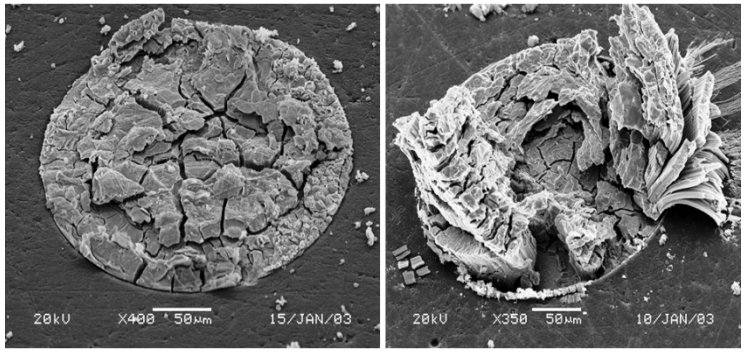
Courtesy: Wannaya Ngamkham (Member of the SMAC-it project).

Why Electrochemical Study?

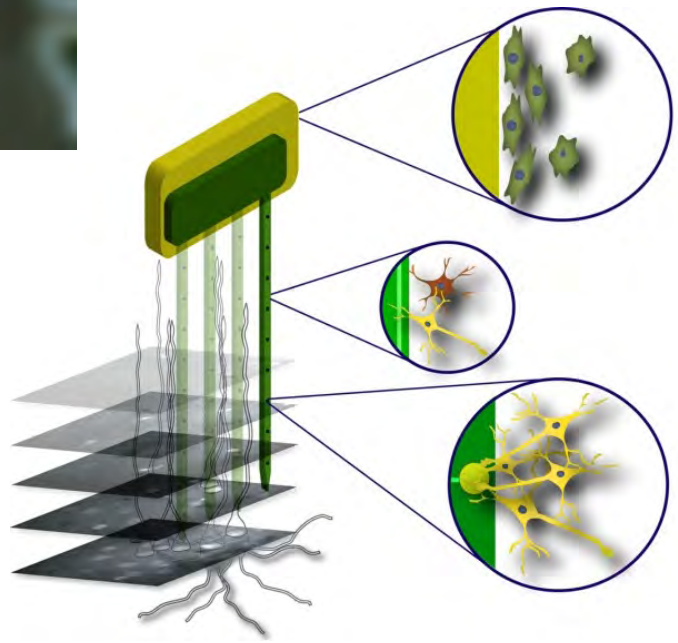






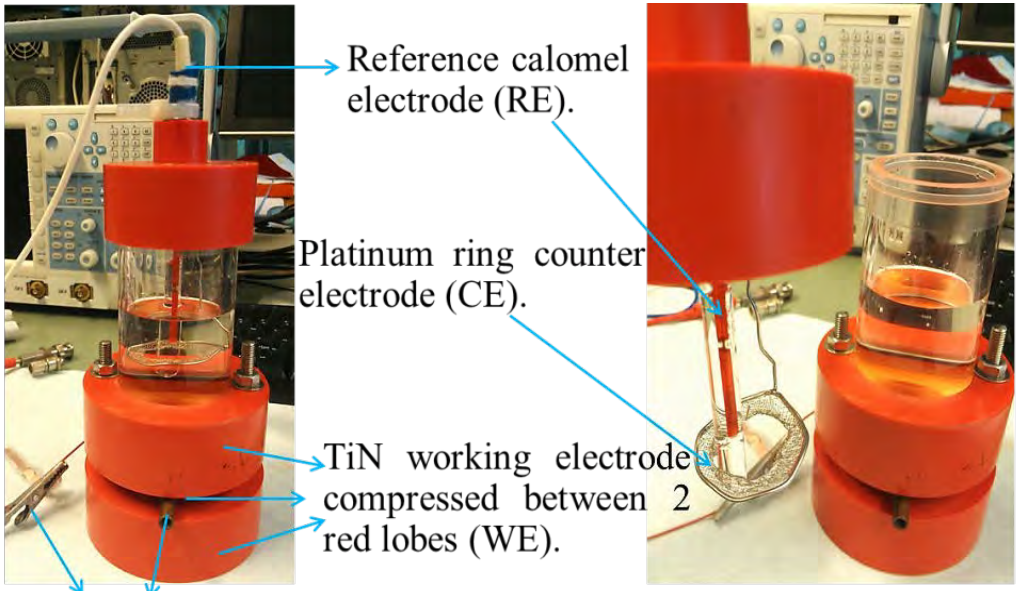


Platinum Oxide surface layer expansion and cracks [1]

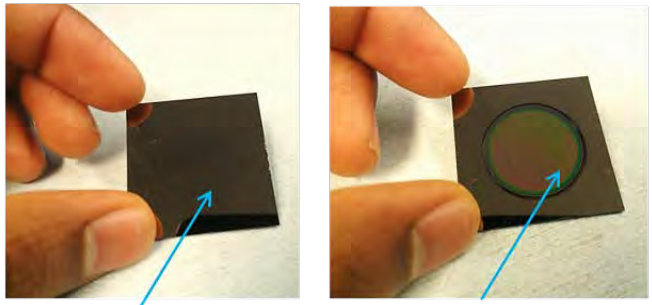


[1] D. Zhou, A. Chu, A. Agazaryan, Proceedings of the 207th Meeting of the Electrochemical Society, Canada, 2005, p. 275.

3 electrode electrochemical cell.



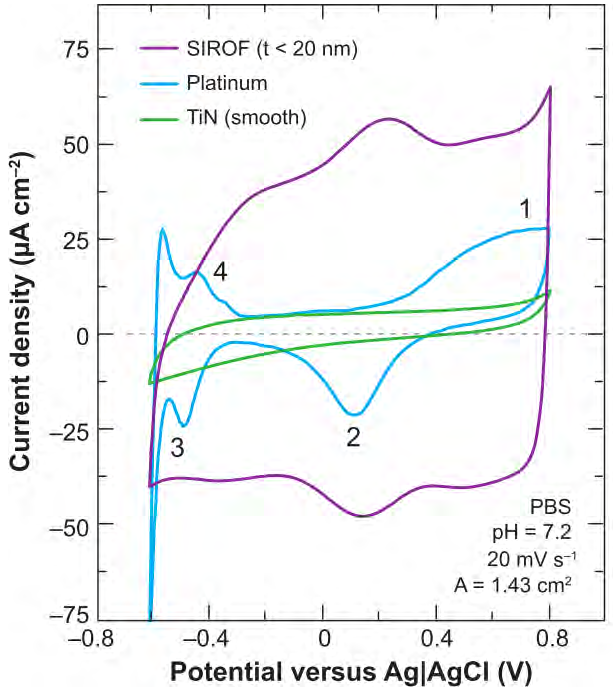
Electrochemical Cell images showing different parts.



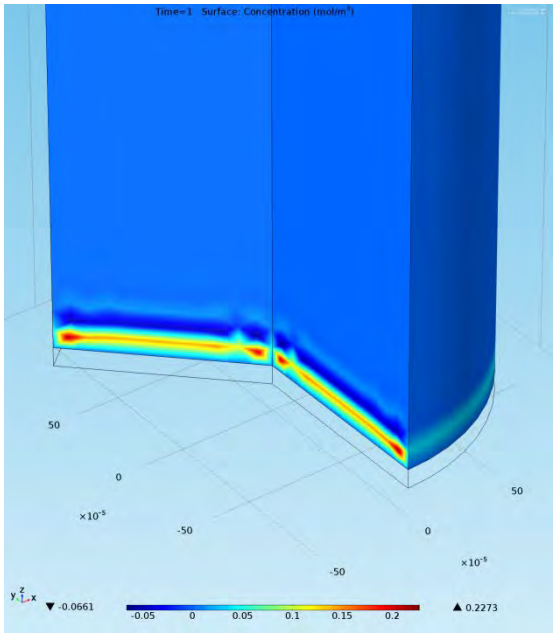
TiN+SiC+PI specimen tested for operating window potential.

Characterization tests:

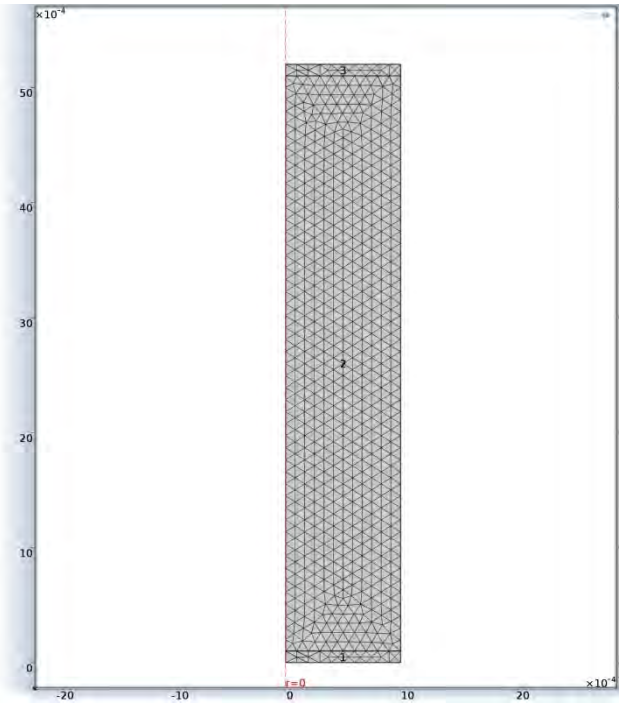
- Cyclic Voltammetry.
- Electrochemical Impedance spectroscopy (EIS).
- Current pulse test.
- Long term stability test.



Electrochemical study using COMSOL 4.3b.

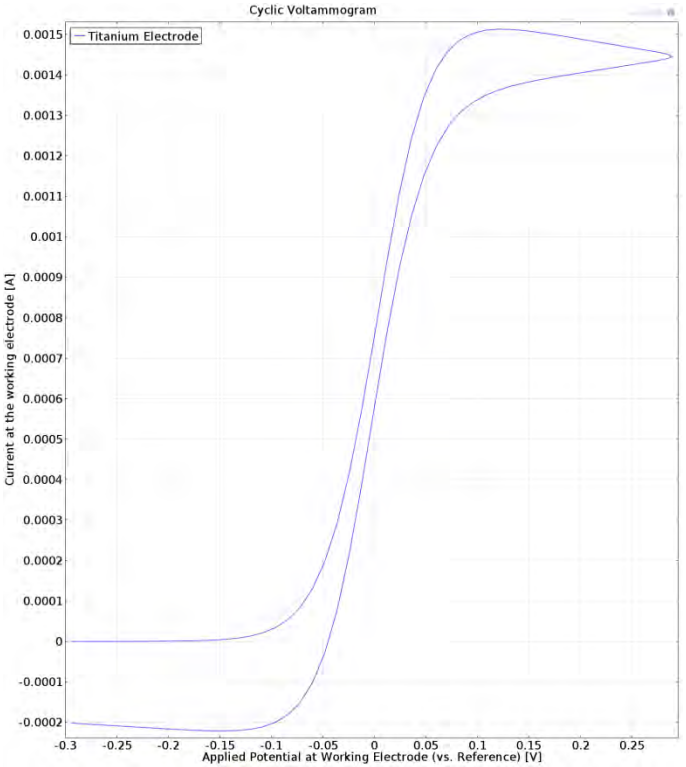


Electrode (Titanium)-Electrolyte interface.



Standard Meshing.

Cyclic Voltammogram.



2D Axis symmetric model.

Thank you.

A common platform to all the players involved in the *Smac it*