Electrochemical Study of Potential Materials for CI Electrode Array.

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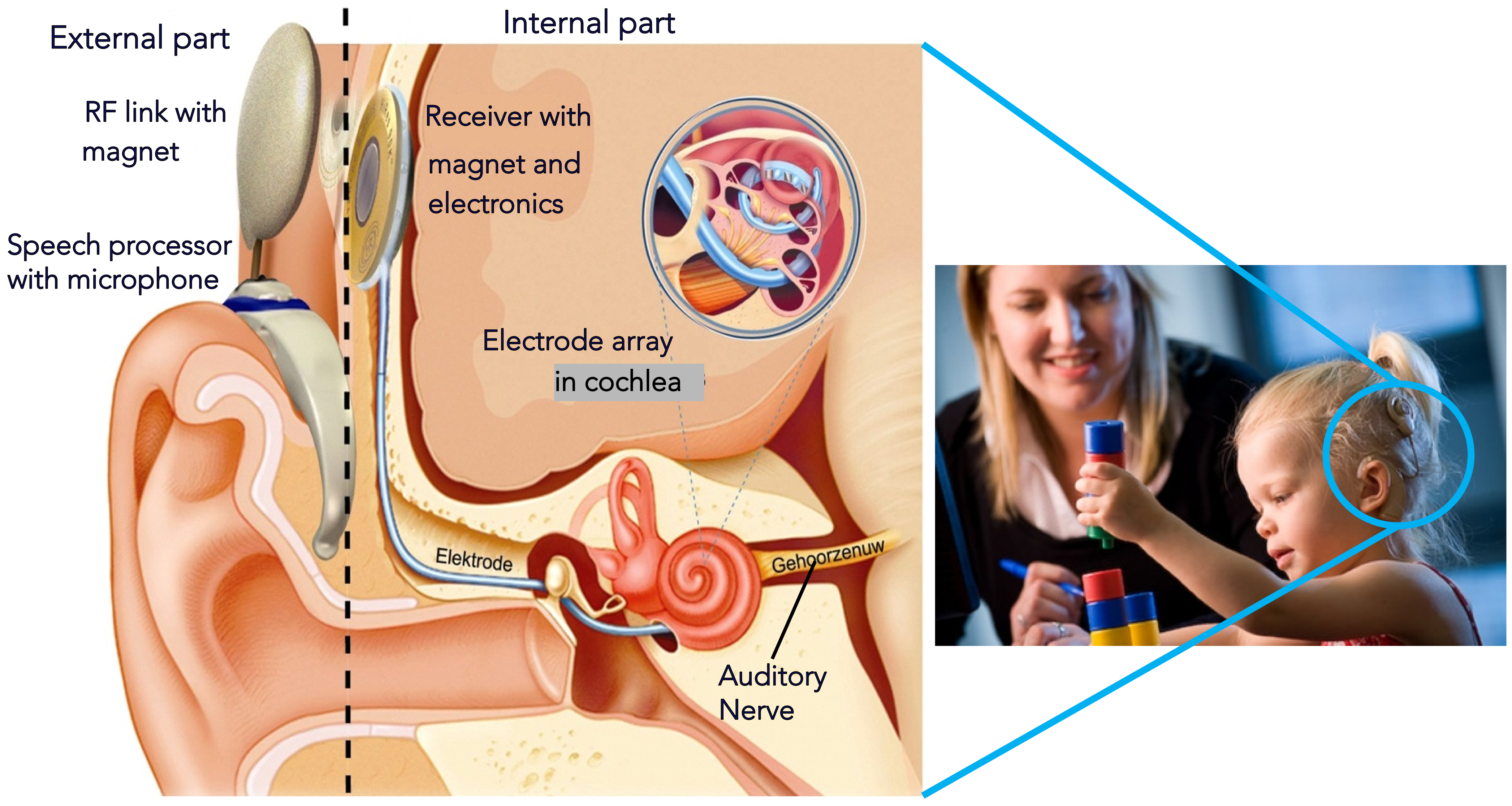

Figure 1: Sketch of a human ear with the implant.

Introduction:

Cochlear Implants (CIs) are accepted implantable prostheses that bypass the non-functional inner ear and directly stimulate the auditory nerve with electric currents, thus enabling deaf people to experience sound again.

Experimental setup:

The basic design of CI electrode array consists of an Silicon substrate with titanium nitride (TiN) stimulation sites [1]. In CI electrode array's metallic wires (Pt+Ir, Ti etc.) are connected to square metallic strips of 0.4mm × 0.5mm which acts as stimulation sites responsible for transferring electric charge to the auditory neurons. An ideal stimulation material must have low impedance with maximum charge transfer capacity in the electrochemical environment of cochlea. To characterize the stimulation materials for various parameters we have developed a characterization setup as shown in Fig. 2.

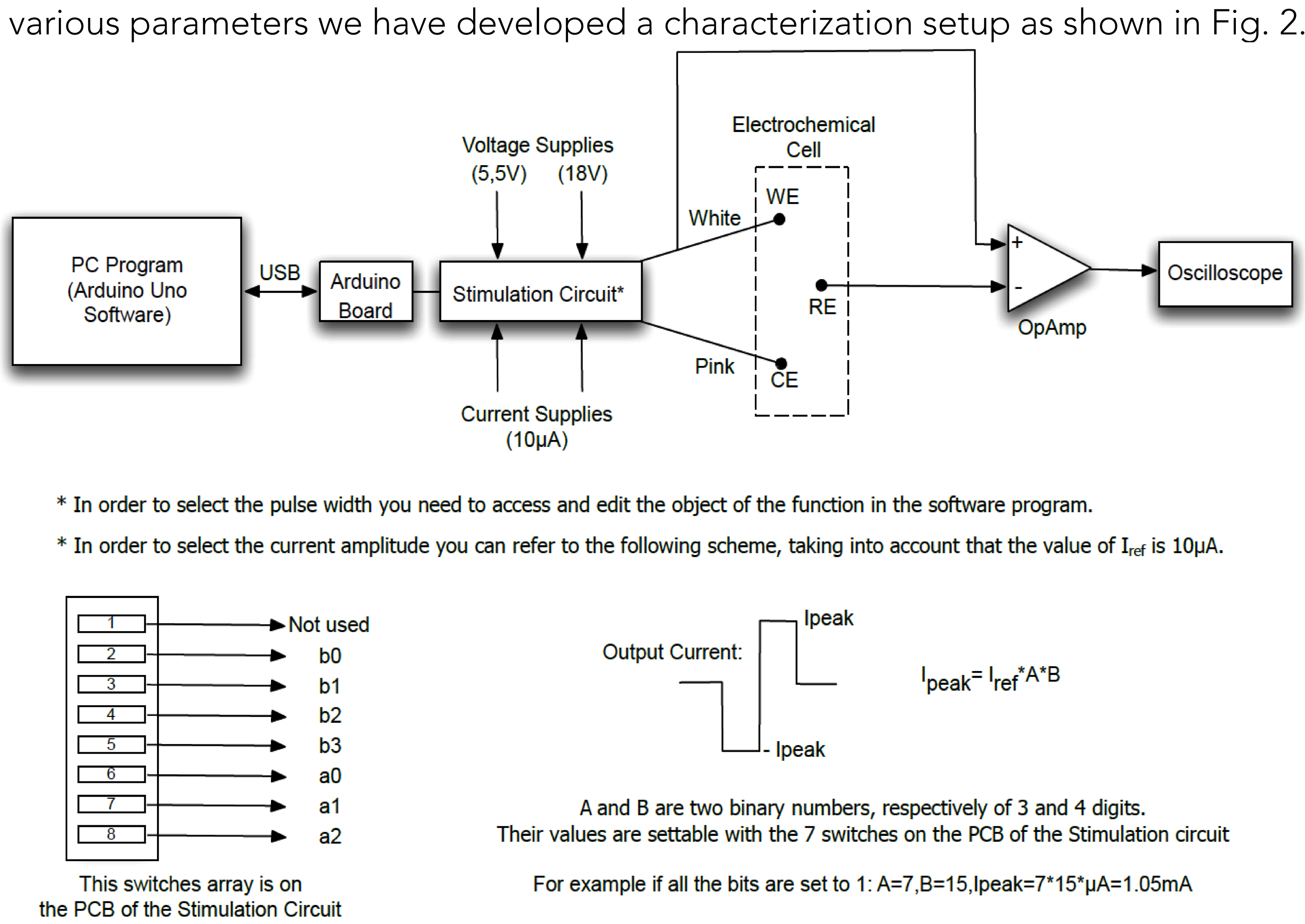

Figure 2: Schematic representation of the proposed electrochemical setup.

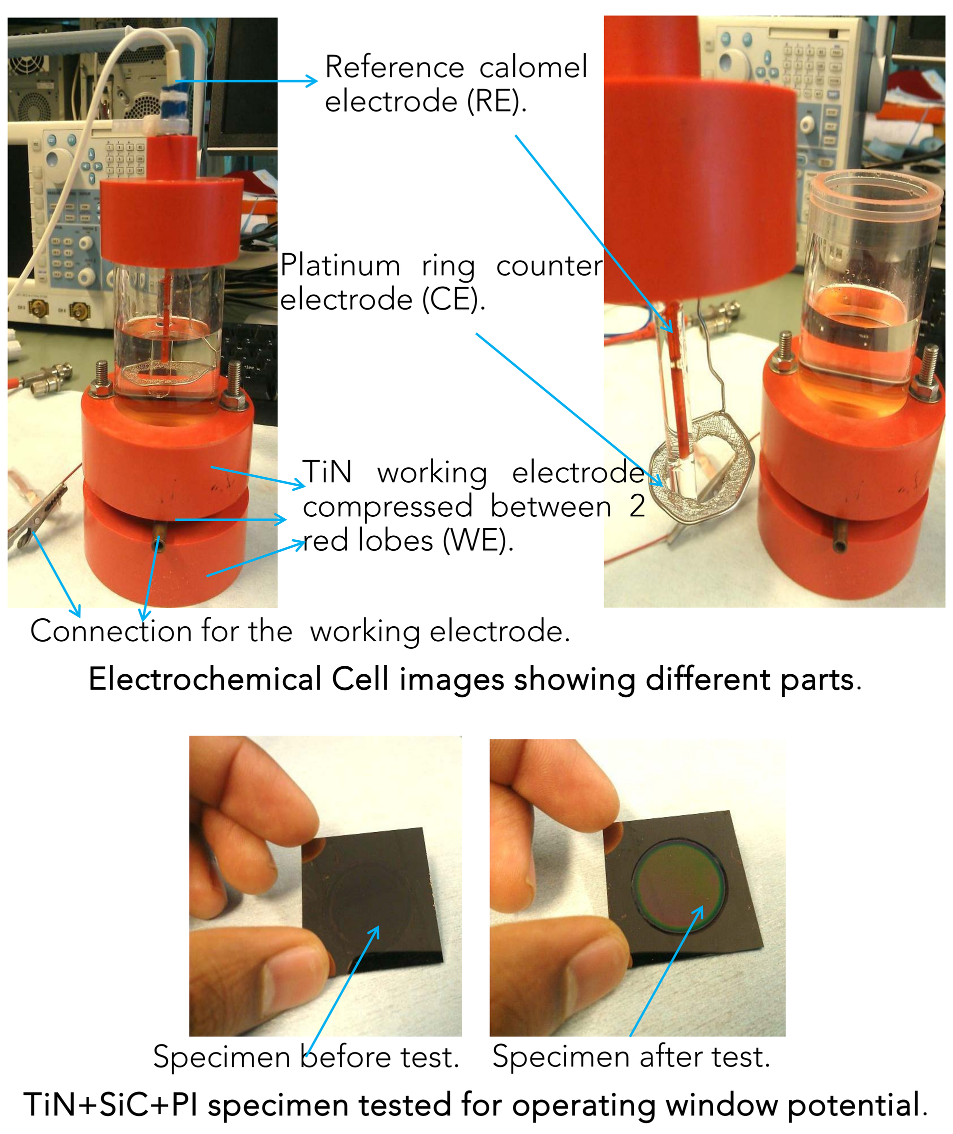

Figure 3: Three electrode electrochemical cell.

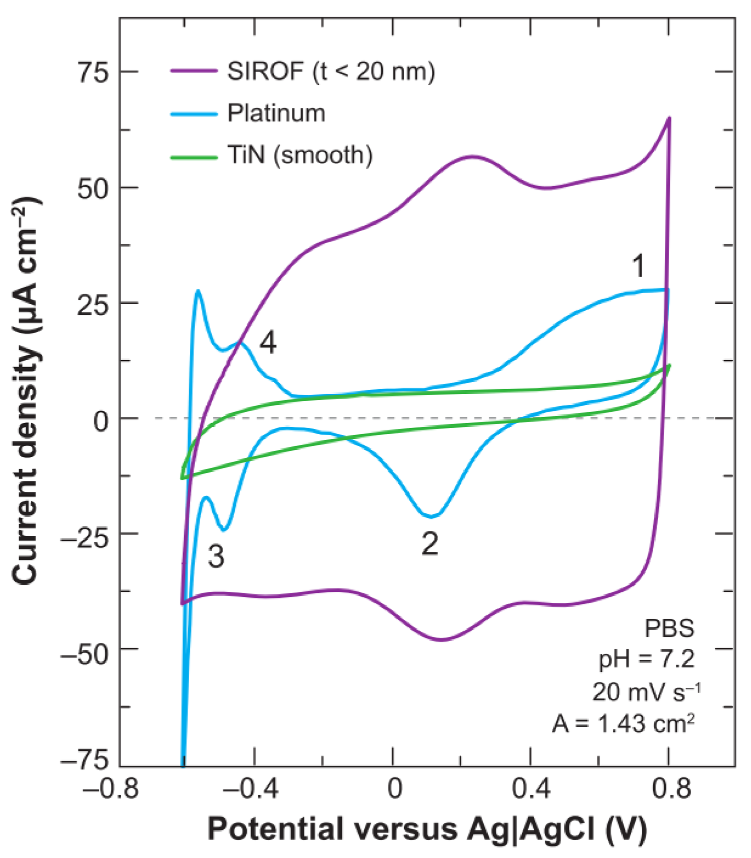

Figure 4: Cyclic Voltammogram [2].

Results:

The AC/DC & the electrochemistry module from Comsol 4.3b has been used with a parametric sweep to switch between the different configurations. A single-electron reaction is modelled at the electrolyte interface of a circular titanium electrode with a radius of 1mm. Standard reactions were assumed which take place at the interface in order to predict the charge transfer capacity for the preferable different geometries.

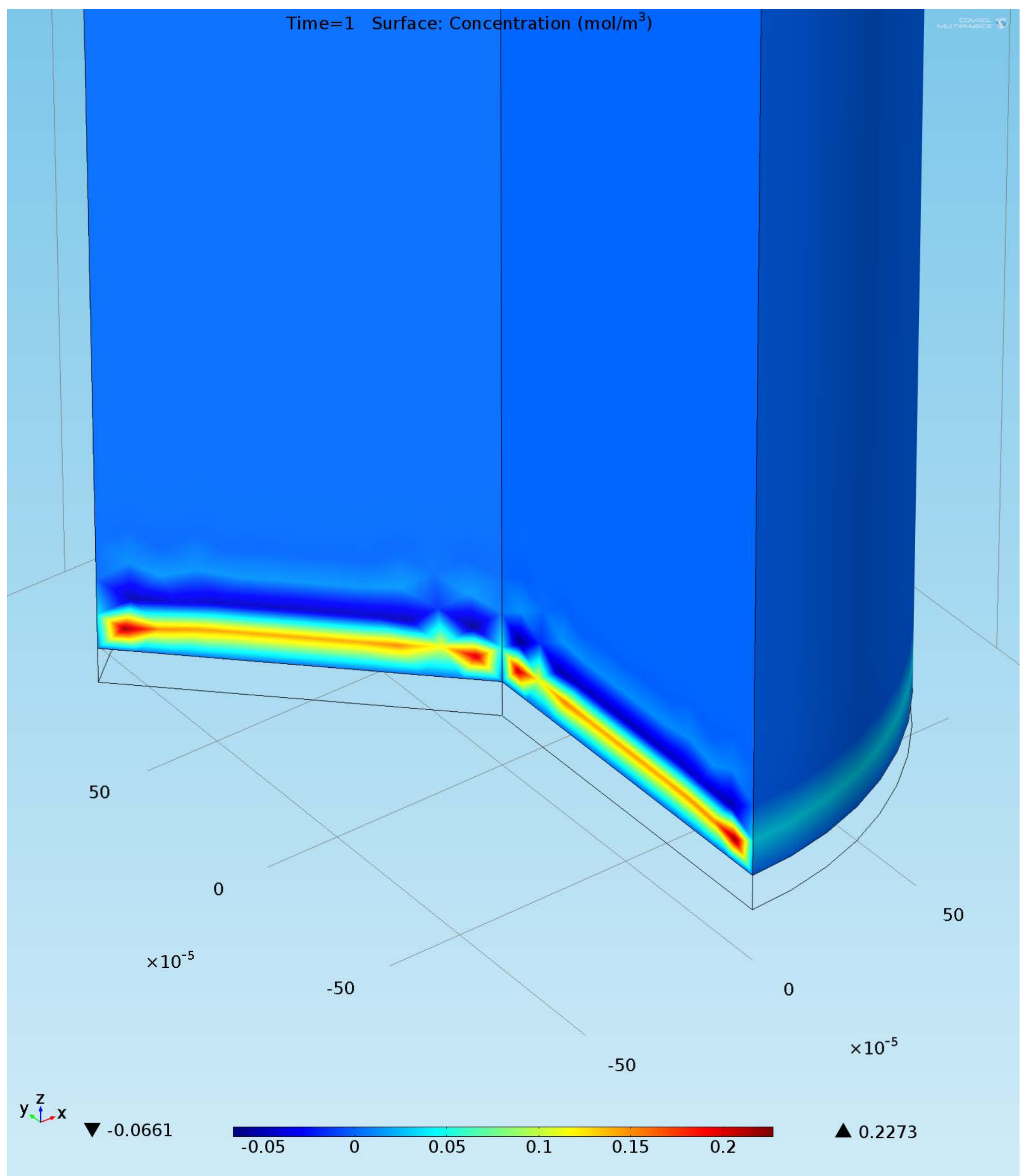

Figure 5: 2D axis symmetric representation of the electrode-electrolyte interface.

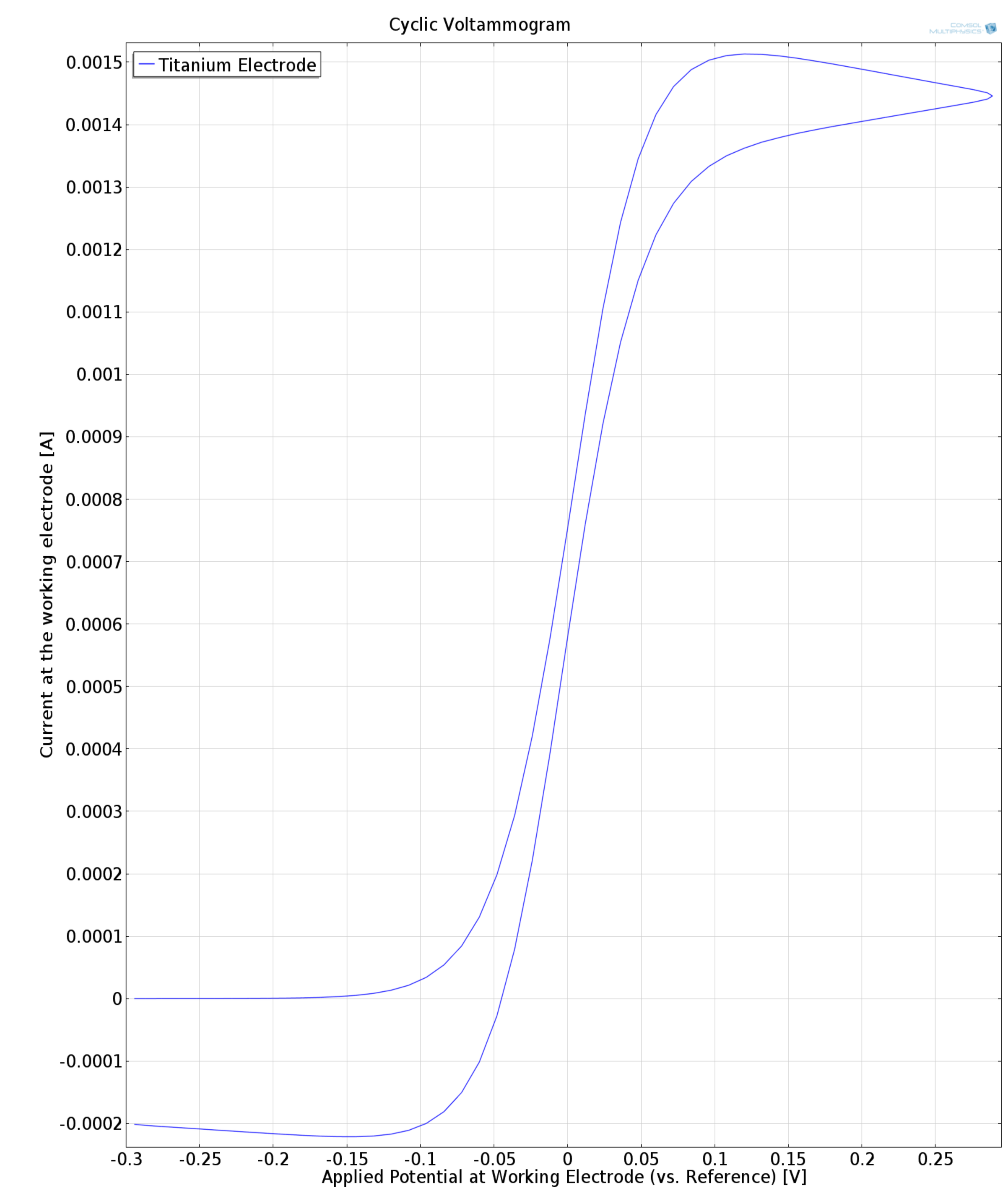

Figure 6: Cyclic voltammogram for the Titanium electrode material.

Conclusions:

COMSOL 4.3b electrochemistry module in combination with the AC/DC module shows the possibility of simulating and performing a study to understand the potential electrochemical limits of the probable stimulation materials prior to the actual electrochemical experiments.

References:

[1] N. S. Lawand, P. J. French, J. J. Briaire, J. H. M Frijns, "Silicon probes for cochlear auditory nerve stimulation and measurement," Advanced Materials Research, Vol. 254, pp. 82 – 85, (2011).

[2] S. F. Cogan, "Neural Stimulation and Recording Electrodes", Annual Review Biomedical Engineering Vol. 10, pp. 275-309, (2008).

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