BVT Technologies, a.s.

Specialized in:

- design and manufacturing of miniaturised TFT electrochemical sensor and biosensor substrates
- further products and accessories integrating the sensor response to user-communicable results, data acquisition systems, miniaturised pumps, microflow system, special connectors, adapters etc.

Characteristic of the company

- Established in 2000
- SME, up to 10 employees + external workers
- Equipped to produce screen printed electrochemical sensors and biosensors and accessories
- Staff with more than 20 years expertise in R&D of electrochemical sensors and biosensors
- Close co-operation with R&D centres (universities and research institutions on international basis)

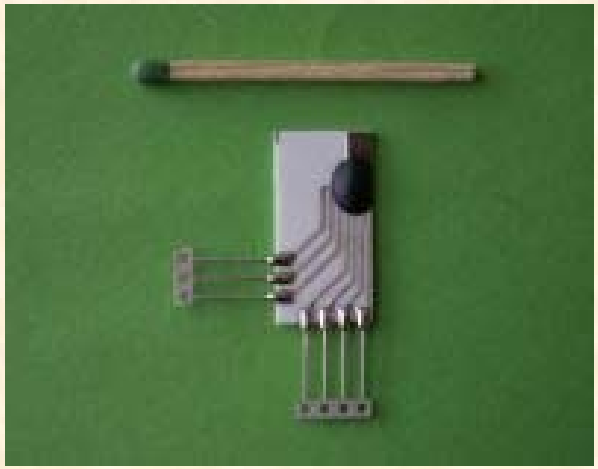
Principle products

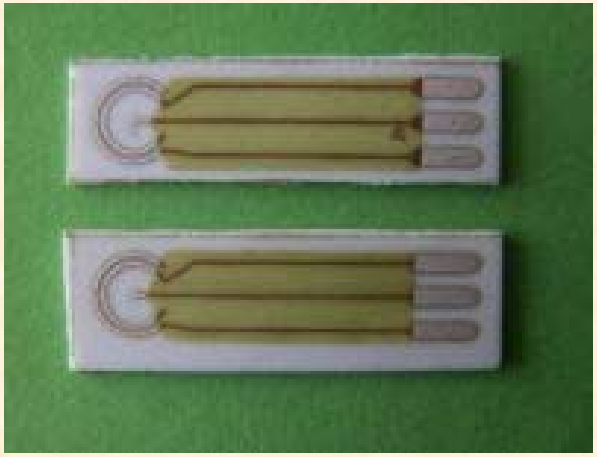
- Sensor substrates: amperometric
  conductometric
- Microflow system: to remove conventional problems rising within the standard electrochemical measurement setup
- Biosensor analyzer: to record directly the sensor measurements and download the information for analysis on PC
- Peristaltic pump: micro-flow pump with changable flow-rate parameters controlled via PC
- Manual screen printer: for in-house small scale production of a wide variety of sensors.

Historie

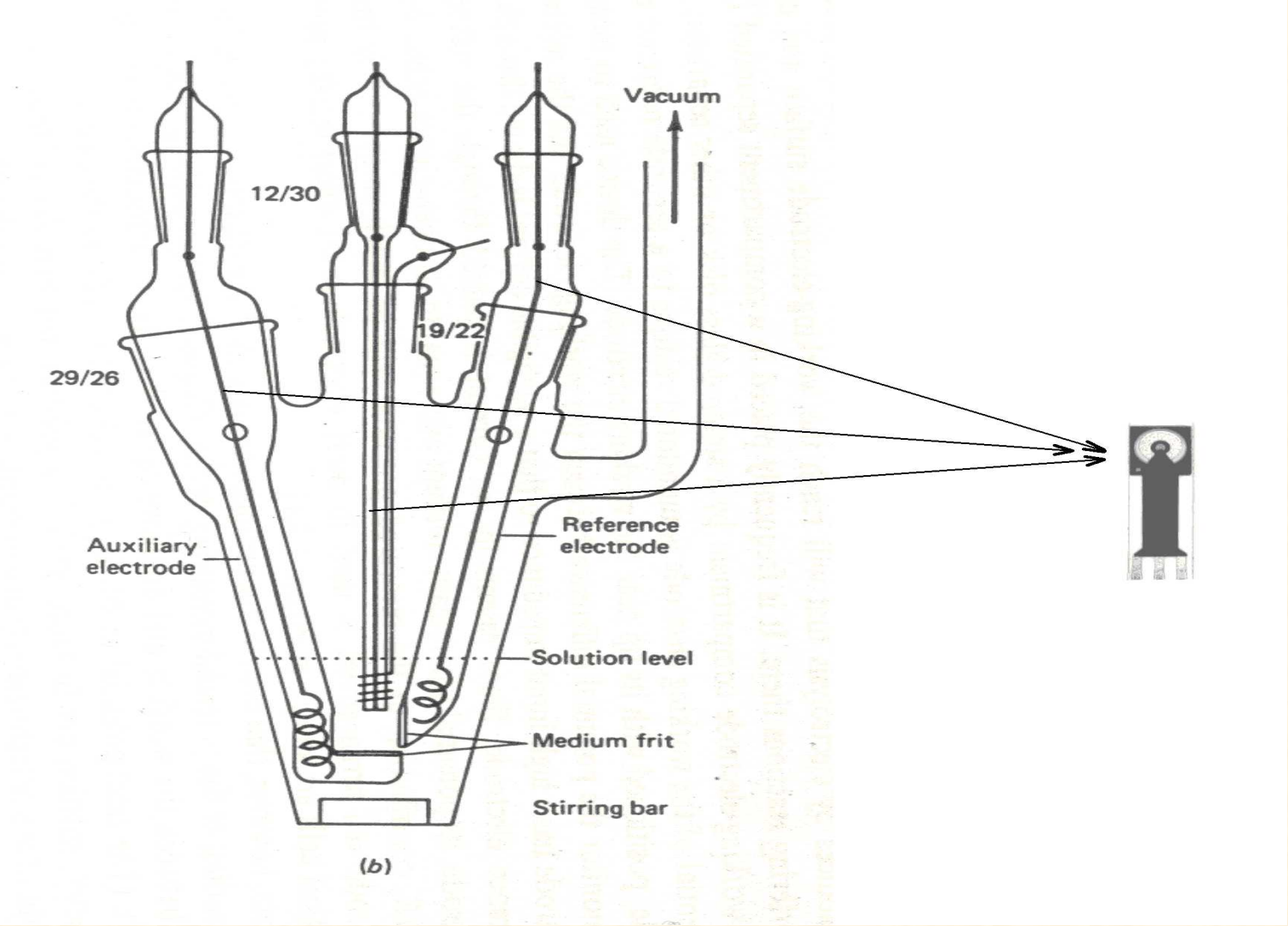
- Výzkumný ústav zdravotnické techniky
- Laboratorní přístroje Praha (Dr. Vozka, Dr. Litomisky)
- Masarykova universita v Brně (UJEP) (Prof. Macholán, Doc. Skládal)
- Excellent Lanškroun (Ing. Burša)
- Endokrinologický ústav v Lubochni (Dr.A. Pírek, Dr. A.Kreze)
- MyLab Prešov (Ing.Chudik,..)
- VUEK –(Ing. Kurtev)
- Mesit – (Dr. Šuranský, Ing. Řezniček)

Příklady

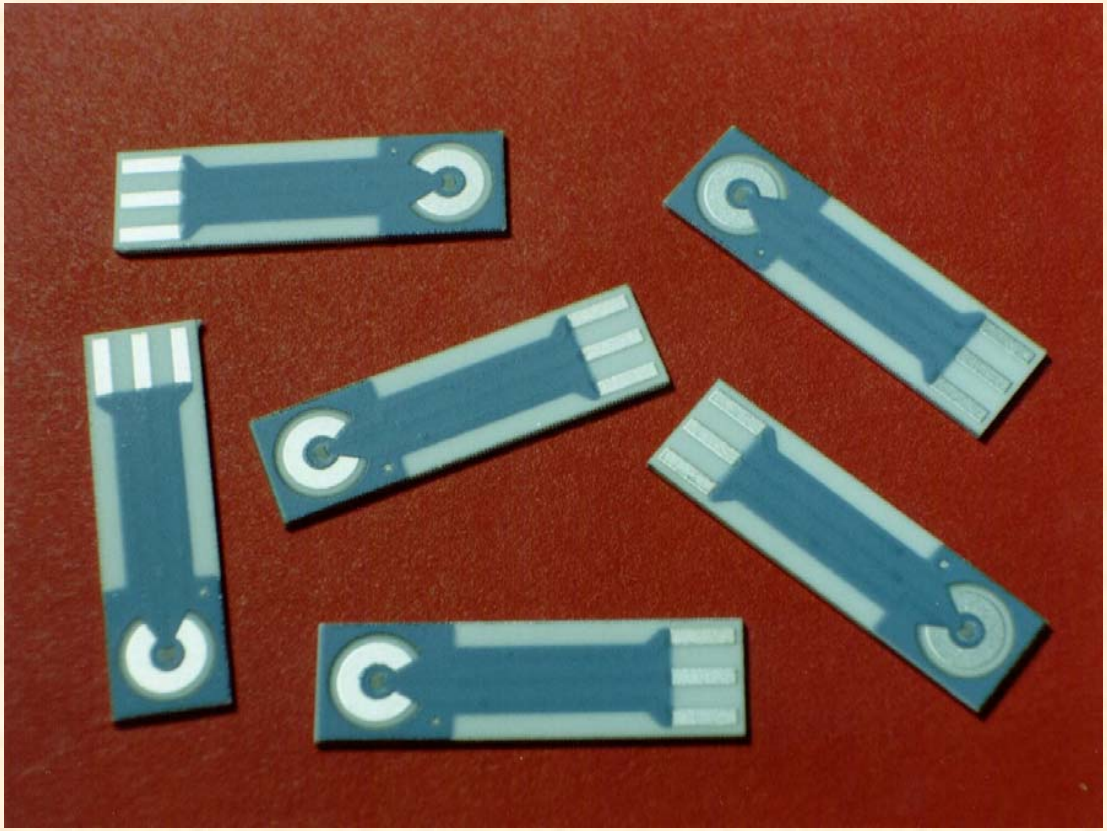


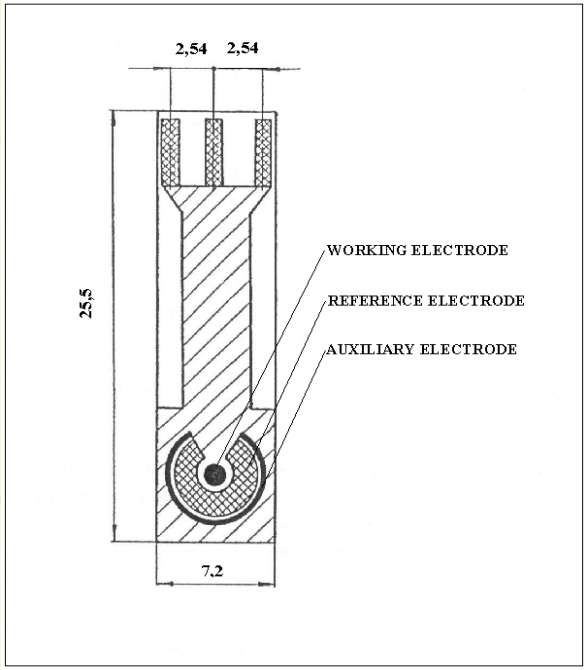


Princip


Vacuum
12/30
19/22
29/26
Auxiliary electrode
Reference electrode
Solution level
Medium frit
Stirring bar
(b)

Substrates for electrochemical biosensors





Amperometric sensor

Type: AC1.W*.R*(*)

Usage in measurement of:

- Basic electrochemical and bio-electrochemical techniques
- H_2O_2 concentration
- Glucose
- Toxicity caused by pesticides
- Enzyme activity
- Ferro – Ferricyanide couple

Weight: 0.4 gms *L-W-T:* 25,4x7.26x0.63mm

*Working electrode material: A*u, Pt, Ag, graphite, alloy of Au and Pt

Reference electrode material: Ag, AgCl, Ag covered with AgCl

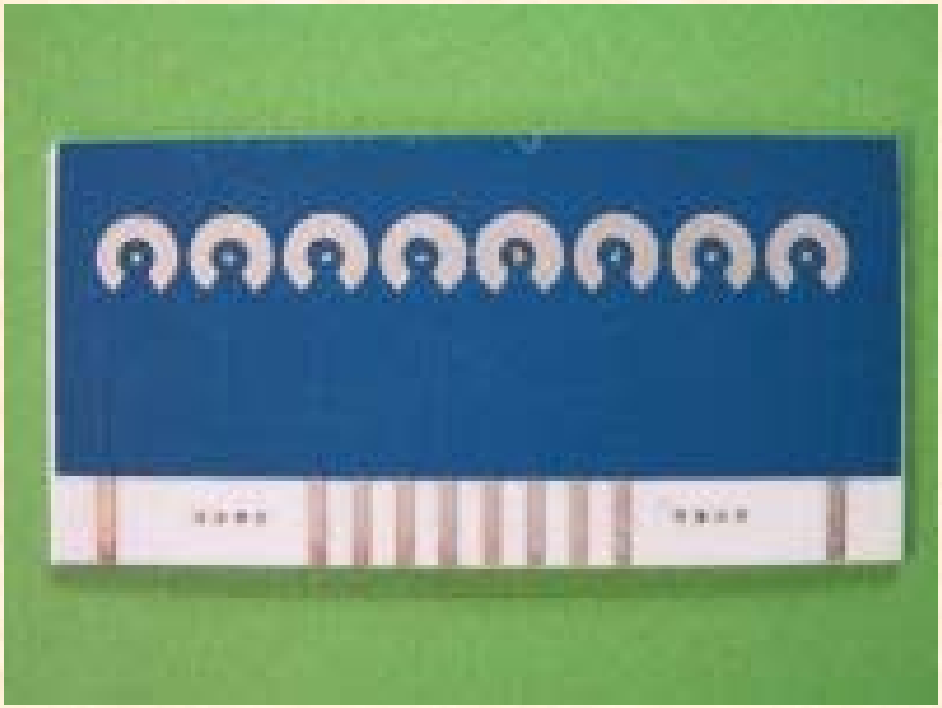
BVT Technologies

AC2.W2.RS

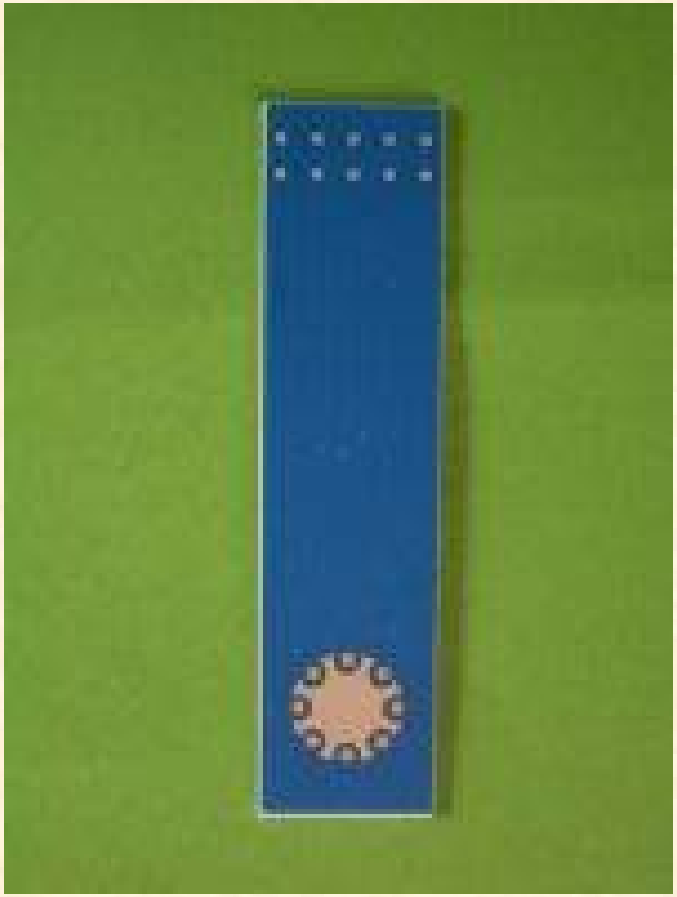
PACI, 6.6.2007, Prague

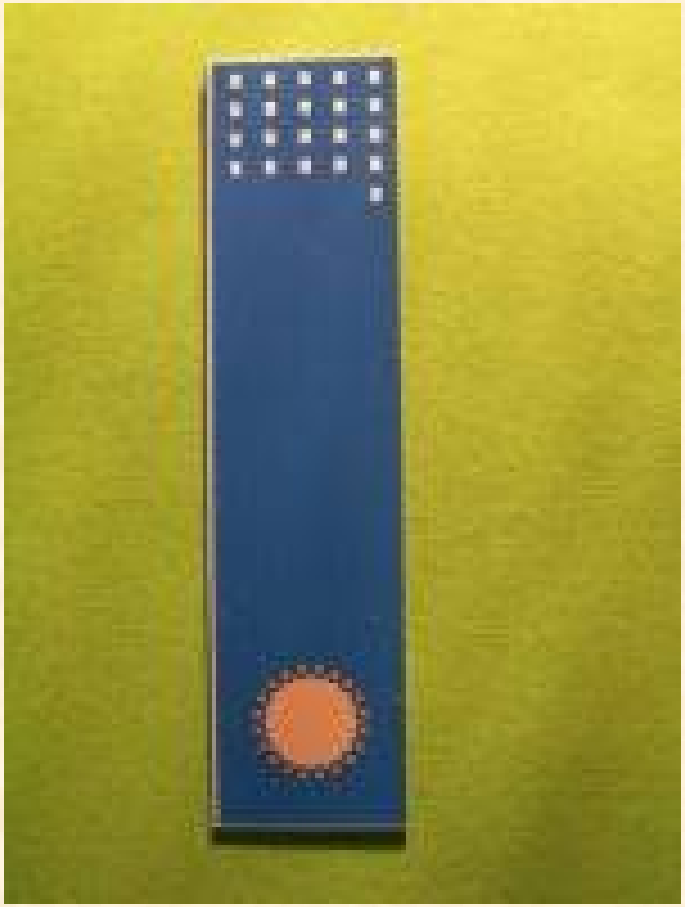
AC3, AC4

AC5,AC8

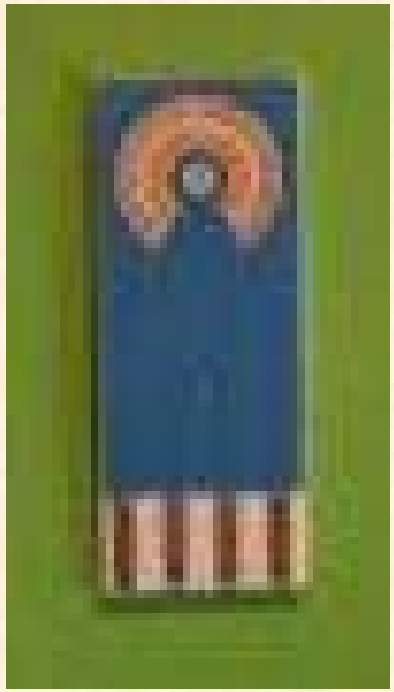


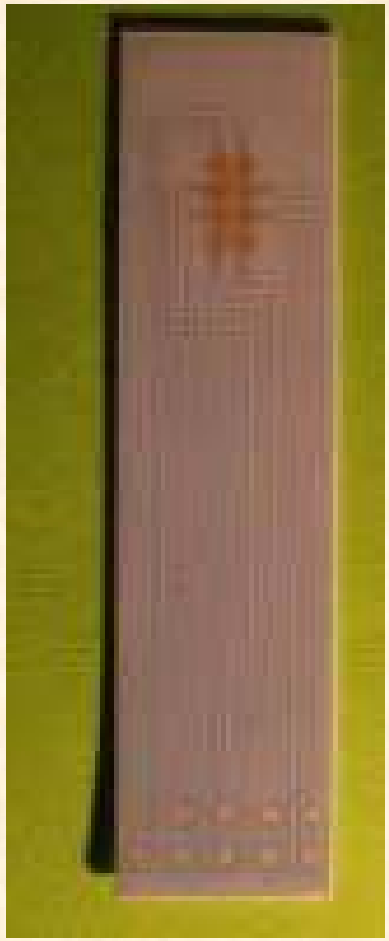
AC9,AC10

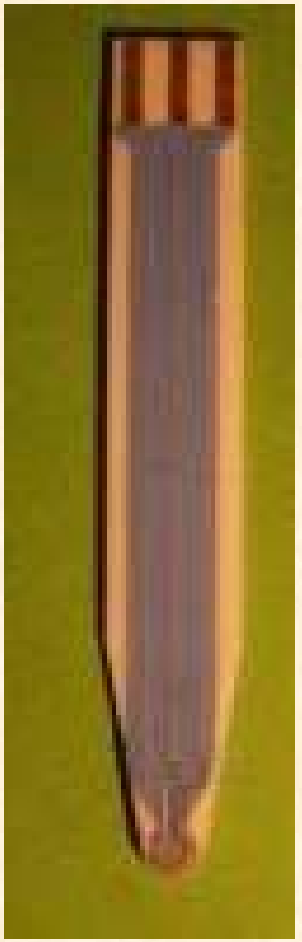




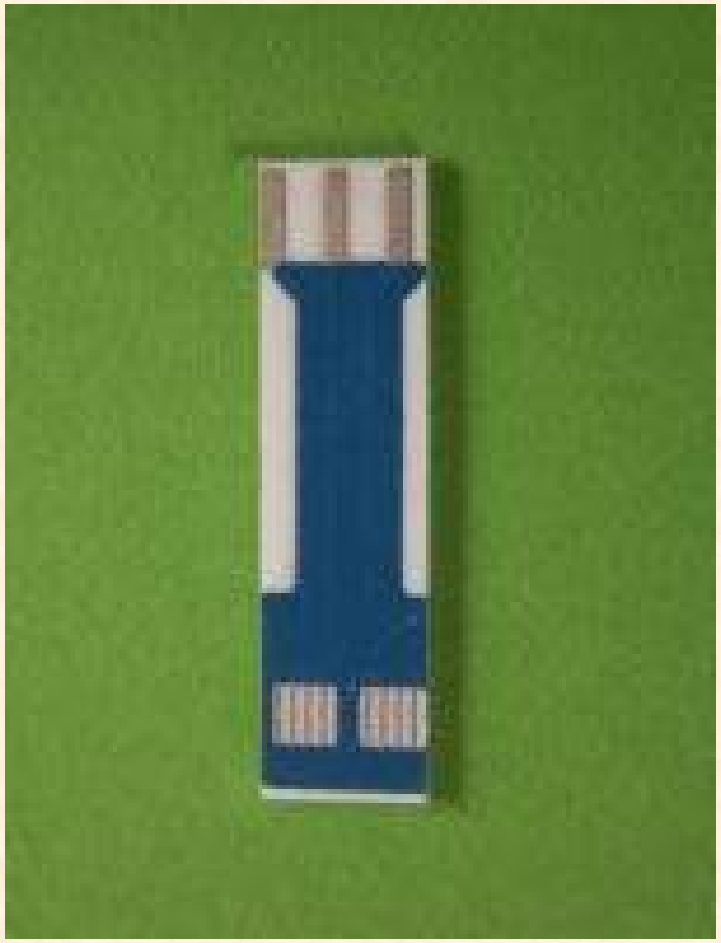
AC6,AC12,AC11







CC1,CC2



Accessories

- Pumps
- Evaluating units
- Connectors
- Flow adapters
- Screen printer
- MFS

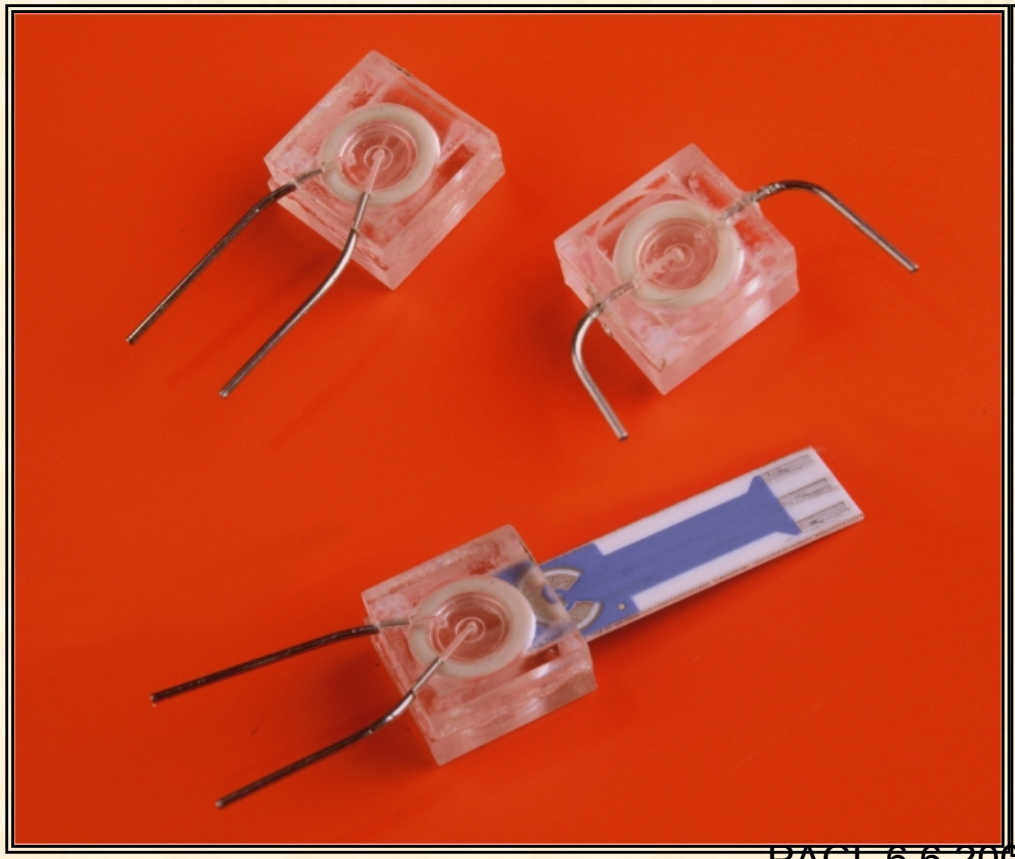
Pump

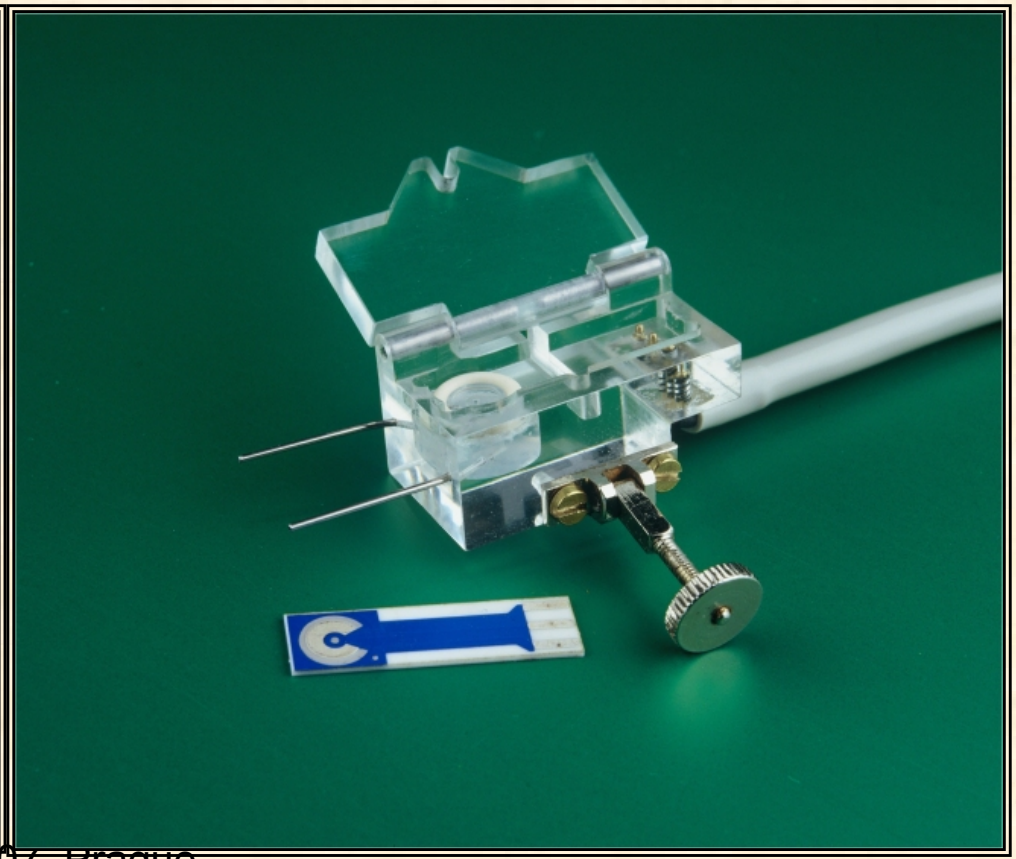
Bioanalyzer

BEEP, OFBio

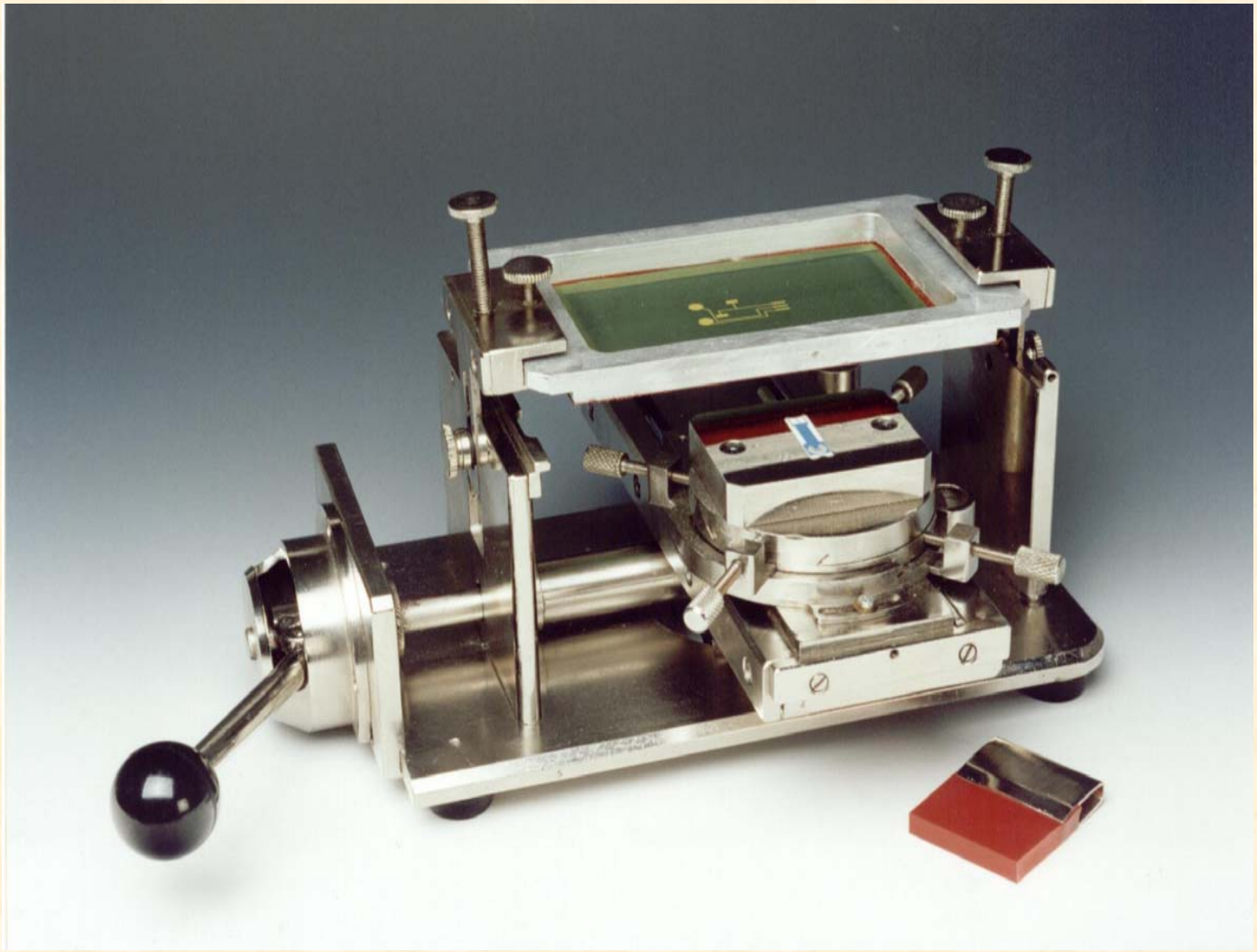
Connectors

Flow adapters





Screen printer

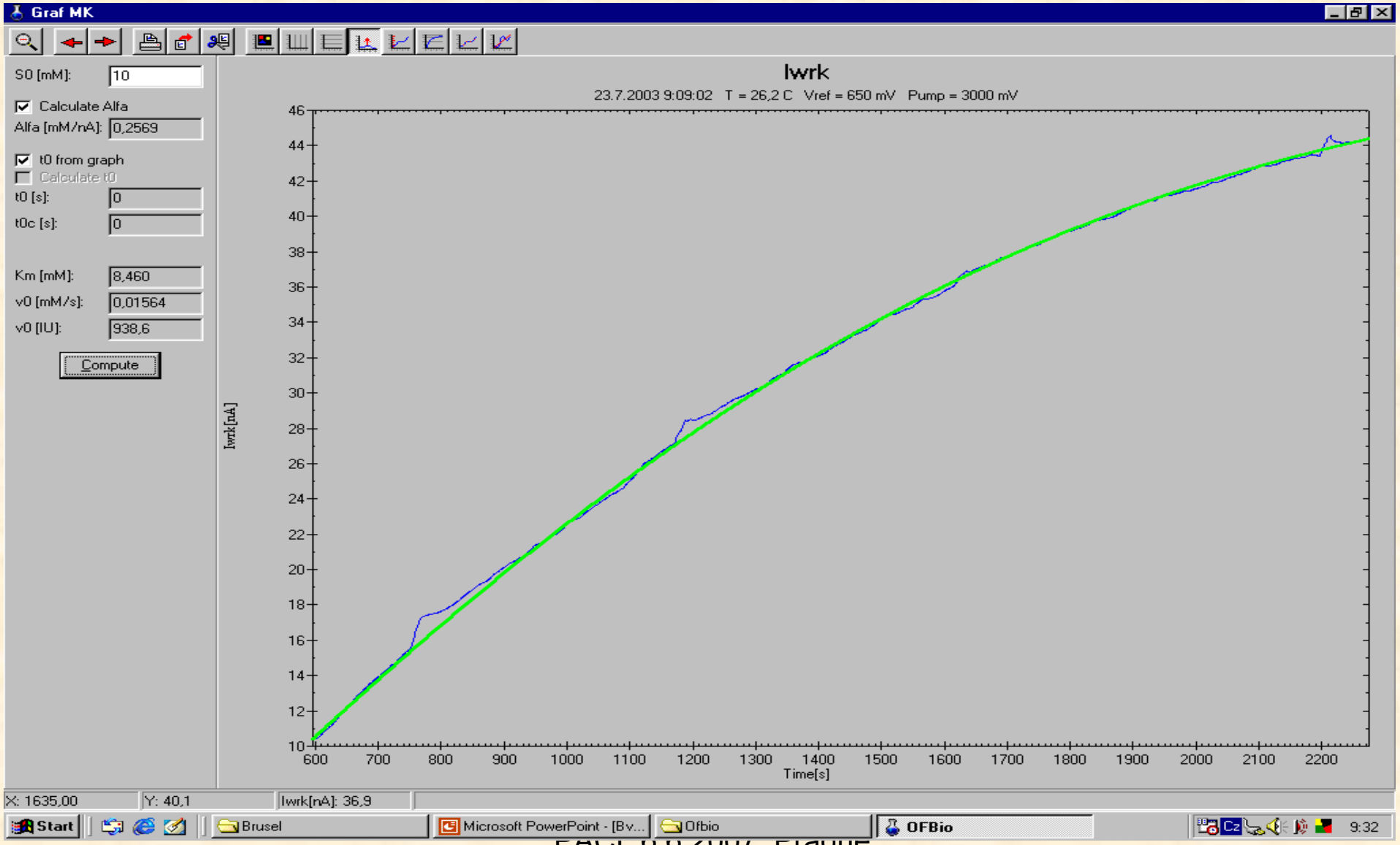


Glass vessels

MFS – Microfluidic system

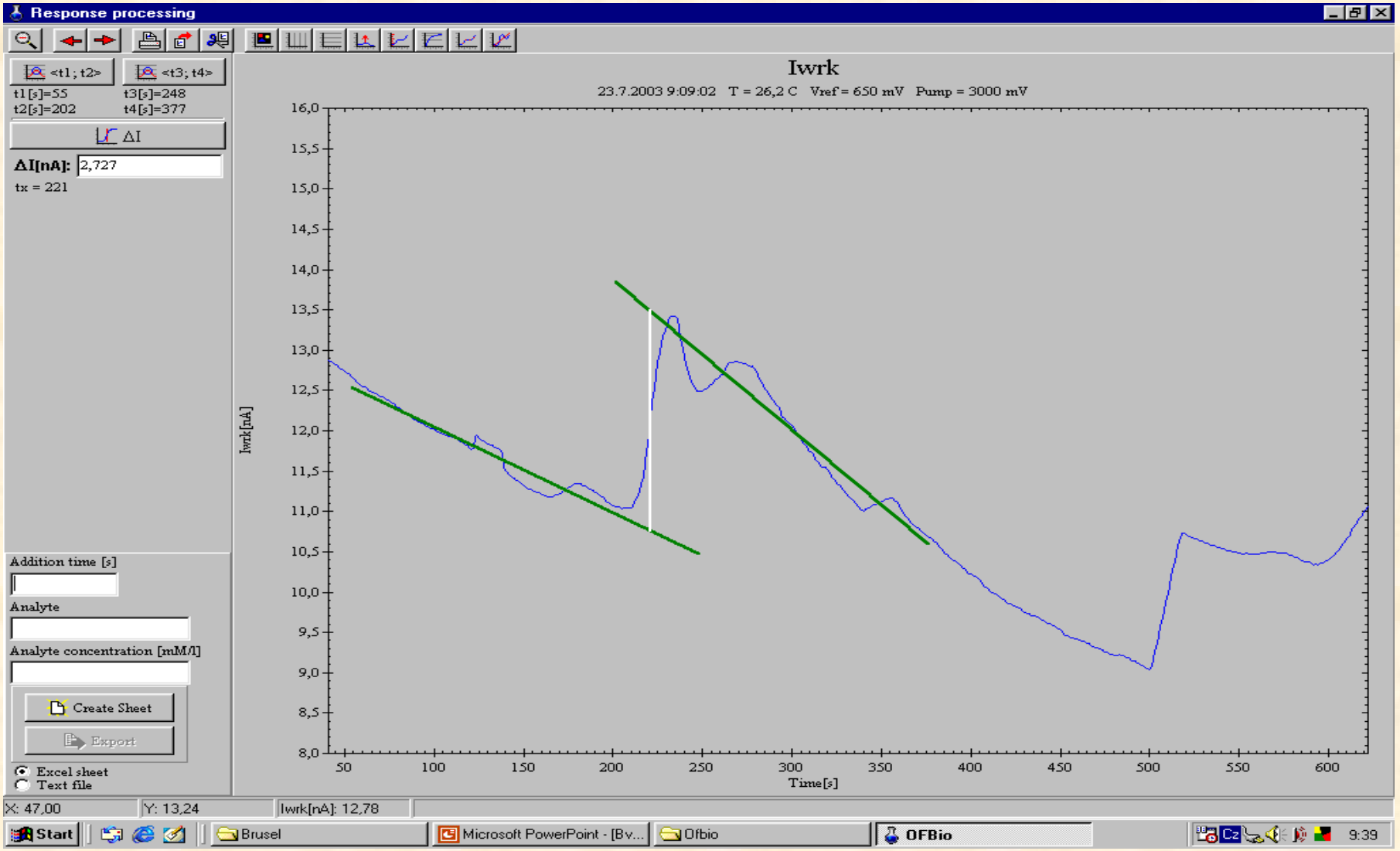
Software

The analysis of reaction kinetics



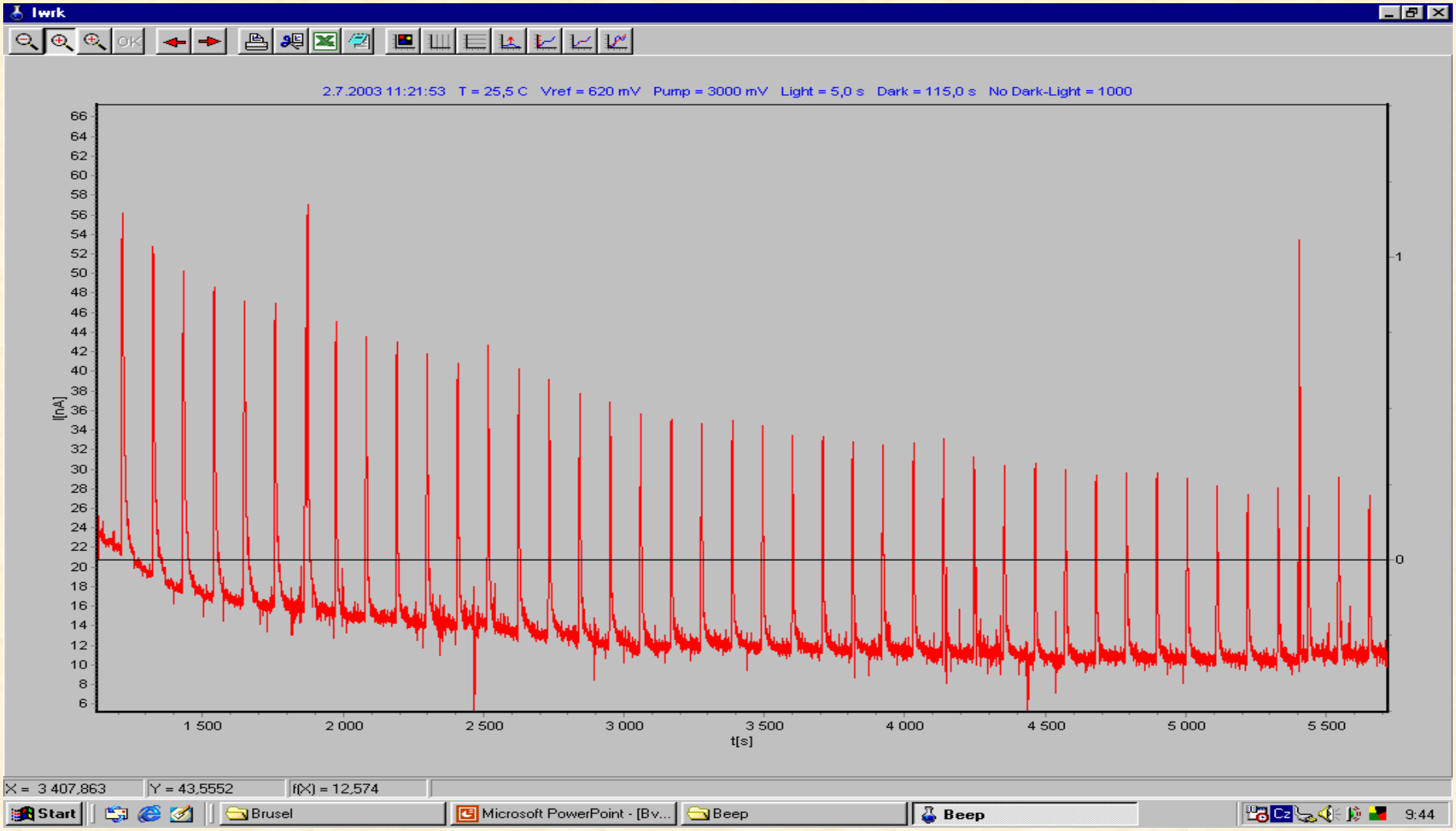
Software

The automatic analysis of electrochemical sensors response



Software

The software developped on demand of customer



Ukazka specialního software

..\..\Programy\Syncdet\7428-SyncDet.exe

..\..\Programy\Modely\rozhrani.exe

..\..\Programy\7429-2BIOAN\Bioanalyzer.exe

Aplikace a odběry

Datum aplikace	Aplikované pesticidy
19.4.2004	AFALON 45 SC
27.5.2004	METHANION 48 EM
16.6.2004	METHANION 48 EM
28.6.2004	DITHANE M 45
16.7.2004	METHANION + DITHANE
6.8.2004	METHANION + DITHANE

Odběry vzorků

- 1 den před, v den postřiku, 1, 3 a 5 dnů po
- půda - sondovací tyč do hloubky 10 cm, 10 x,
- listy – náhodně 10 g z parcely
- hlízy – 2-3 ks z parcely

Universal Rotating Disc Electrode

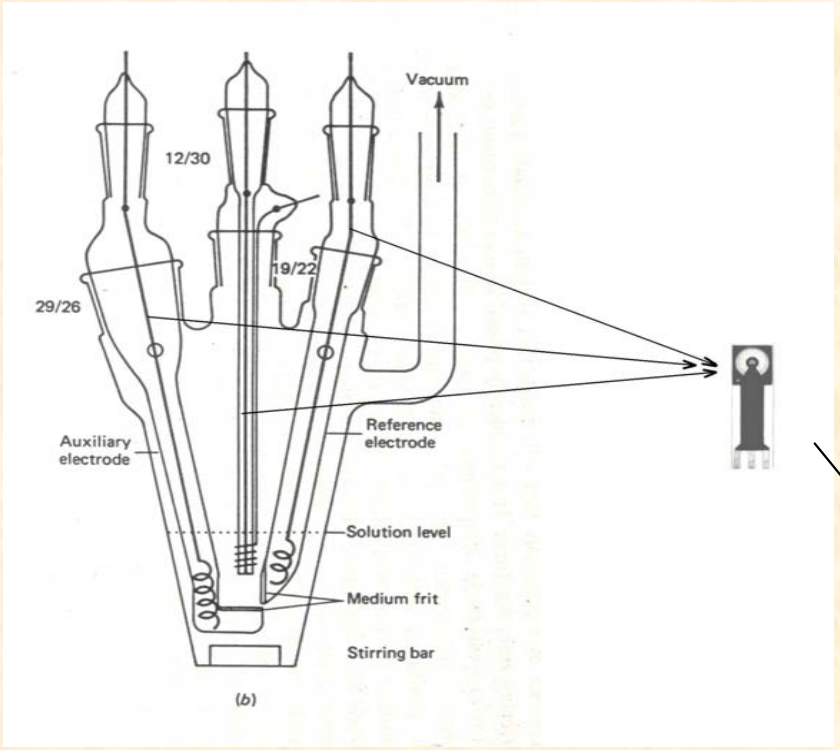
Jan Krejčí[(1)], Petr Skládal[(2)] , Dagmar Krejcova[(3)], J. Kubka[(4)], Z. Grosmanova[(3)]

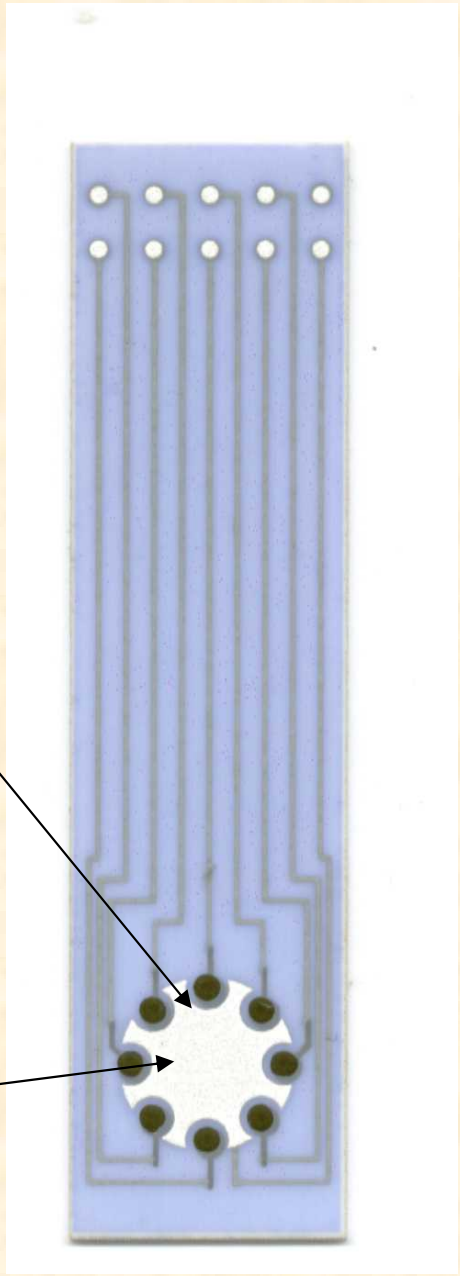
(1) Krejčí Engineering, Tišnov, Czech Republic

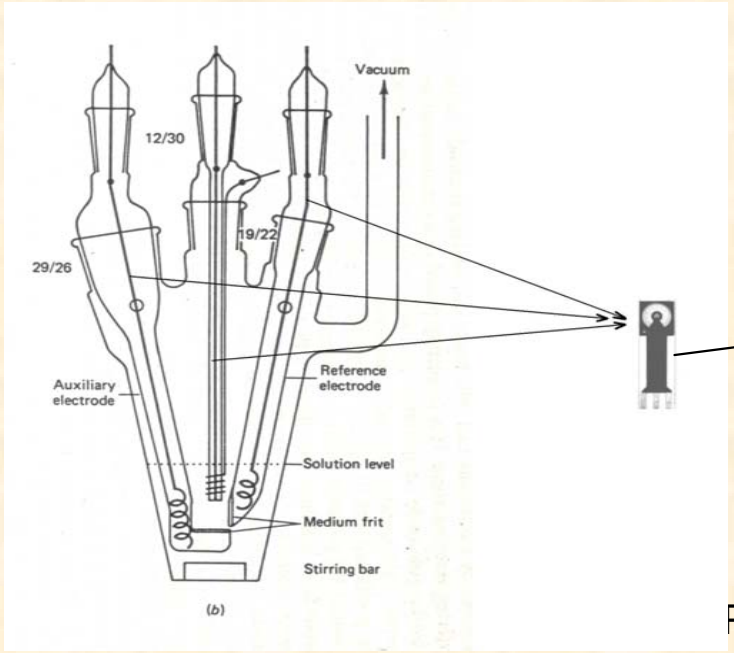
(2) MU Brno, Czech Republic

(3) BVT Technologies a.s., Hudcova 72c, Brno

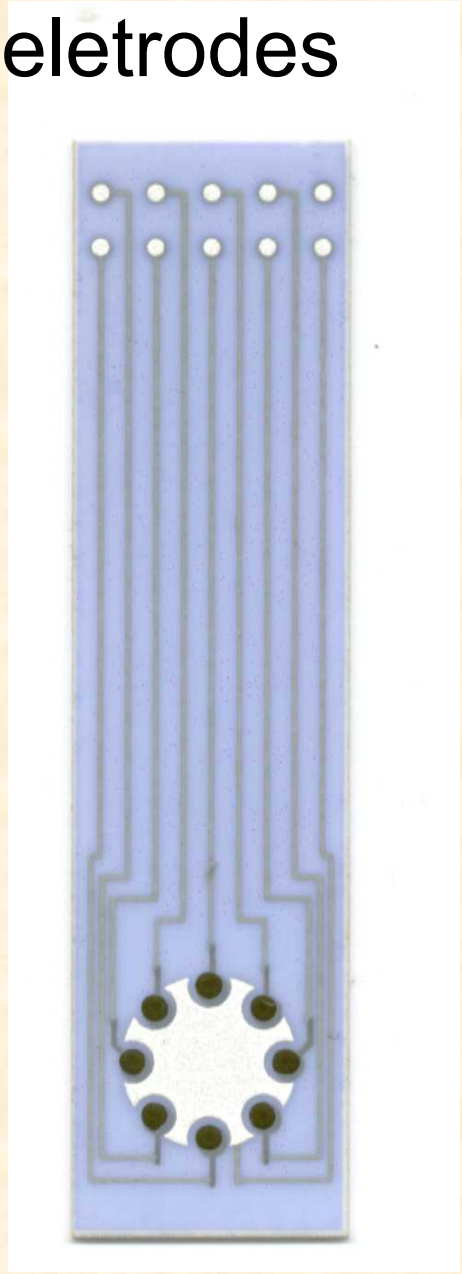
(4) EMO, Hudcova 72c, Brno


Vacuum
12/30
19/22
29/26
Auxiliary electrode
Reference electrode
Solution level
Medium frit
Stirring bar
(b)

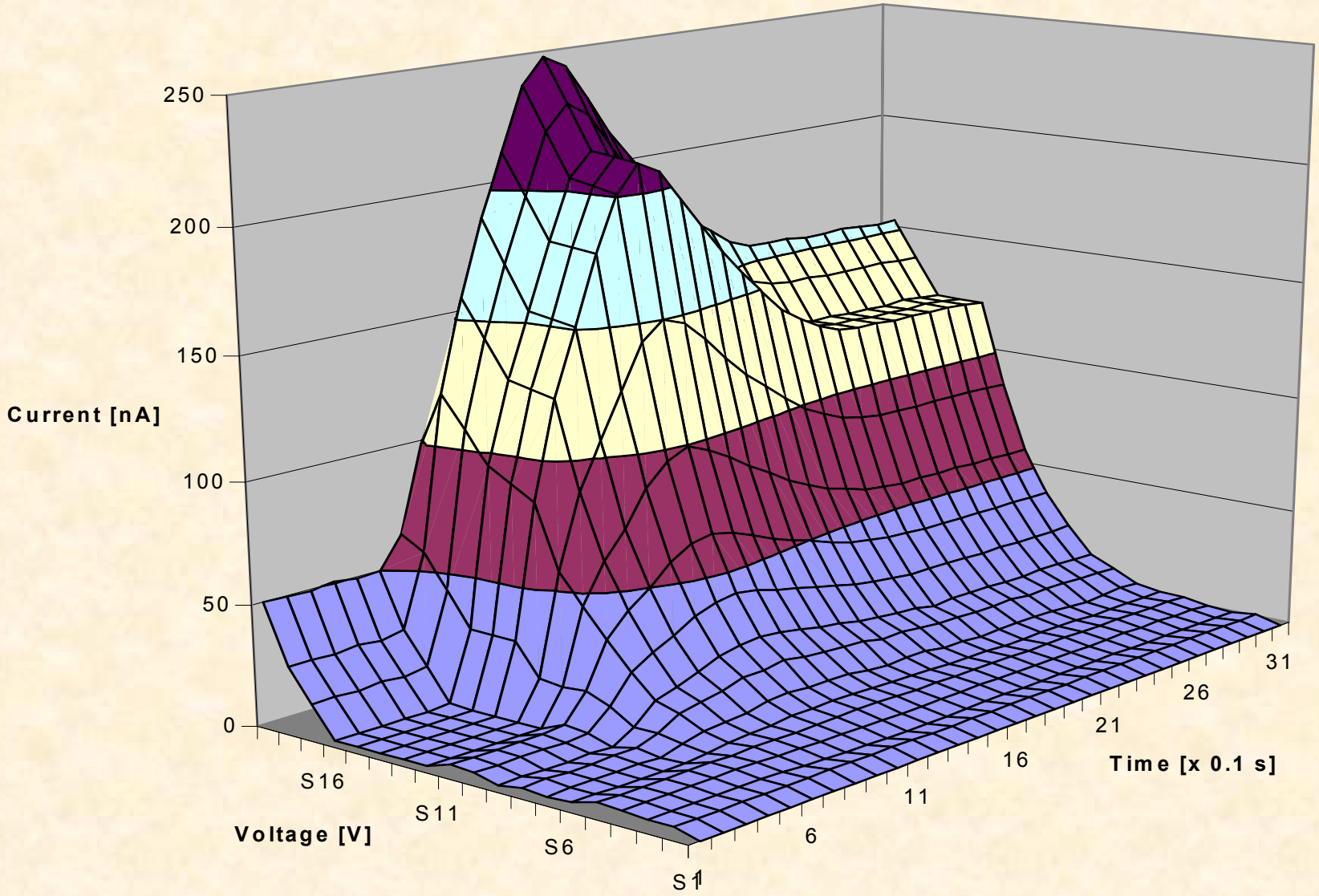



Vacuum
12/30
19/22
29/26
Auxiliary electrode
Reference electrode
Solution level
Medium frit
Stirring bar
(b)

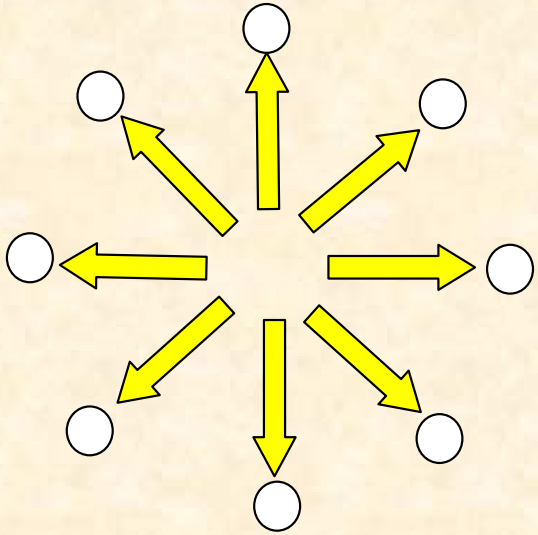
Arrays of microeletrodes

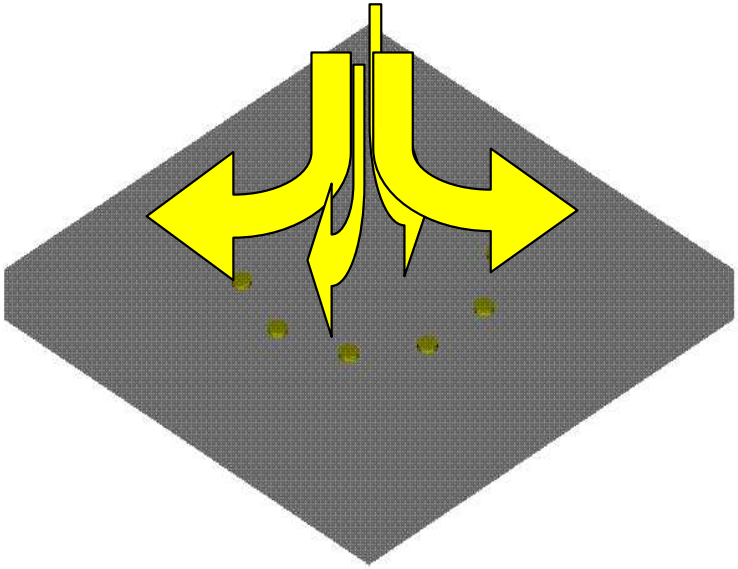


Direct voltametry on electrodes array



- The principle

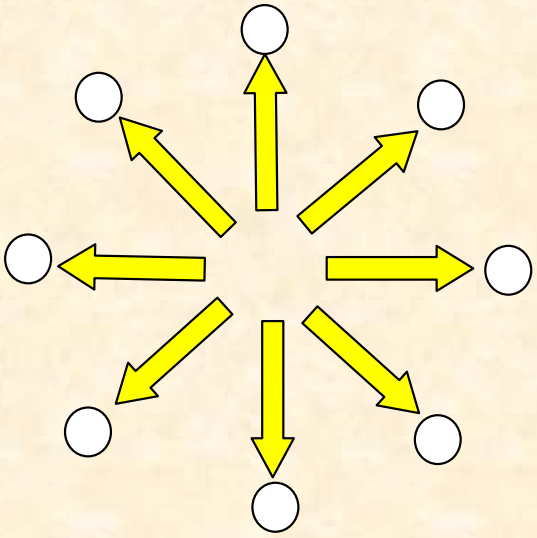


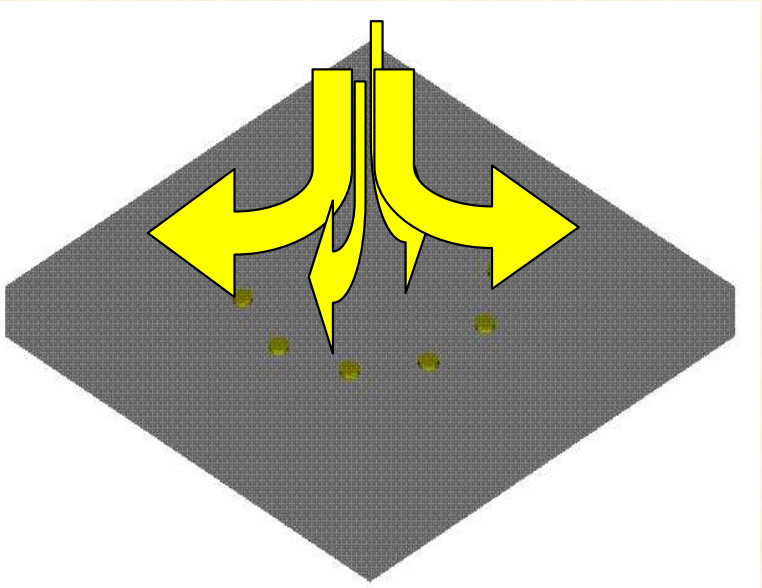


Test of electrode arrays

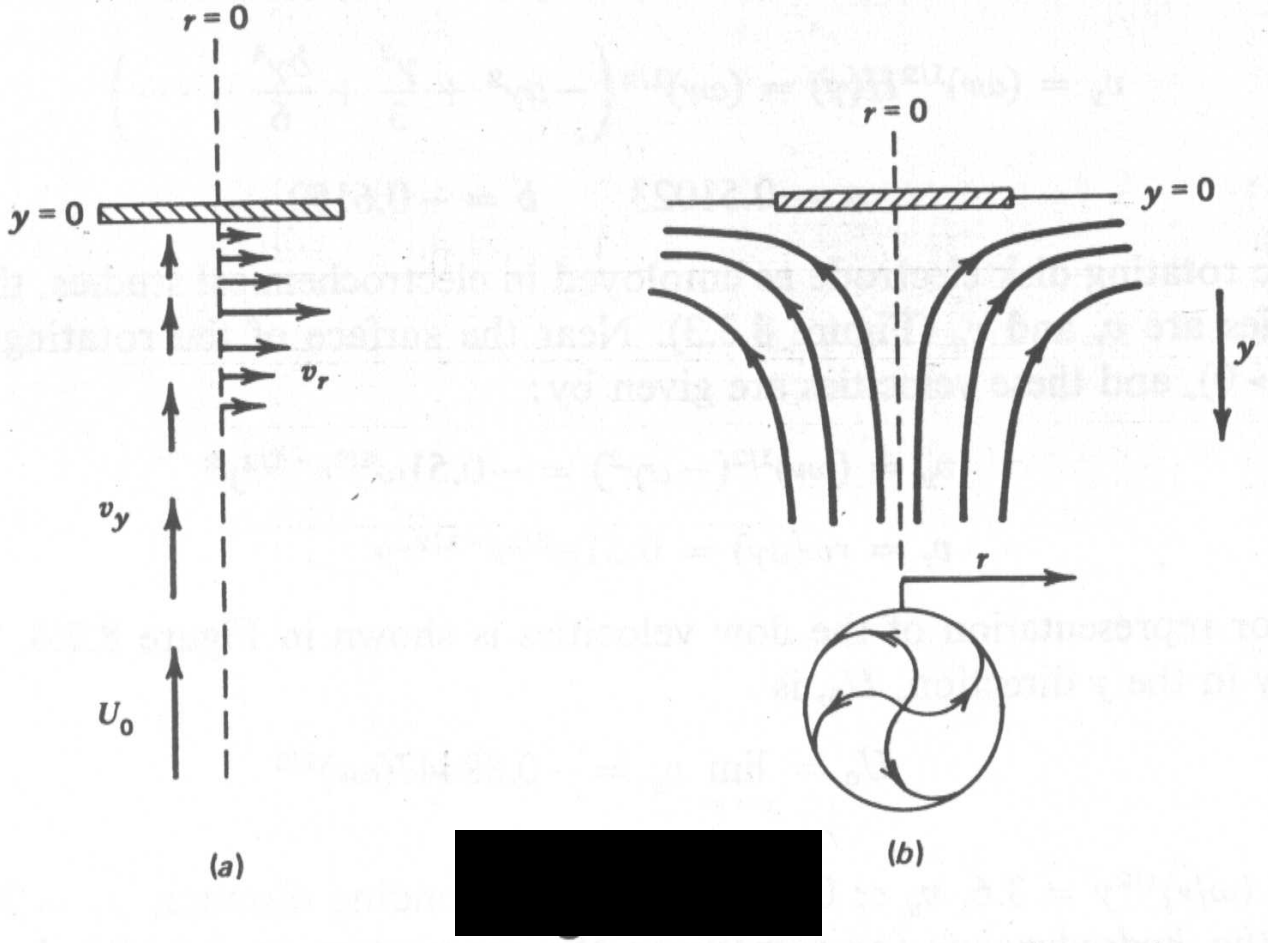
- Very poor reproducibility. The signal changed more than 30 % in same condition only by new inserting of sensor to the testing chamber. The sensor is extremely sensitive to hydrodynamic conditions
- High cross talk between electrodes

Radial flow to electrode arrays





The principle of Rotating disc electrode



(*a*) Vector representation of fluid velocities near disk. (*b*) Schematic resultant streamlines (or flows).

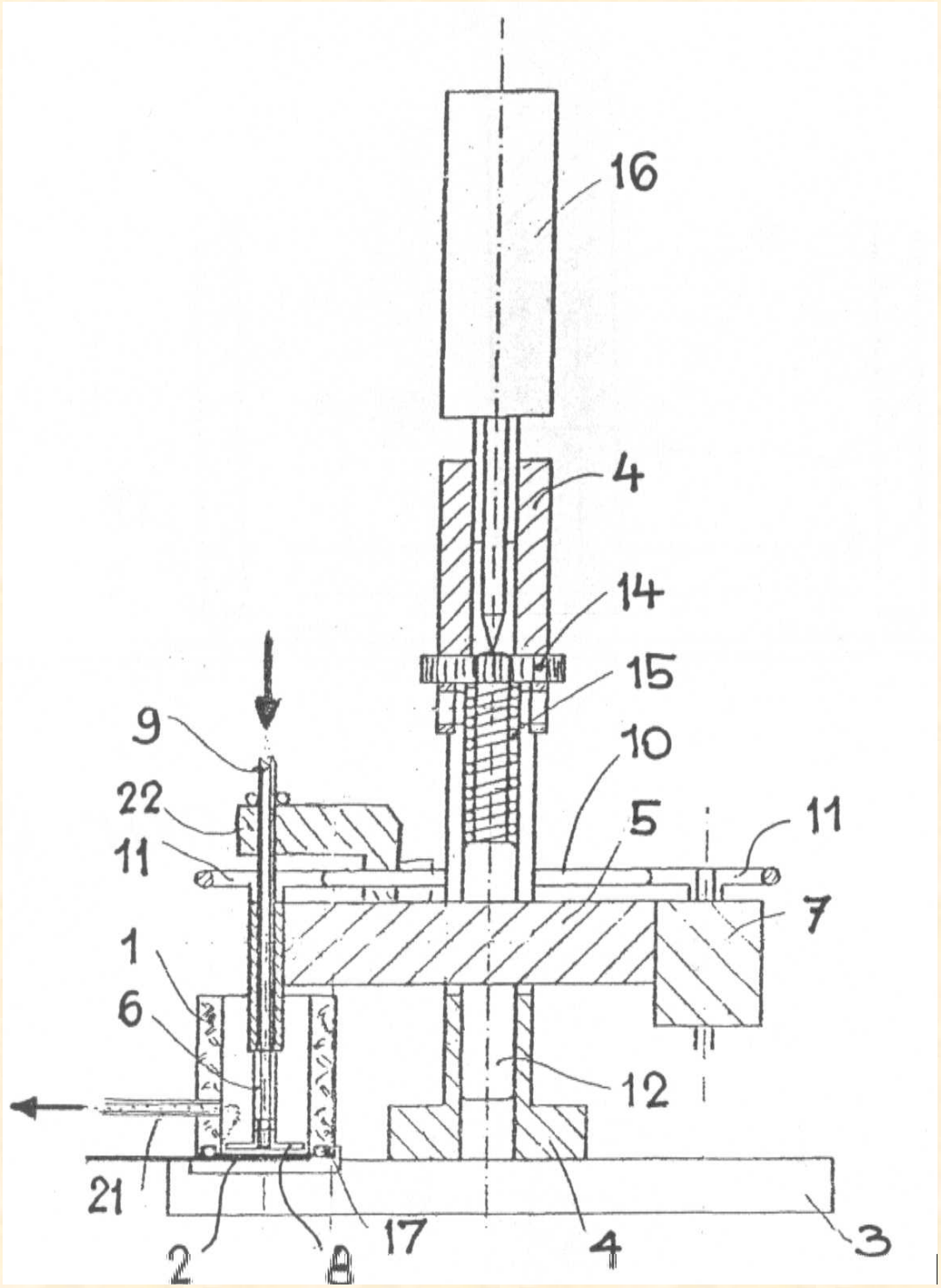
Rotating disc electrode

Advantages

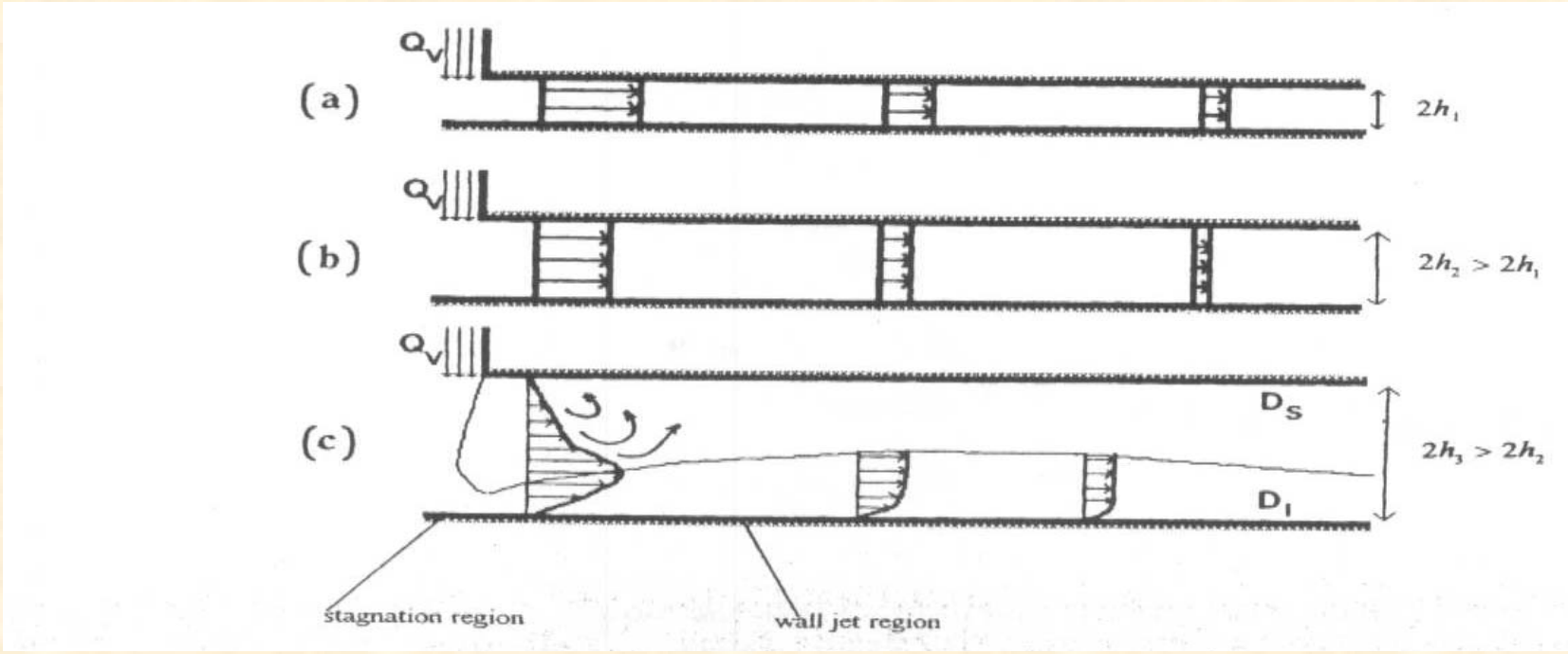
- The hydrodynamics is solved
- The response is known (Levich equation)
- The methods which enables the monitoring of chemical reaction kinetics are described

Technical solution

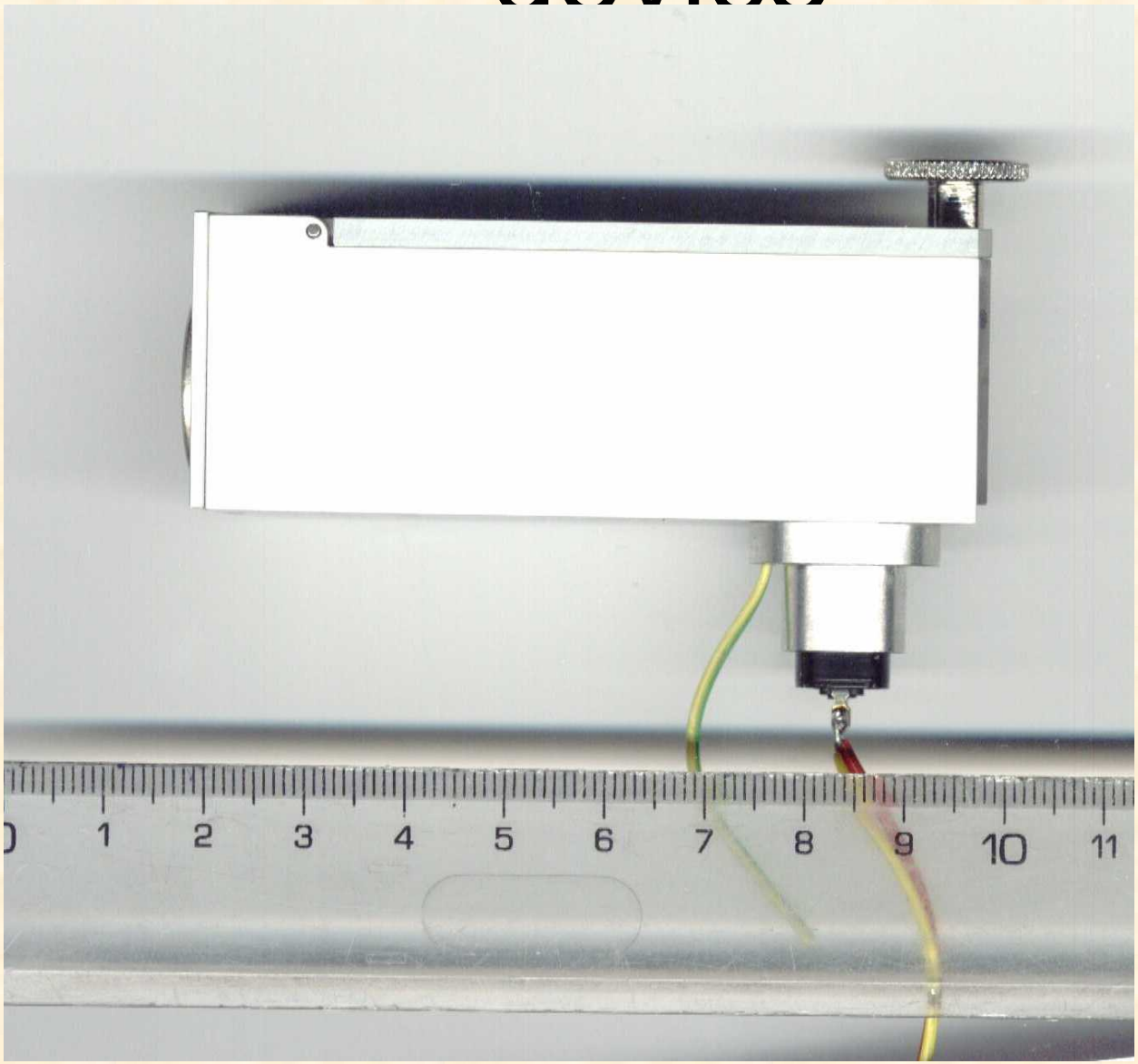
1. The solution is inserting through the axis of rotating element
2. The element rotates above array of electrodes



The flow characteristic

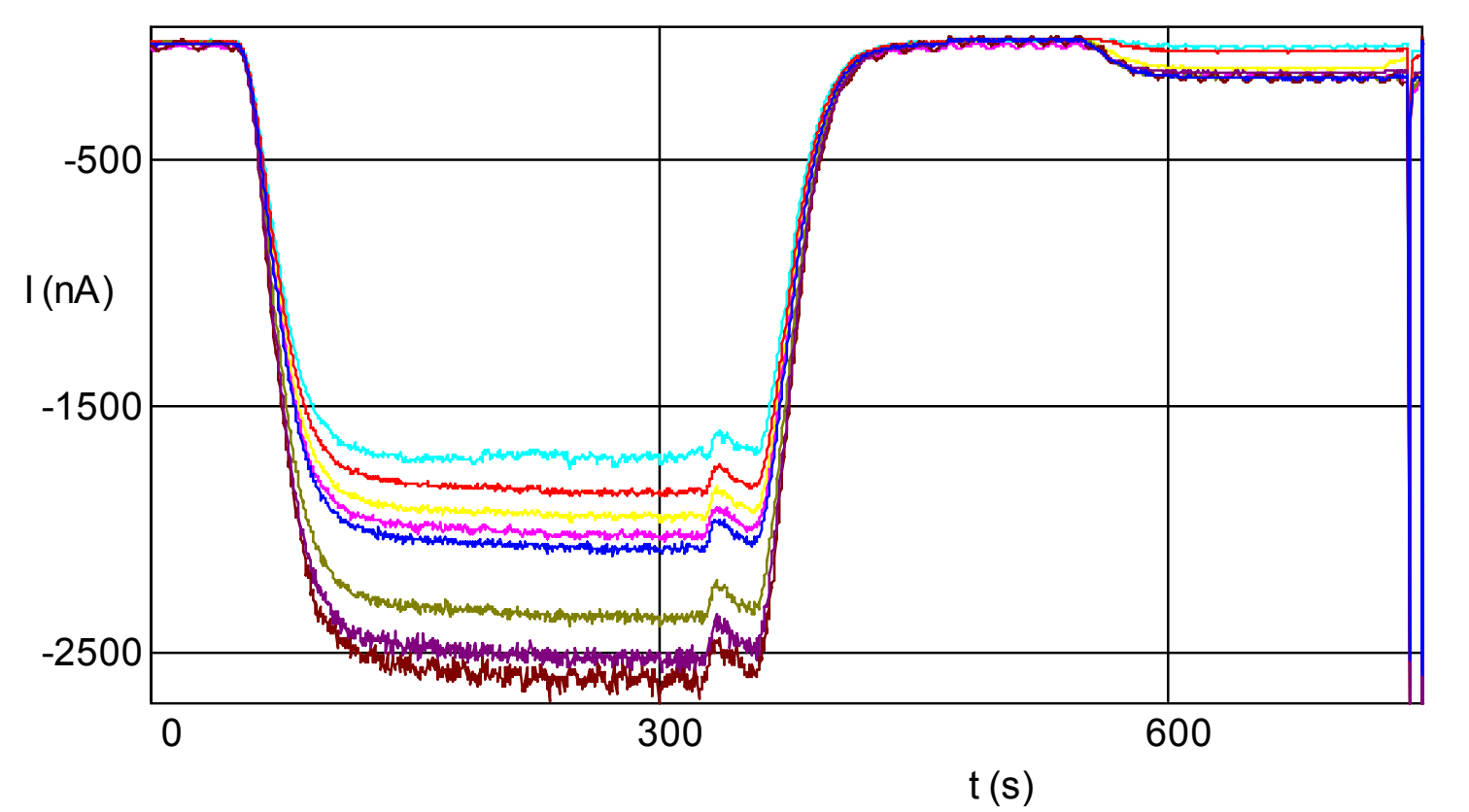


Miniaturization to compact device

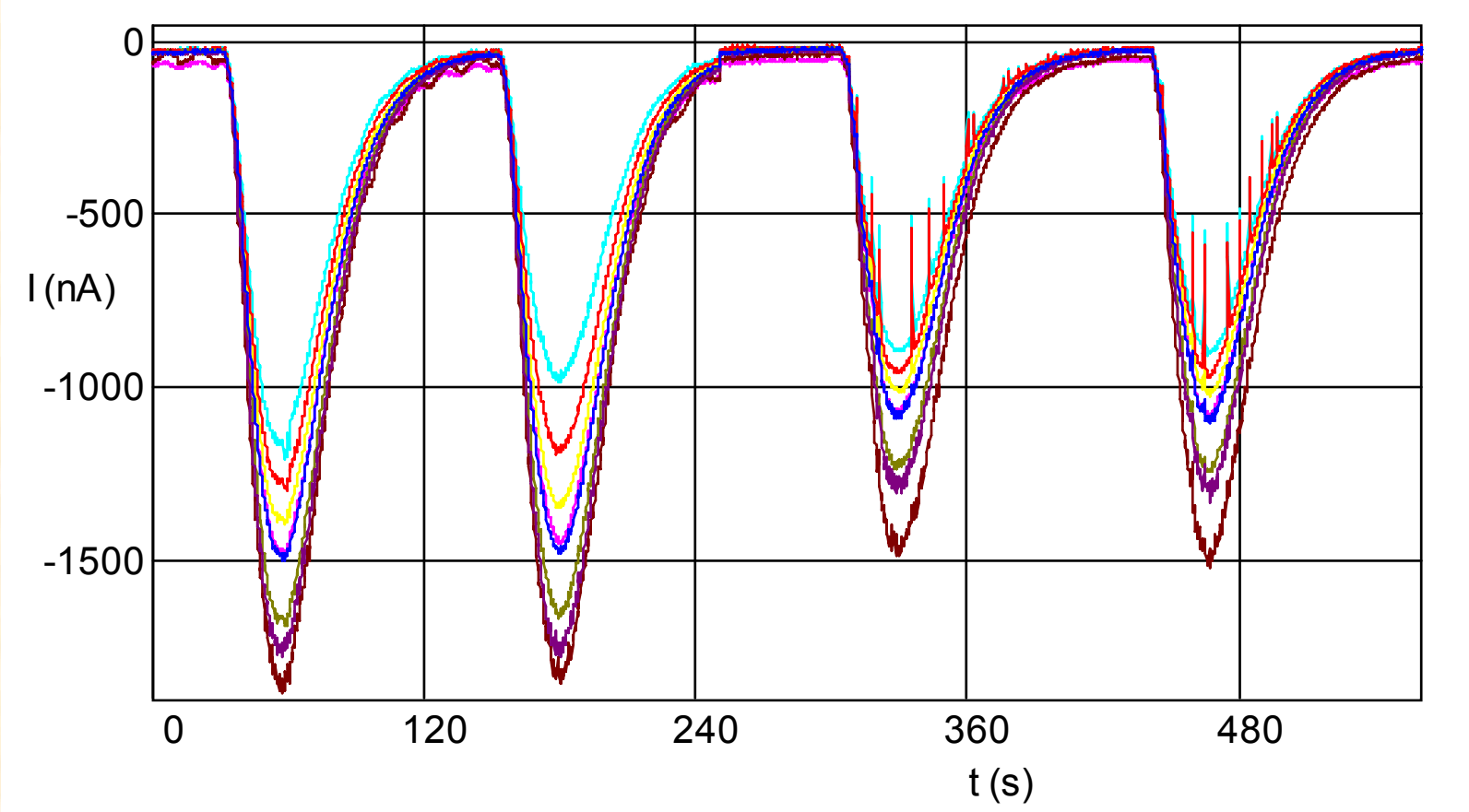


Results

zones of 0.25 mM ferricyanide, 1 ml/min, -100 mV/int. ref. better mass transfer with stirring - 15-times enhanced response



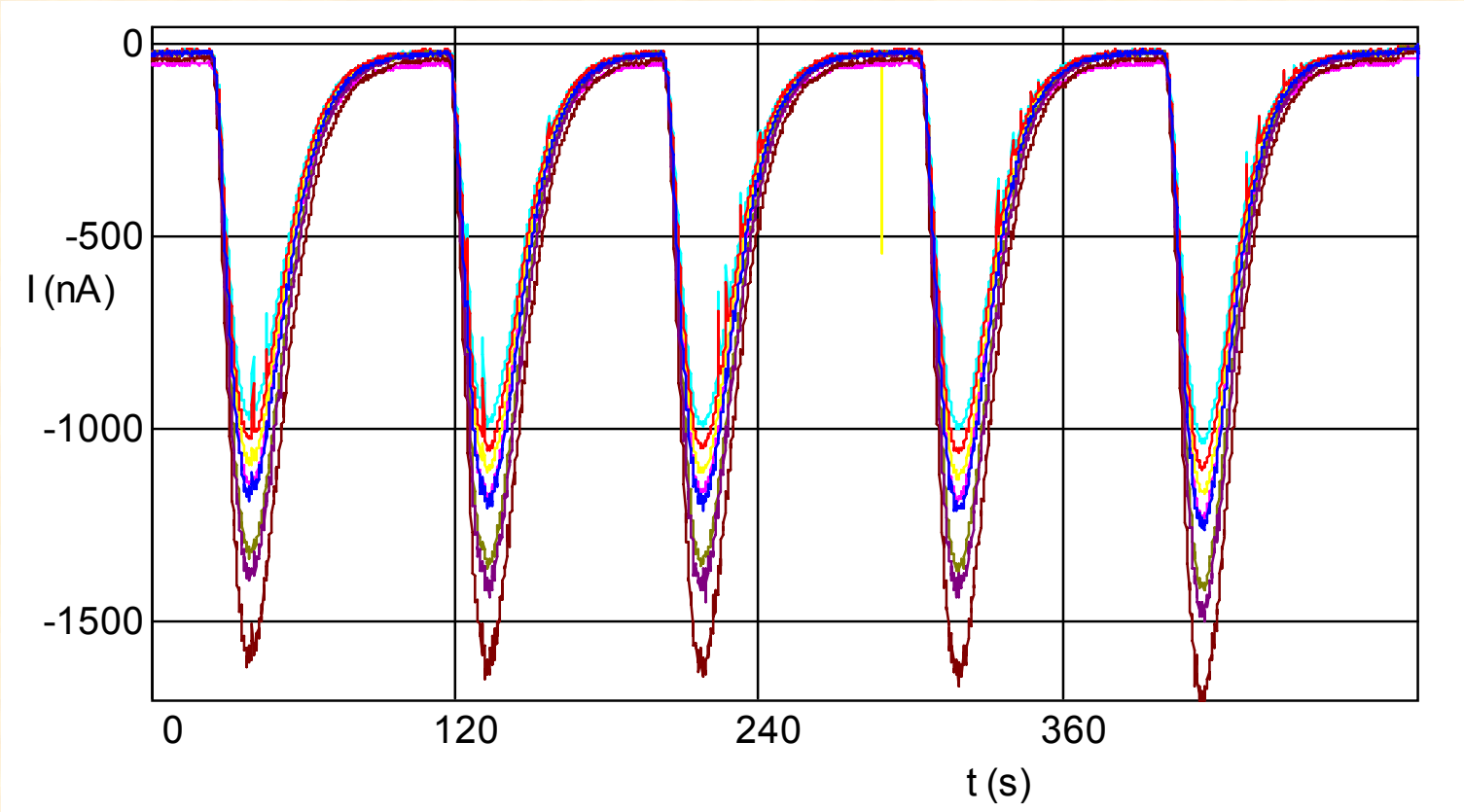
Effect of velocity of stiring element



The test in FIA mode

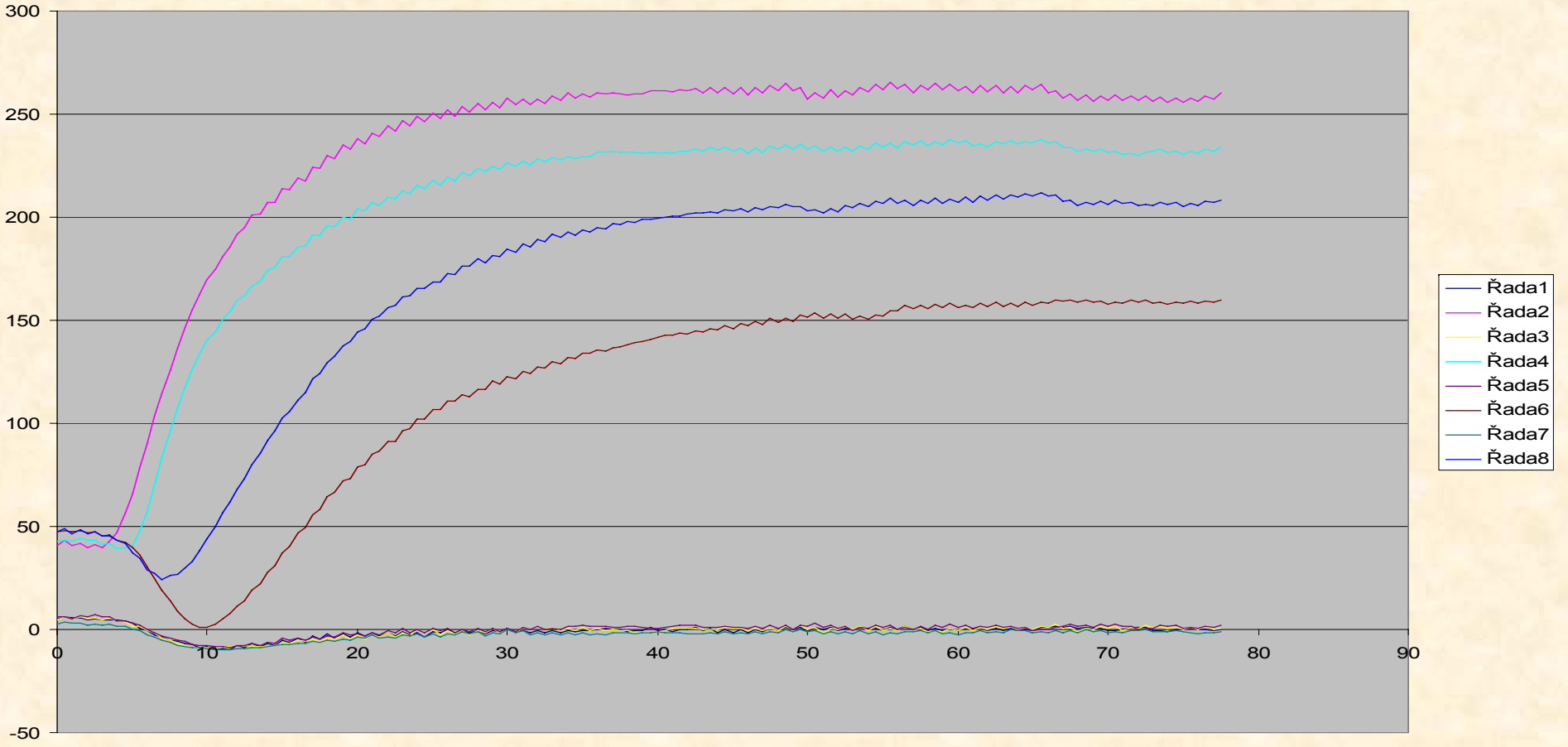
peaks of 1 mM ferricyanide, 1 ml/min, -100 mV/int. ref.

excellent reproducibility



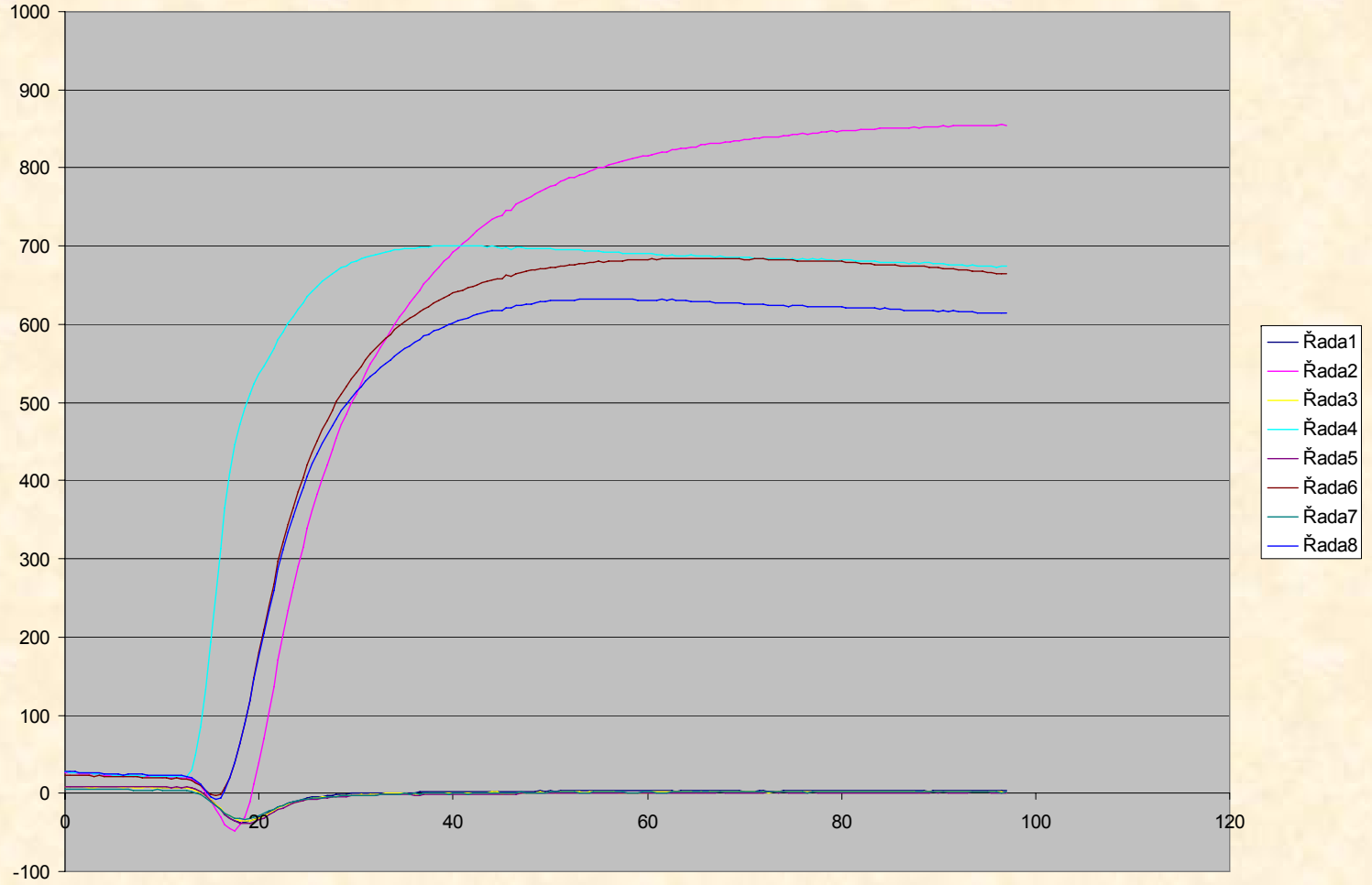
Cross-Talk between electrodes

The result of measurement with immobilised glucose oxidase. The enzyme was immobilised on electrode no. 2,4,6,8. The electrodes 1,3,5,7 was without enzyme. The electrode was immersed in stirred vessel.



Cross-talk between electrodes

The result of measurement with immobilised glucose oxidase. The enzyme was immobilised on electrode no. 2,4,6,8. The electrodes 1,3,5,7 was without enzyme. The measurement was done with URDE cell.

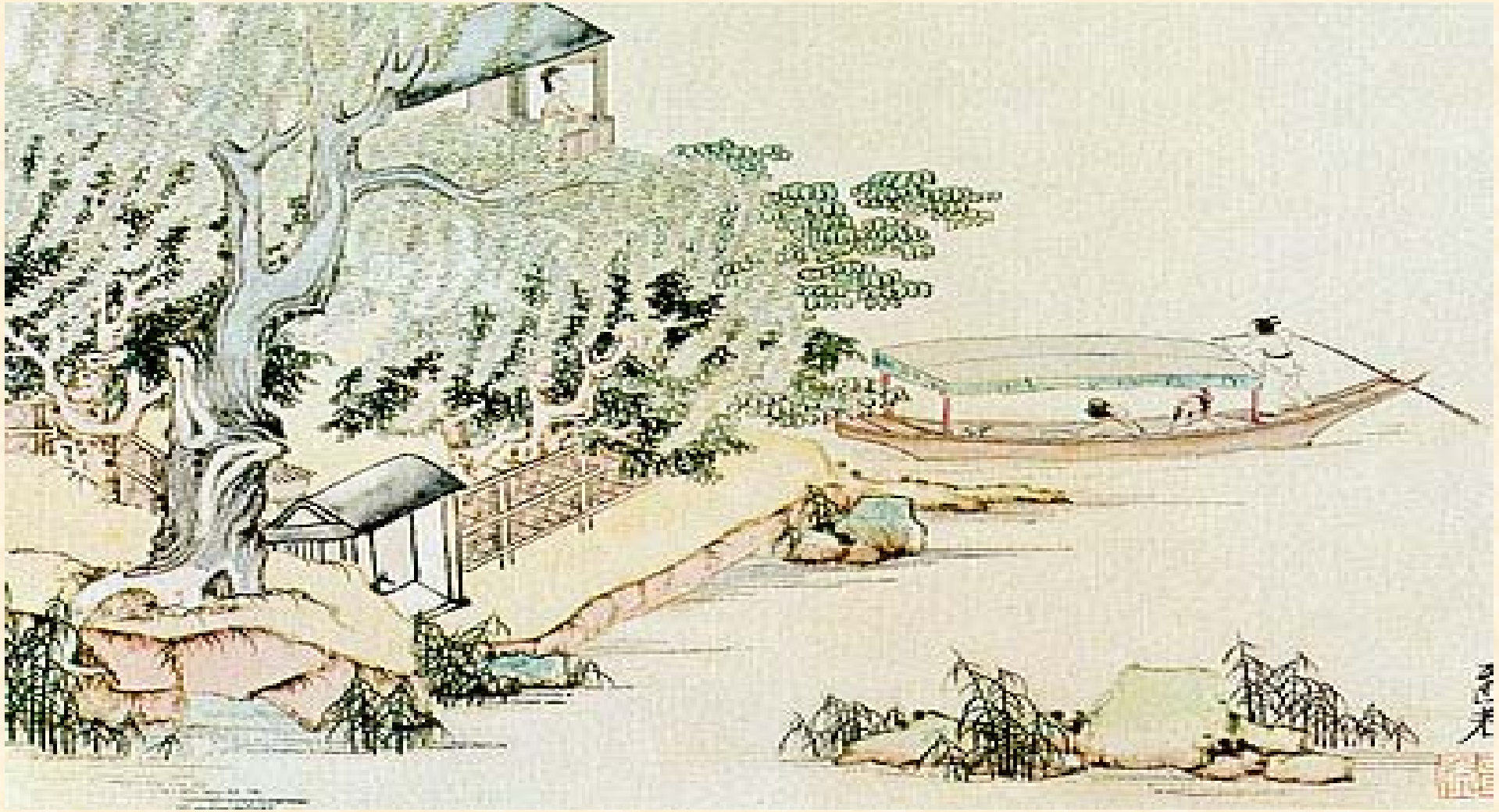


Acknowledgement

This work was partially supported by

- EU project GRD1-2001-4183 Microprotein
- Project Antope FD-K2-53, Czech Ministry of Industry

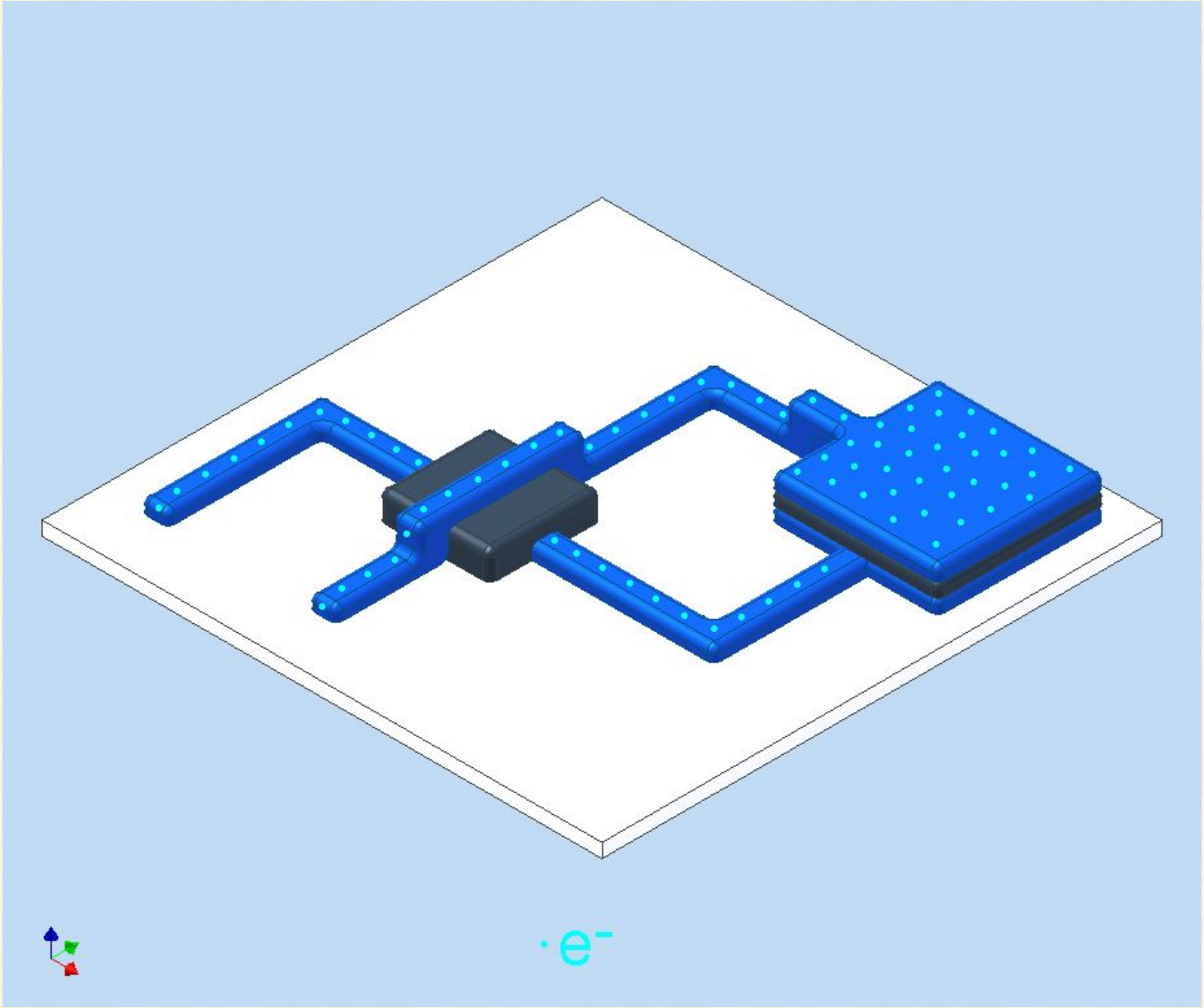
The Origins of TFT



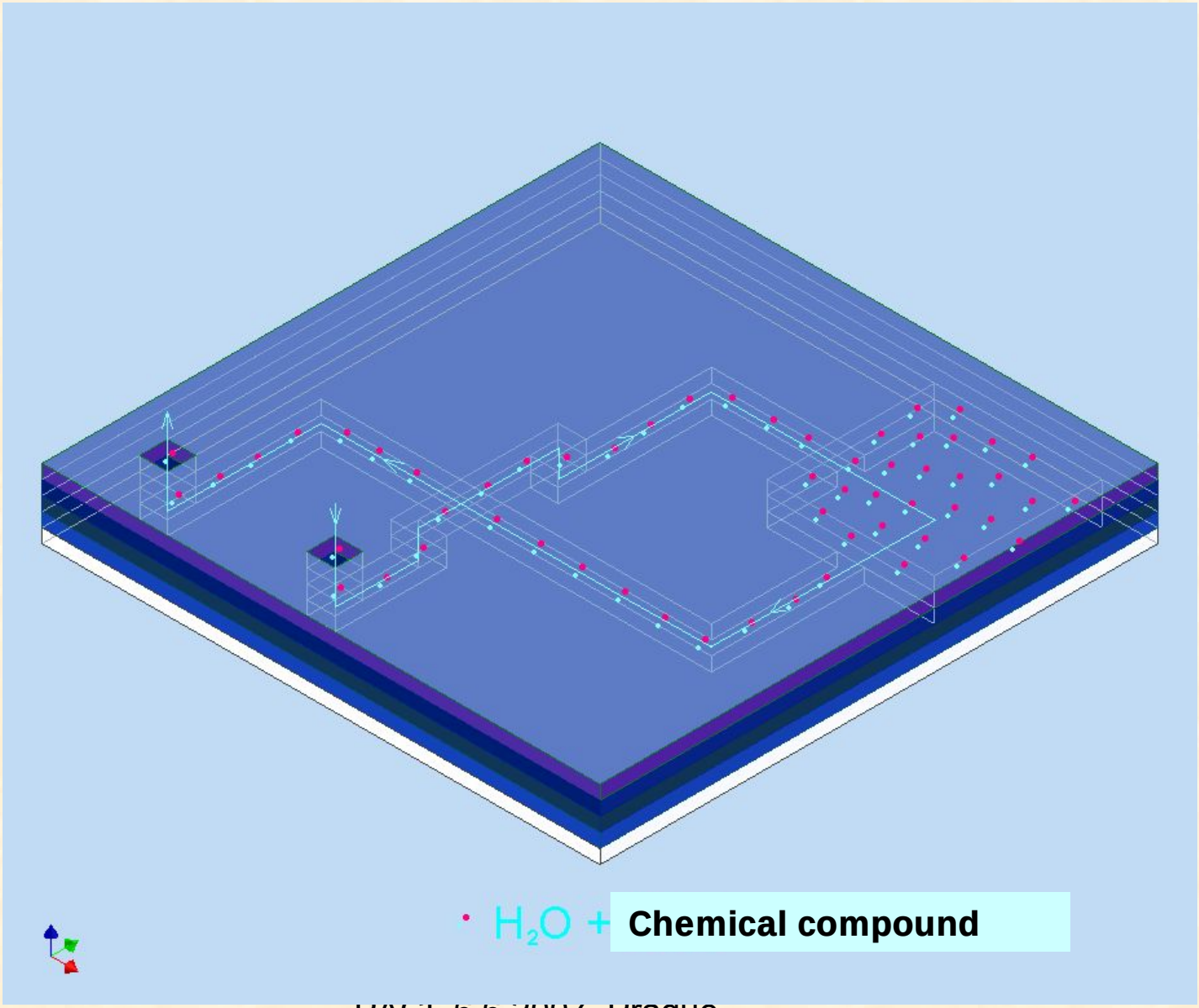
3D Thick Film Technology

Dr. Jan Krejčí

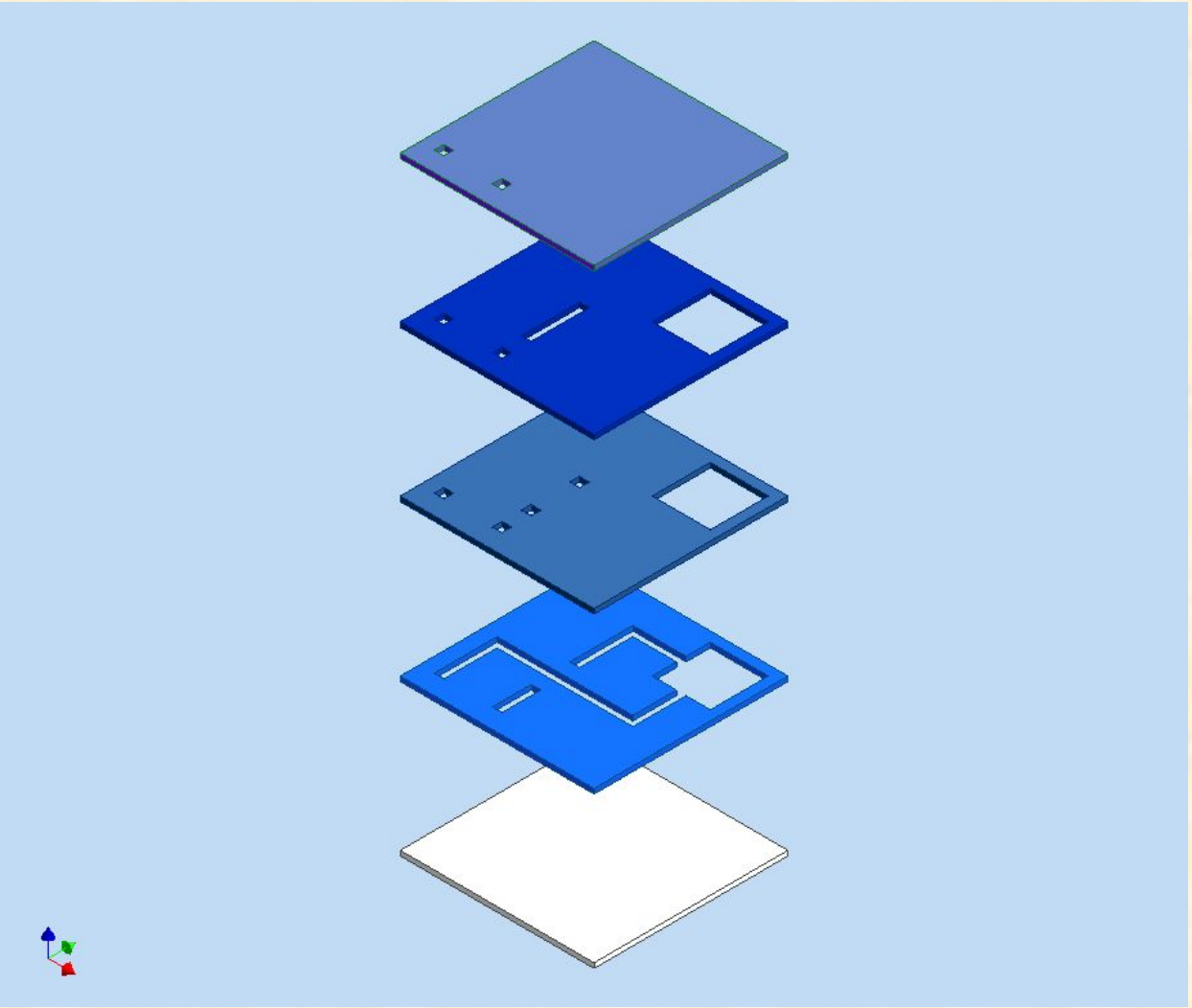
Principles of the TFT Electronic Circuit



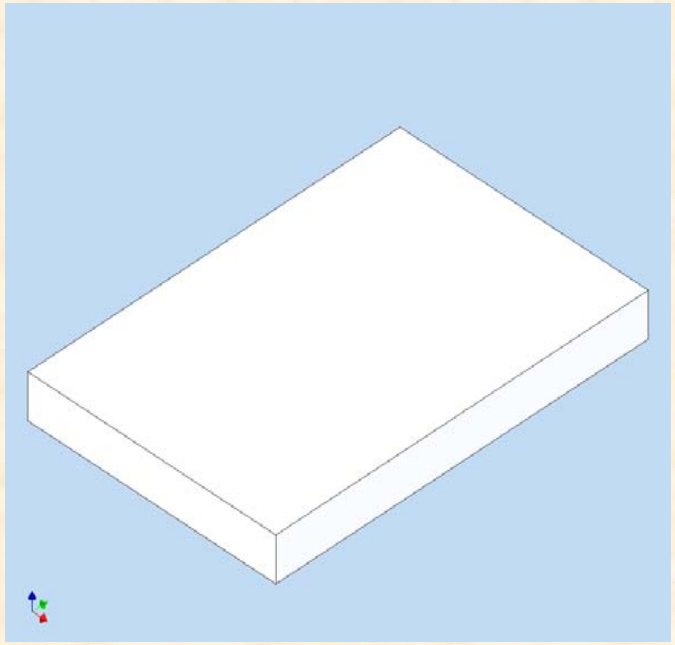
The Chemical Circuit

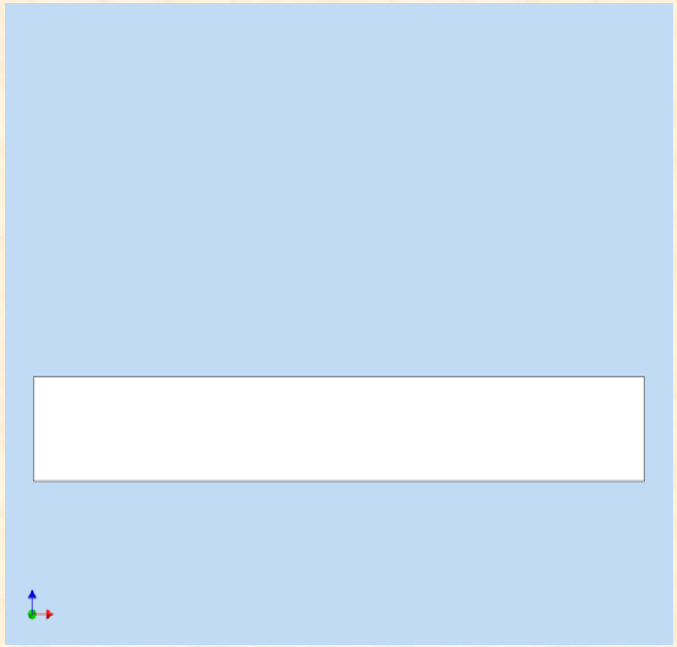


Production principles of the 3D TFT Chemical Chip



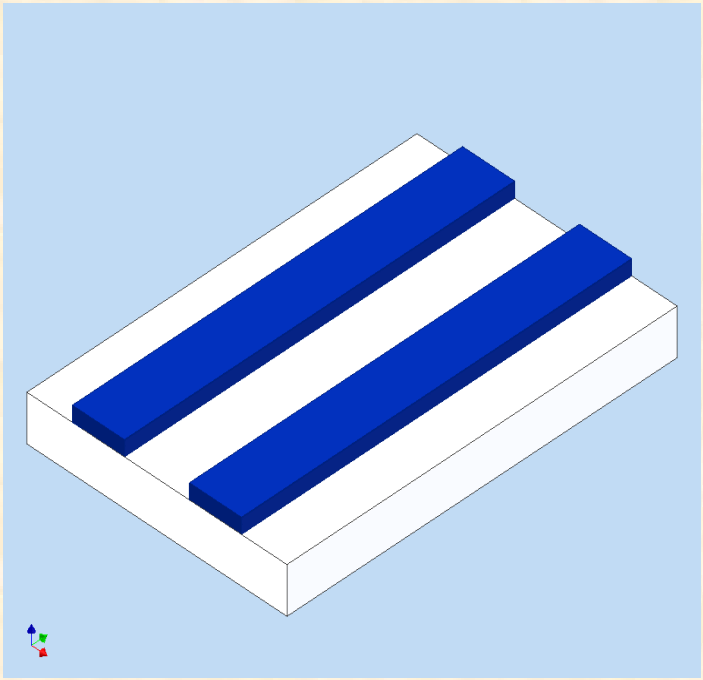
Channel preparation of the 3D - TFT

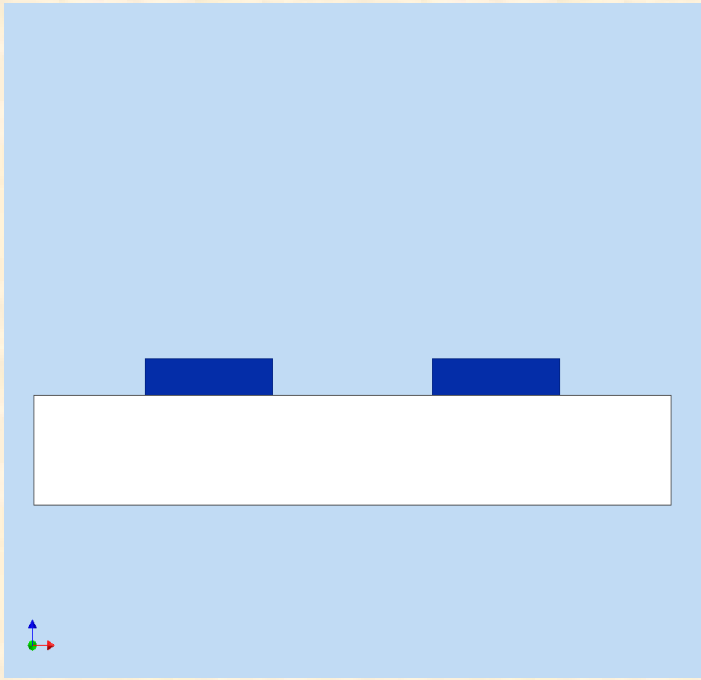




Alumina substrate

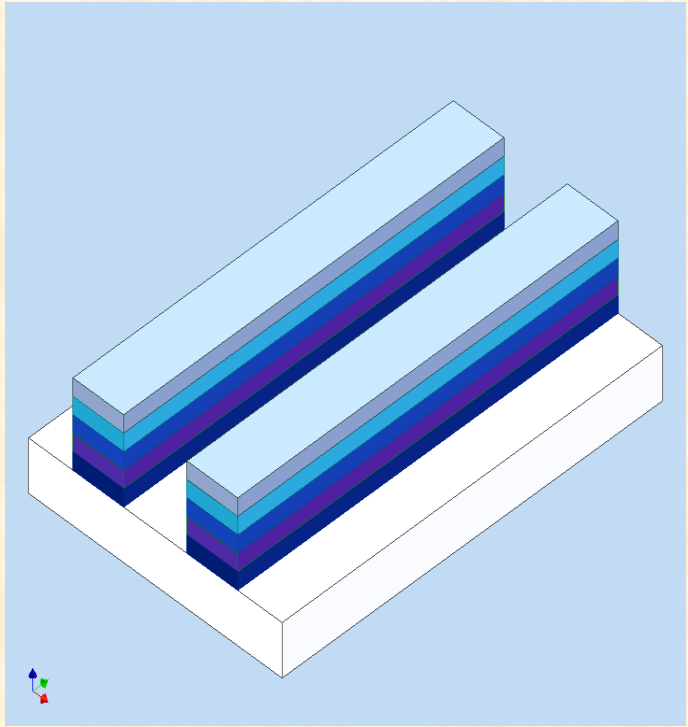
Channel preparation of the 3D - TFT

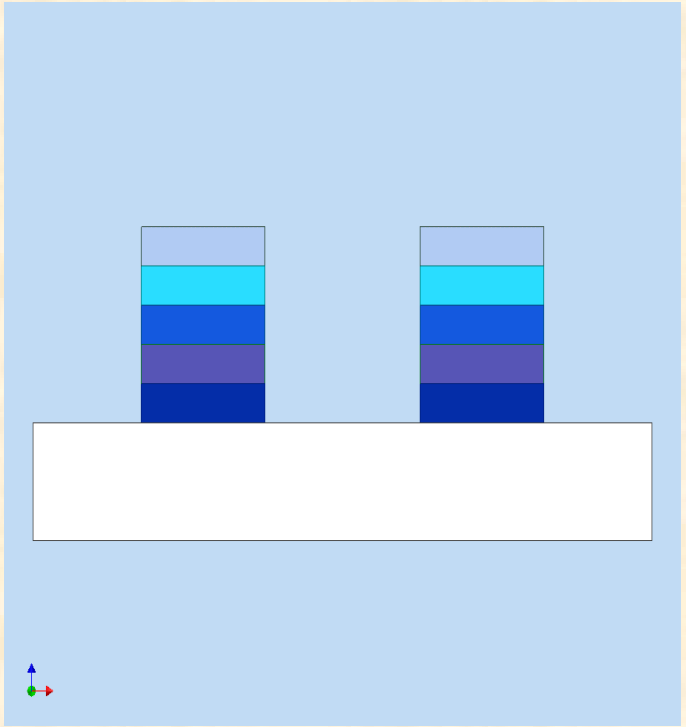




Printing of the first layer

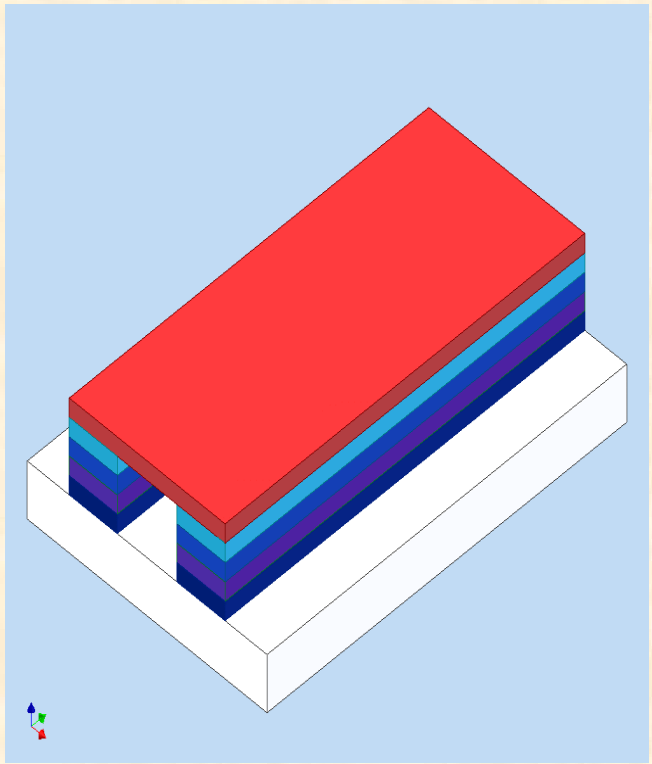
Channel preparation of the 3D - TFT

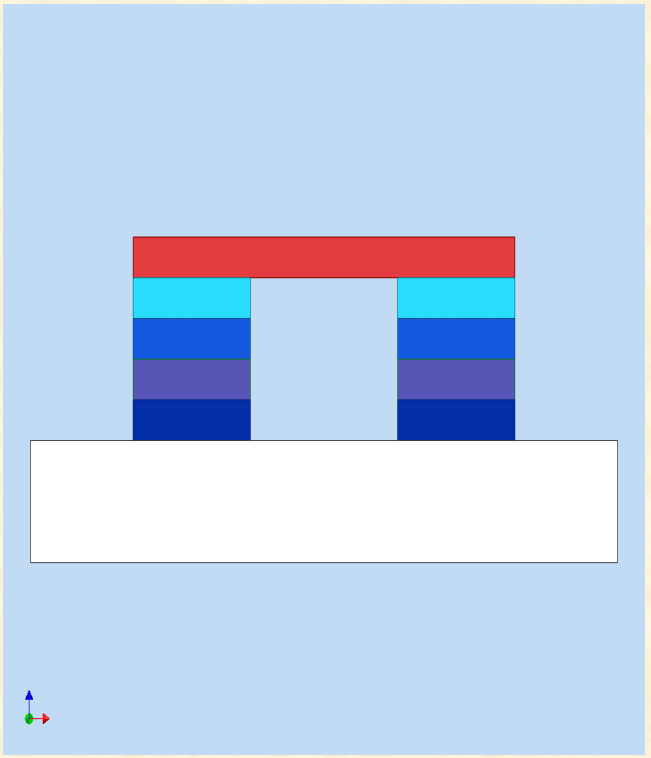




Channel height is created by repeated printing

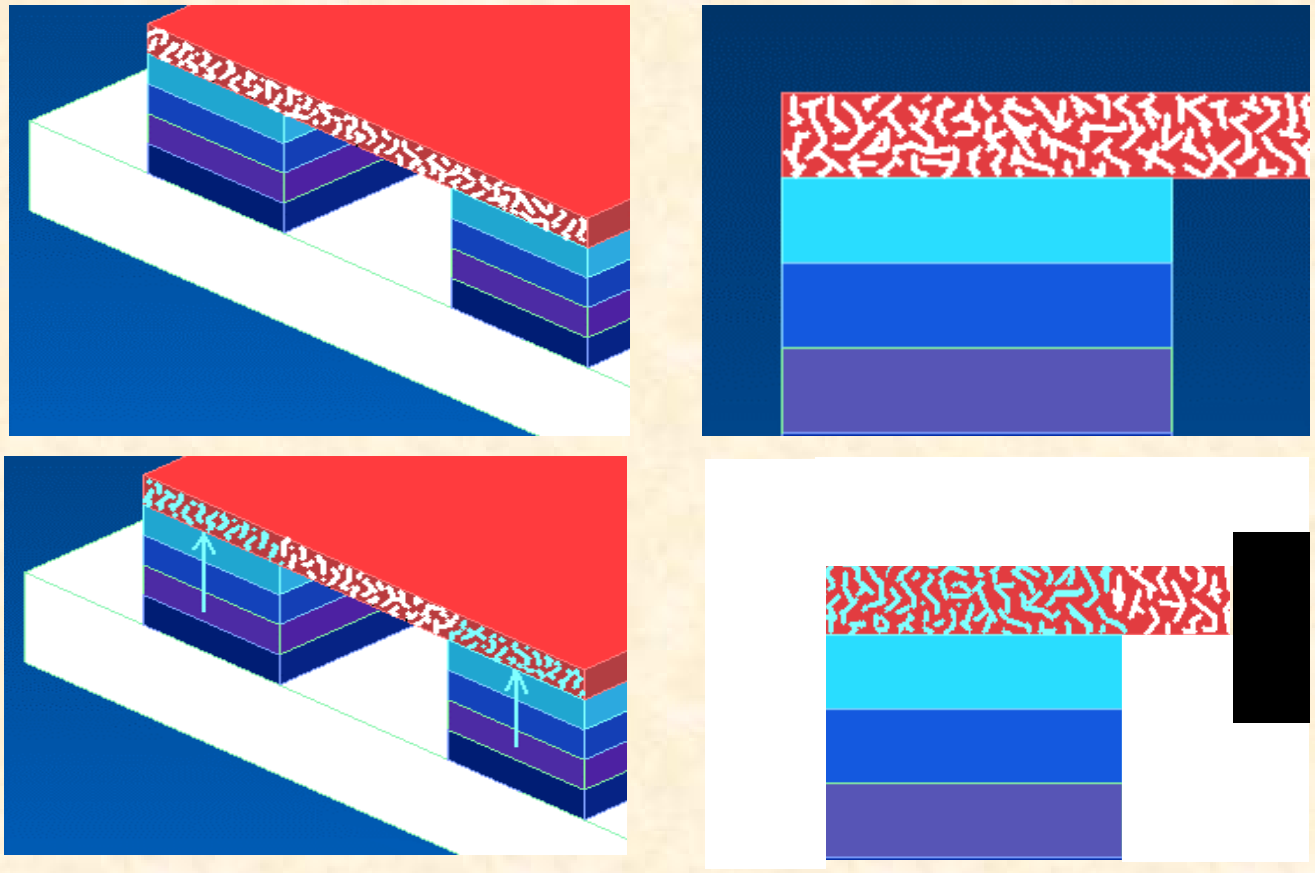
Channel preparation of the 3D - TFT





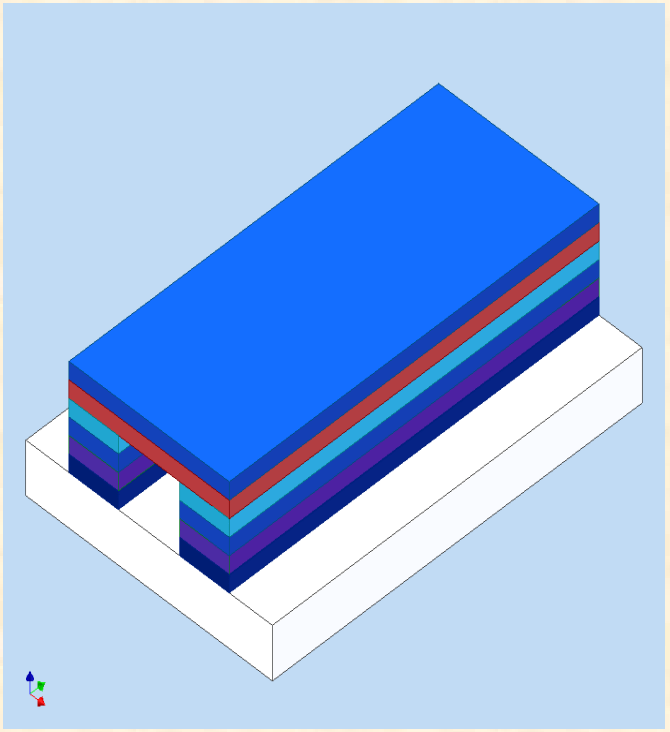
The supporting membrane is inserted

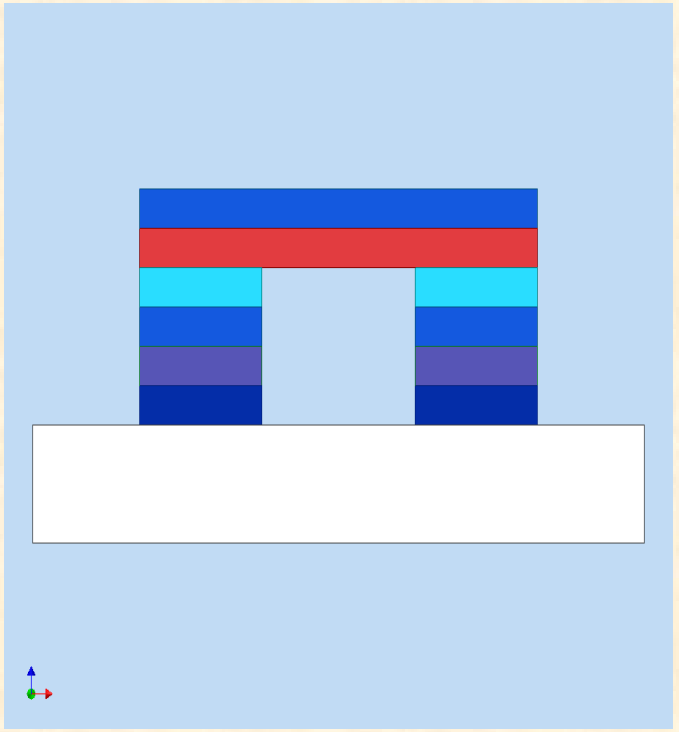
Channel preparation of the 3D - TFT



The structure of the supporting membrane ensures that the paste material penetrates to the membrane

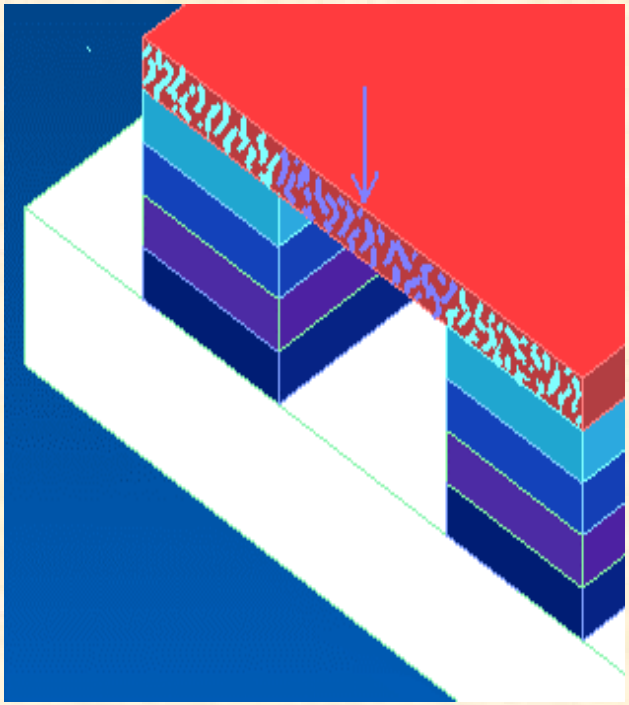
Channel preparation of the 3D - TFT

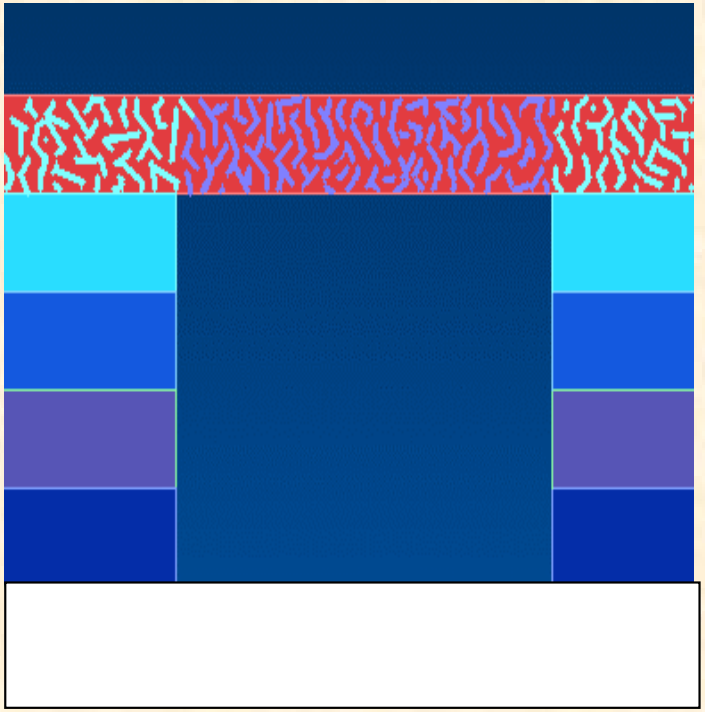




The last print finalises the channel

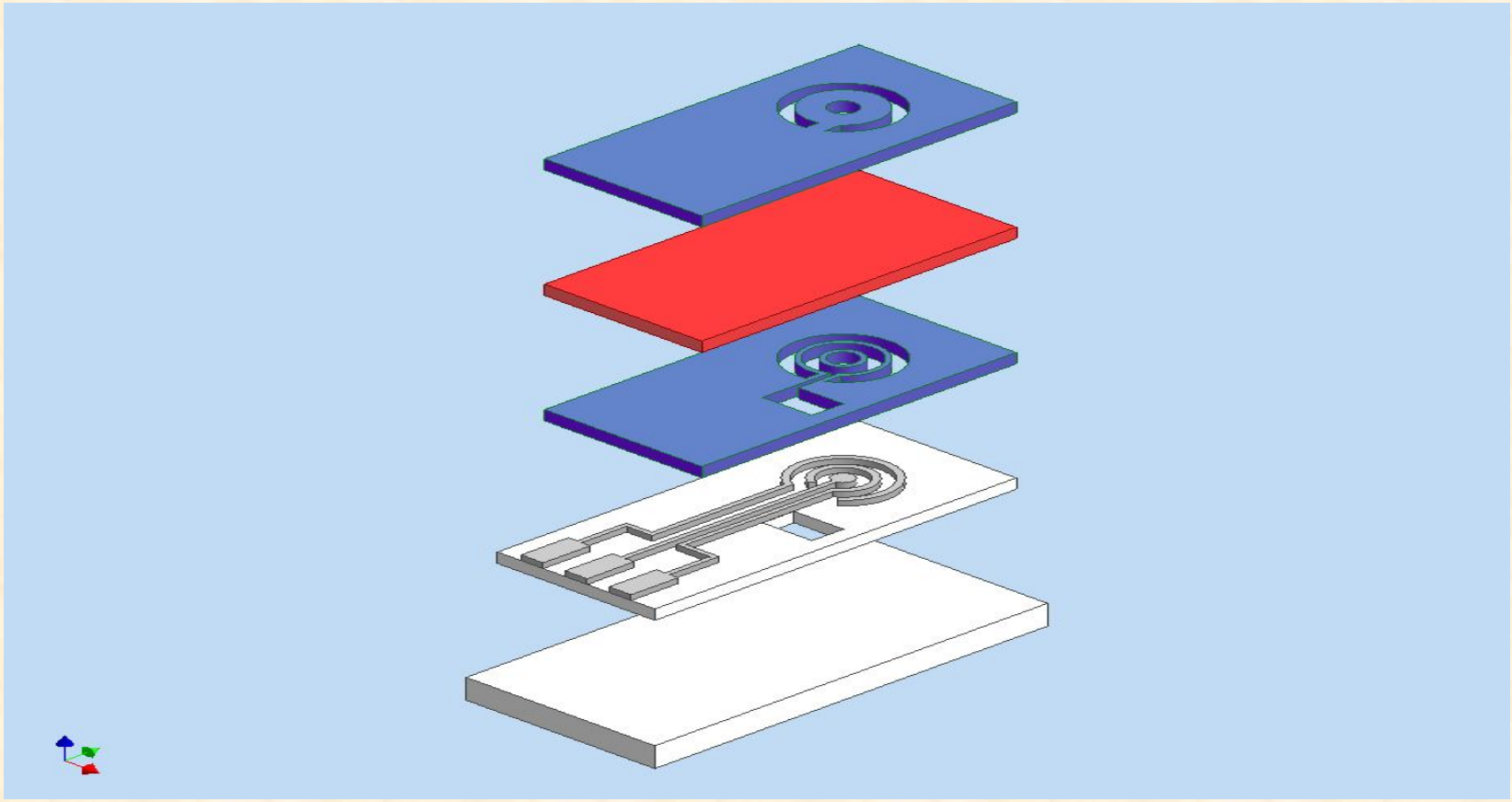
Channel preparation of the 3D - TFT





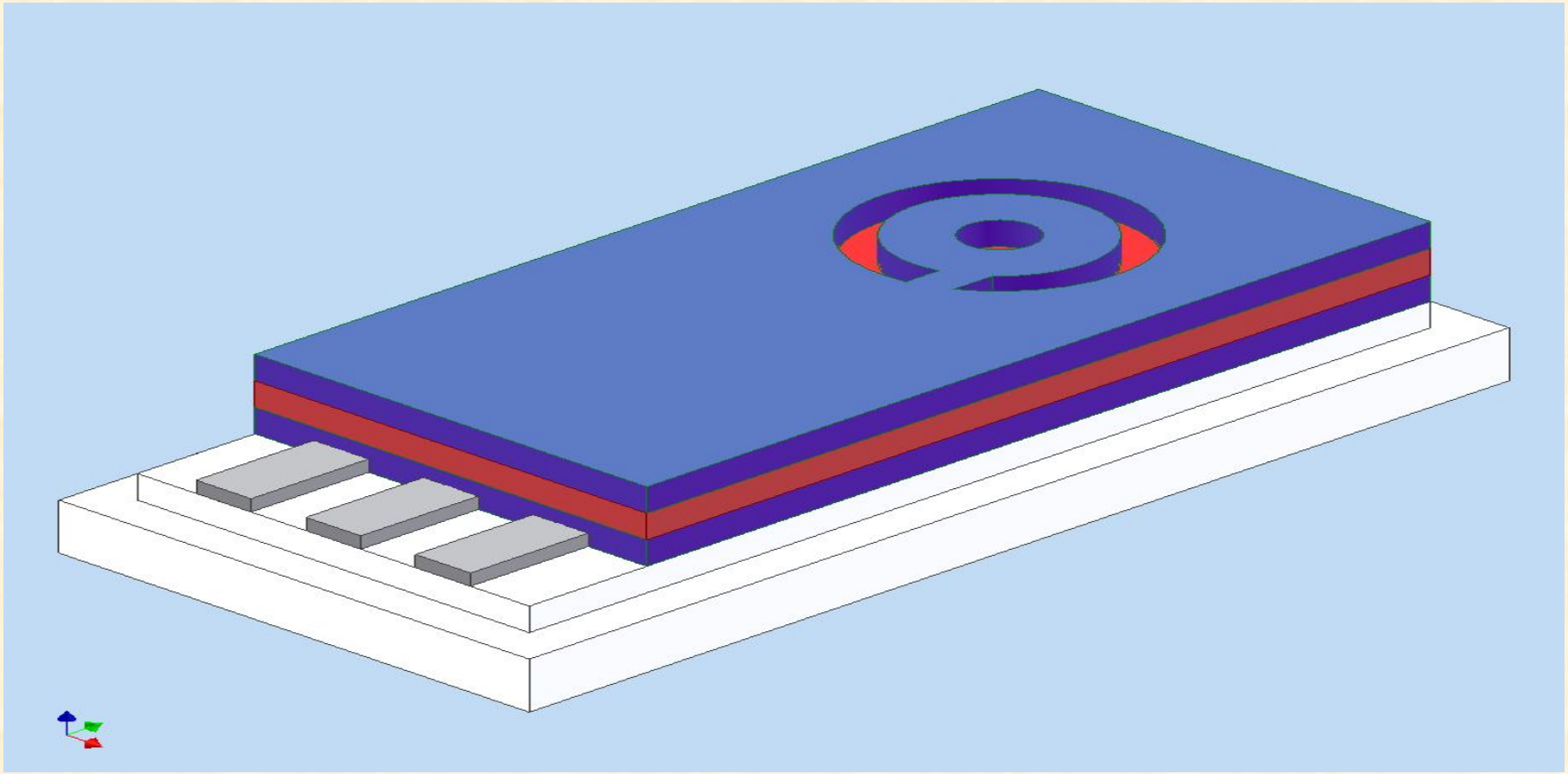
The paste penetrates to the membrane and the properties of the channel walls are determined by the printed paste material

Amperometric sensor with an exact reference electrode

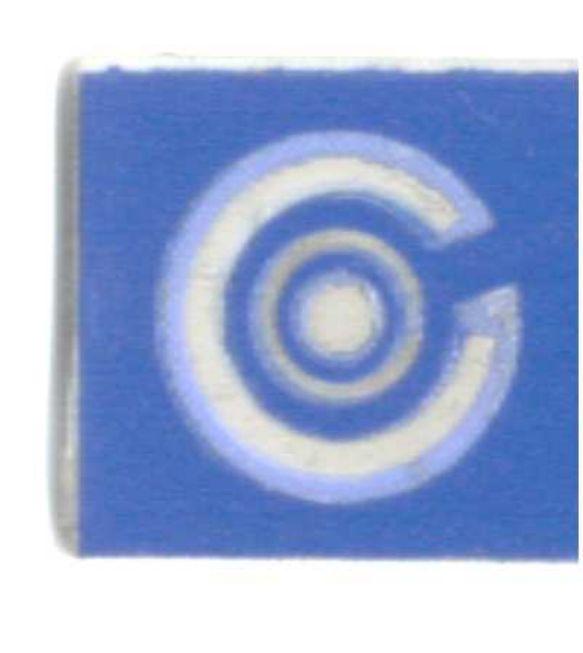


An example of 3D-TFT use showing an amperometric sensor with an exact reference electrode.

Amperometric sensor with an exact reference electrode

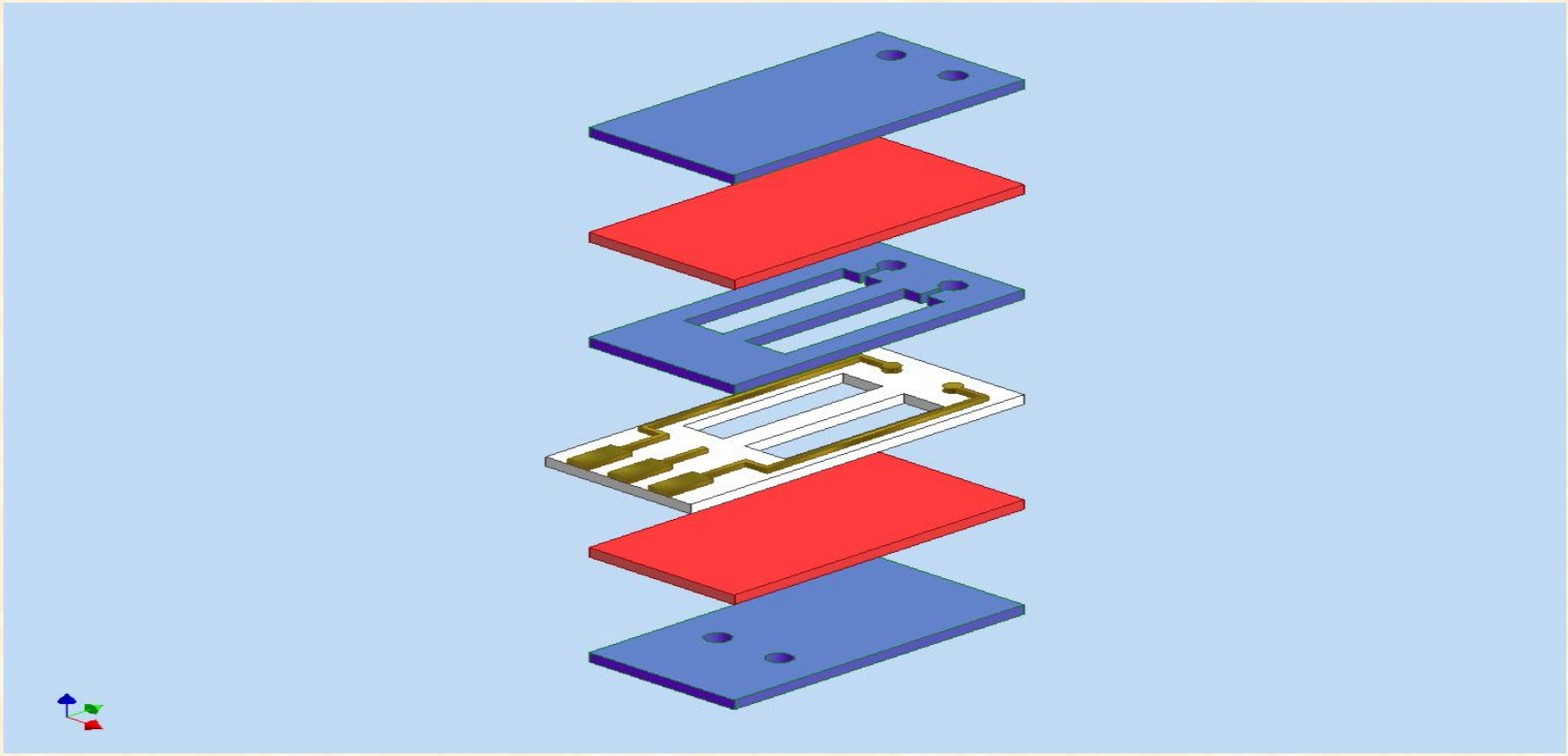


Amperometric sensor with an exact reference electrode



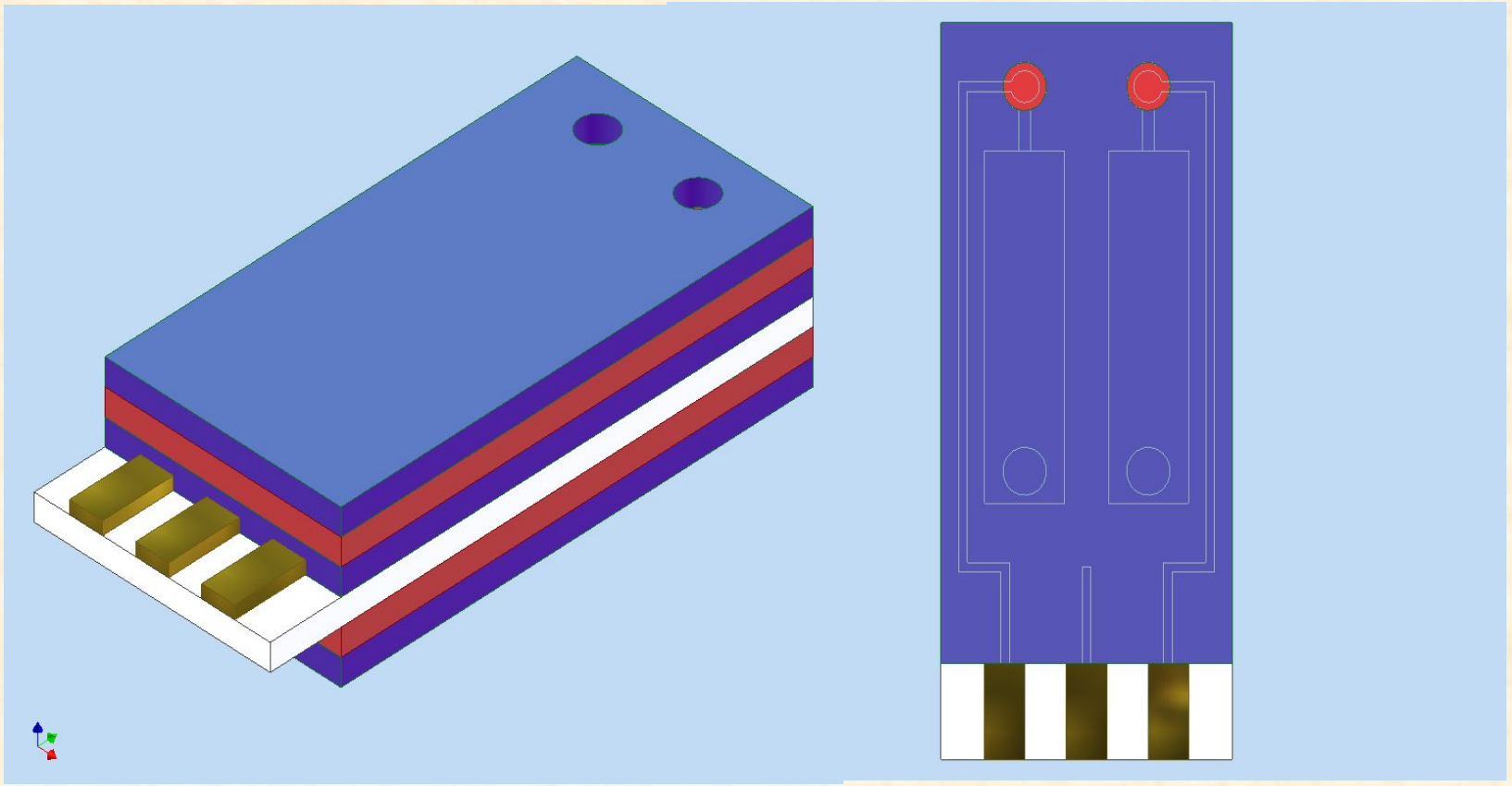
Final product. The electrochemical sensor is 25 mm long and 7.3 mm wide. The diameter of the working electrode is 1 mm.

Ion-selective Electrode



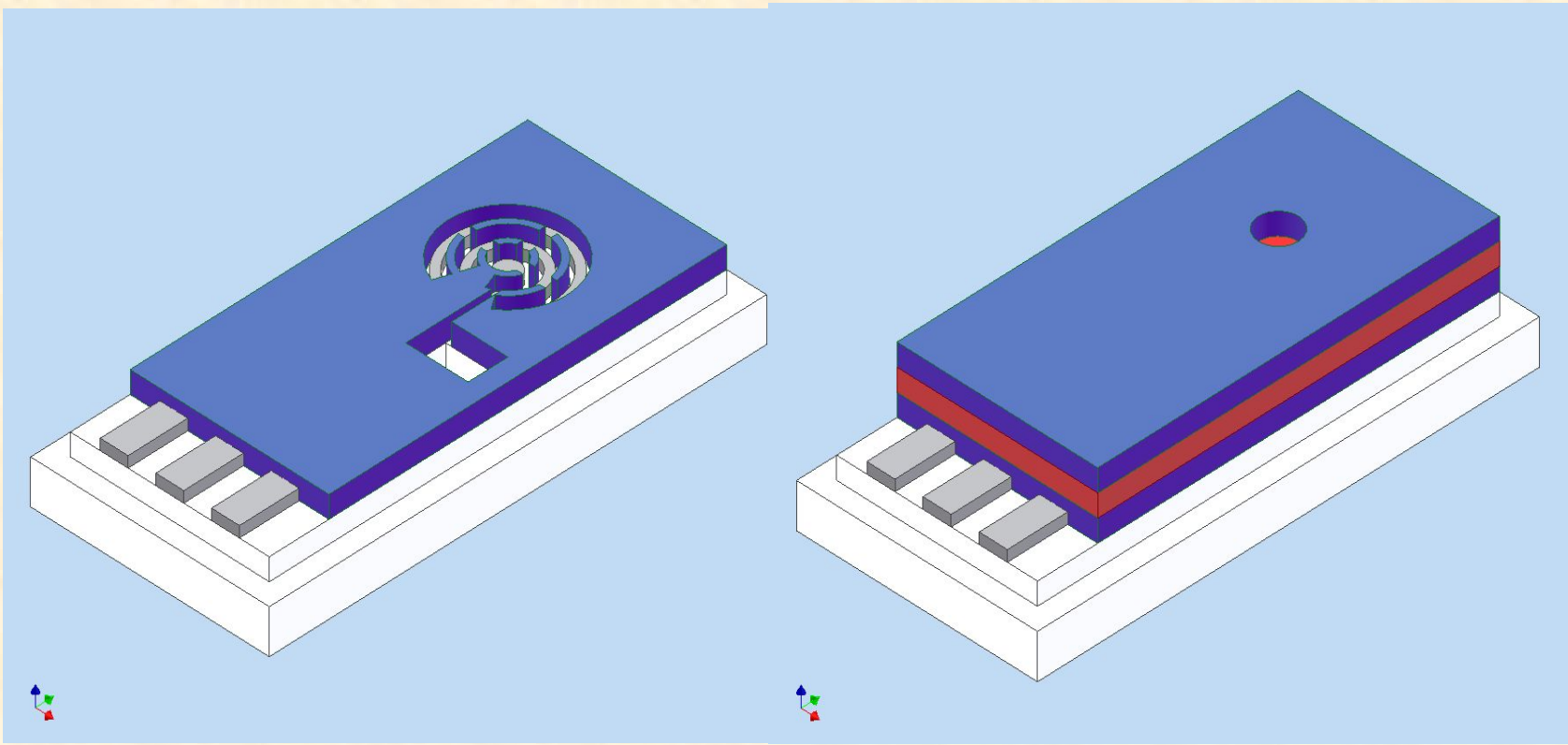
The sensor consists of two potentiometric electrodes. The first one is a reference electrode and the second one is ion-selective.

Ion-selective Electrode



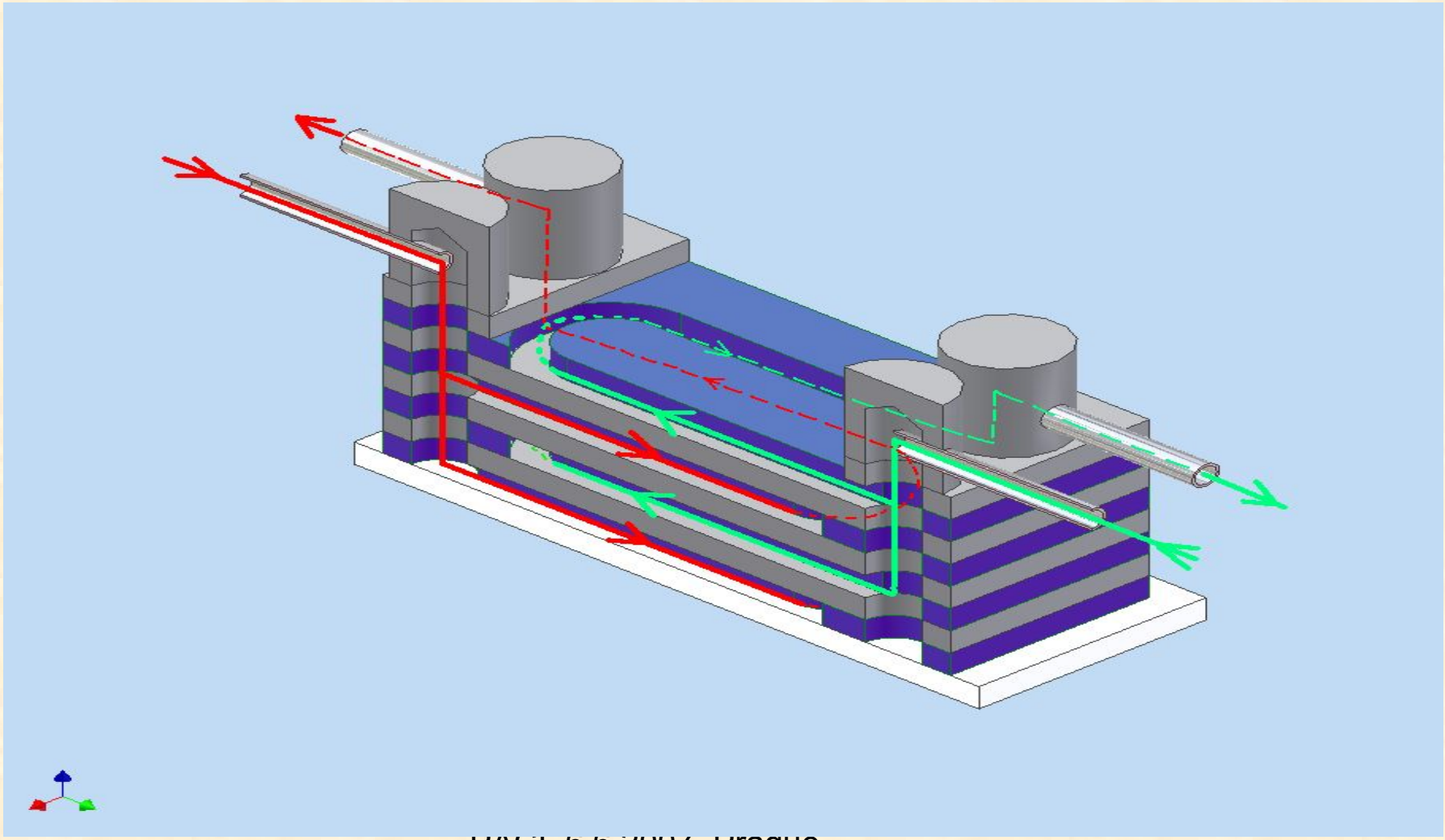
Ion-selective Electrode

Oxygen Electrode

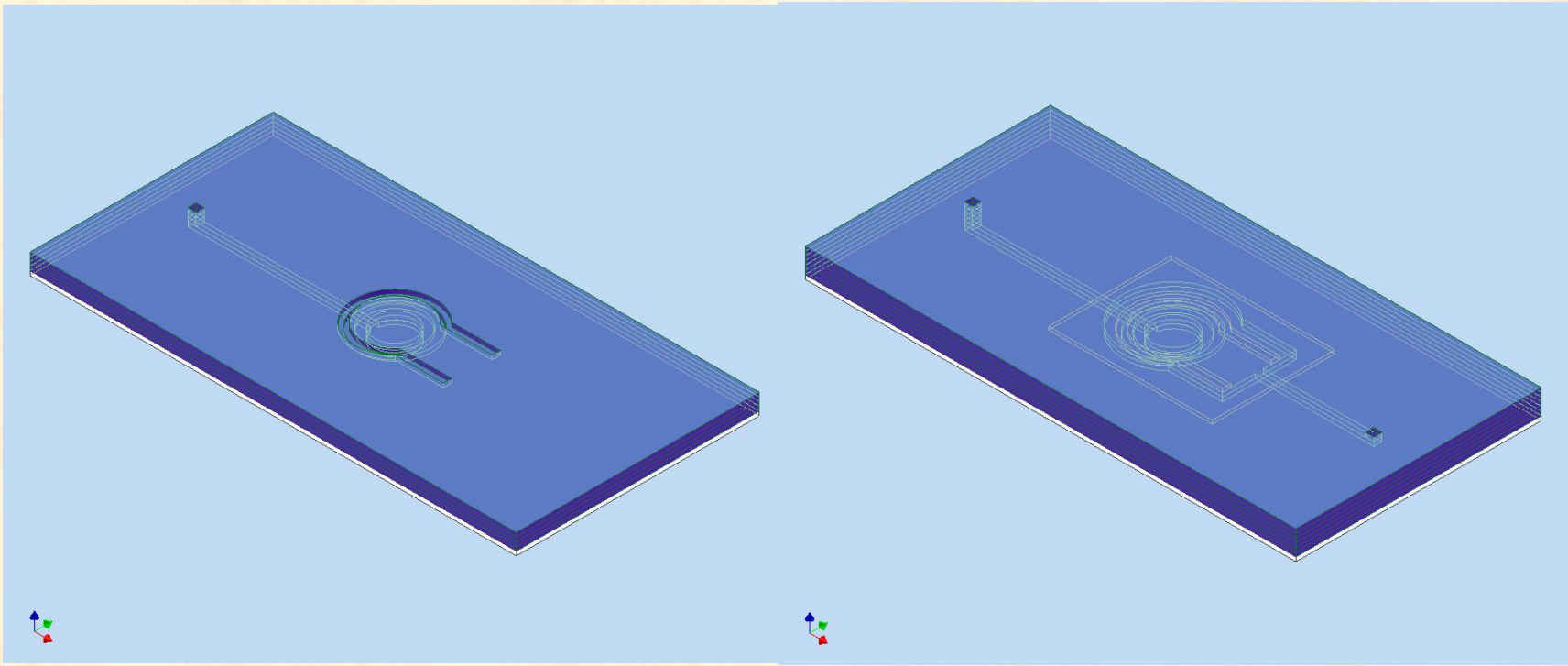


The internal space is filled by an internal electrolyte. Small windows within the membrane enable oxygen diffusion to the working electrode.

Micro-filter

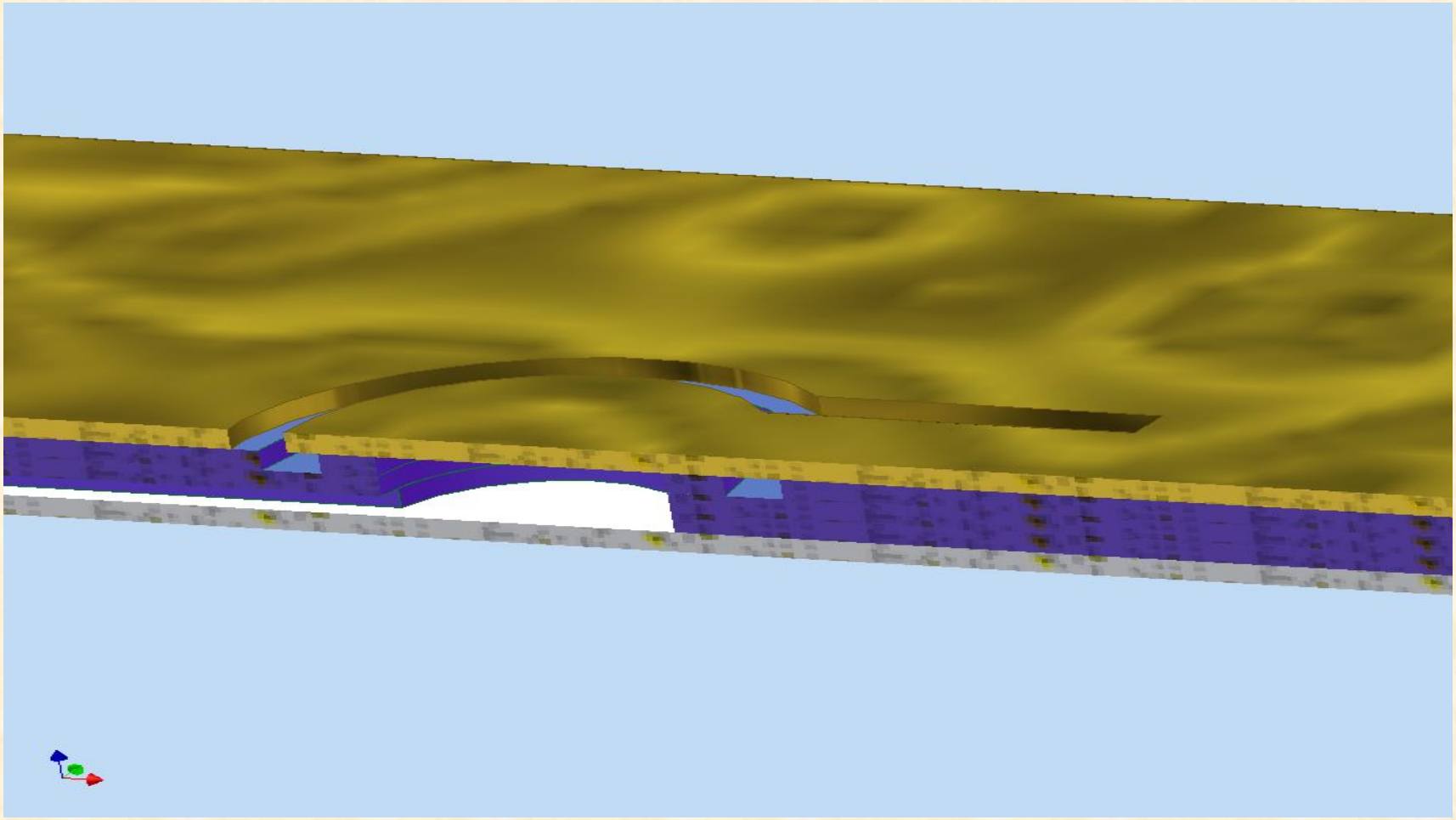


Valve

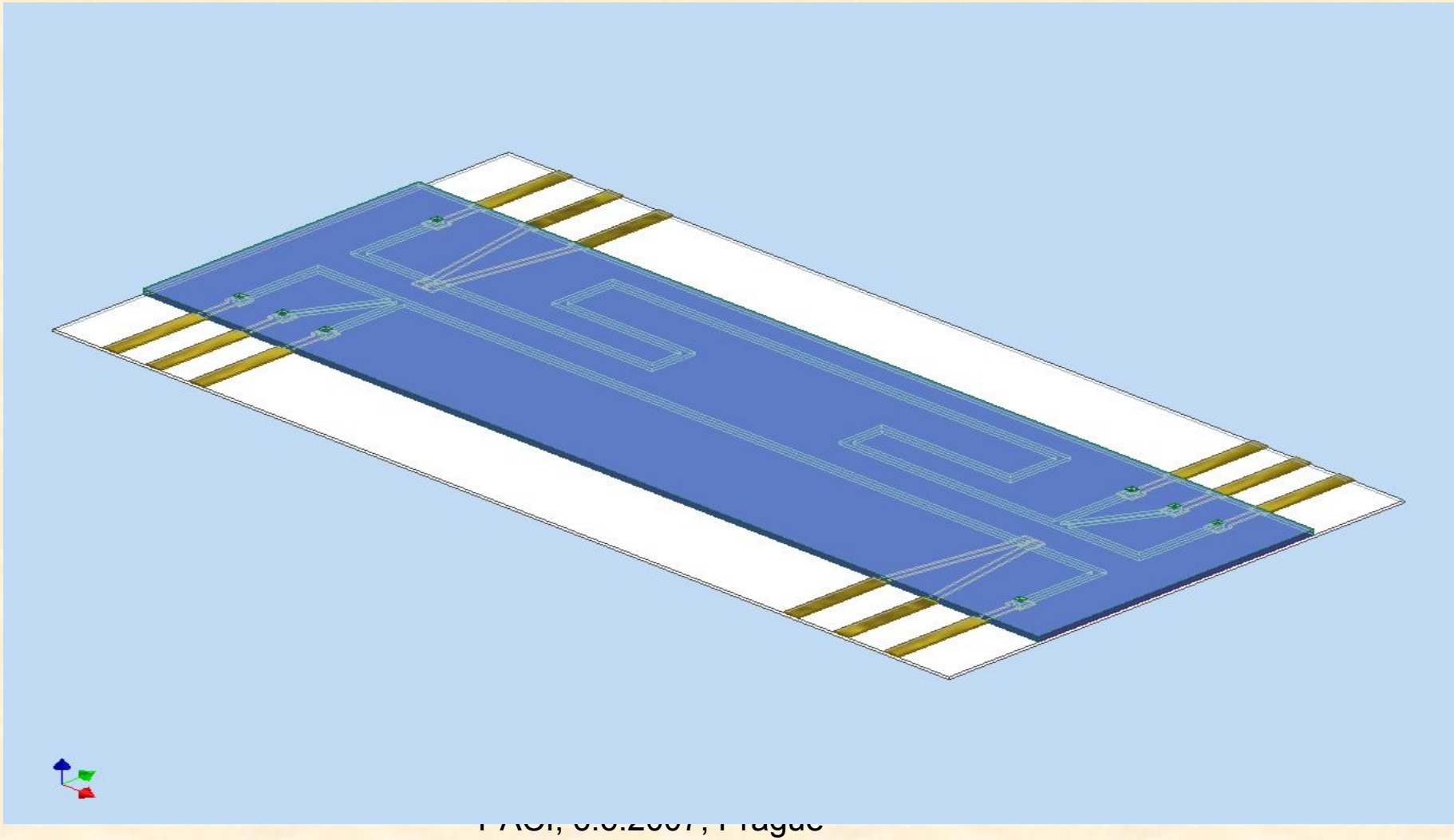


The supporting membrane can be made from metal. The membrane must be selectively cut by laser.

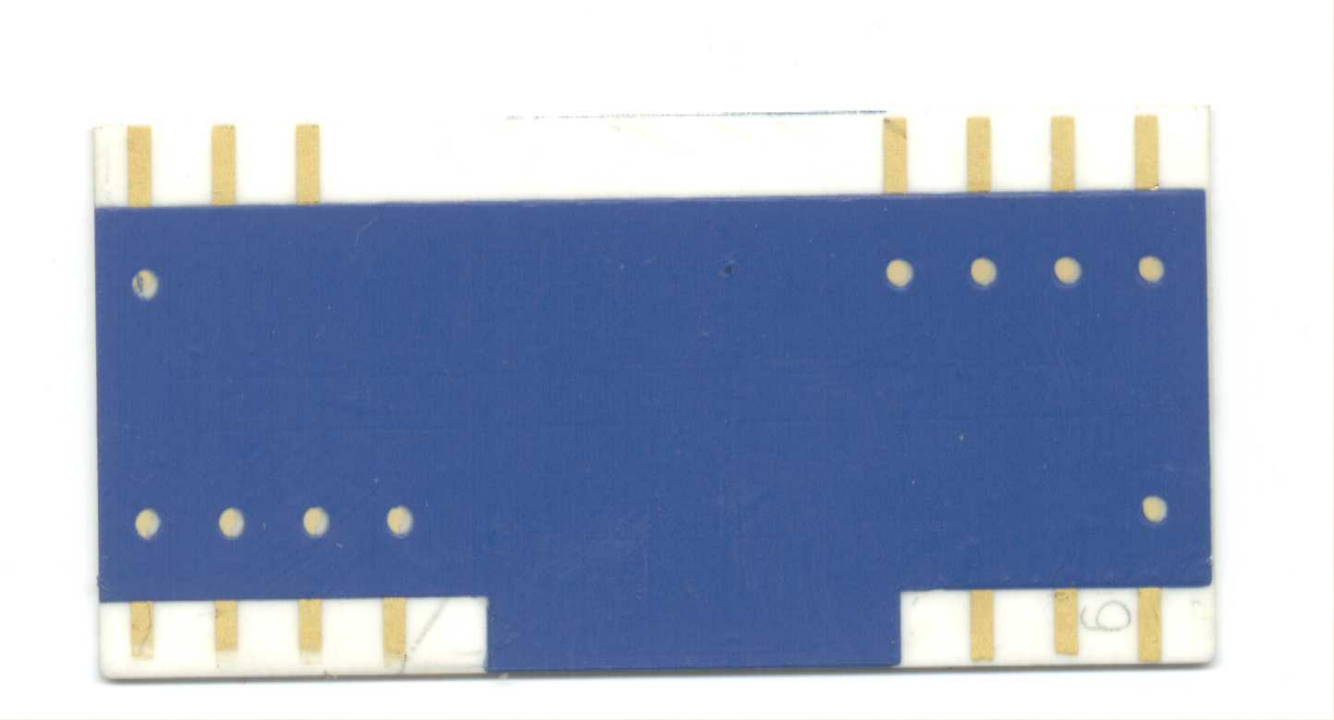
Valve



Capillary Electrophoresis



Capillary Electrophoresis



Final product

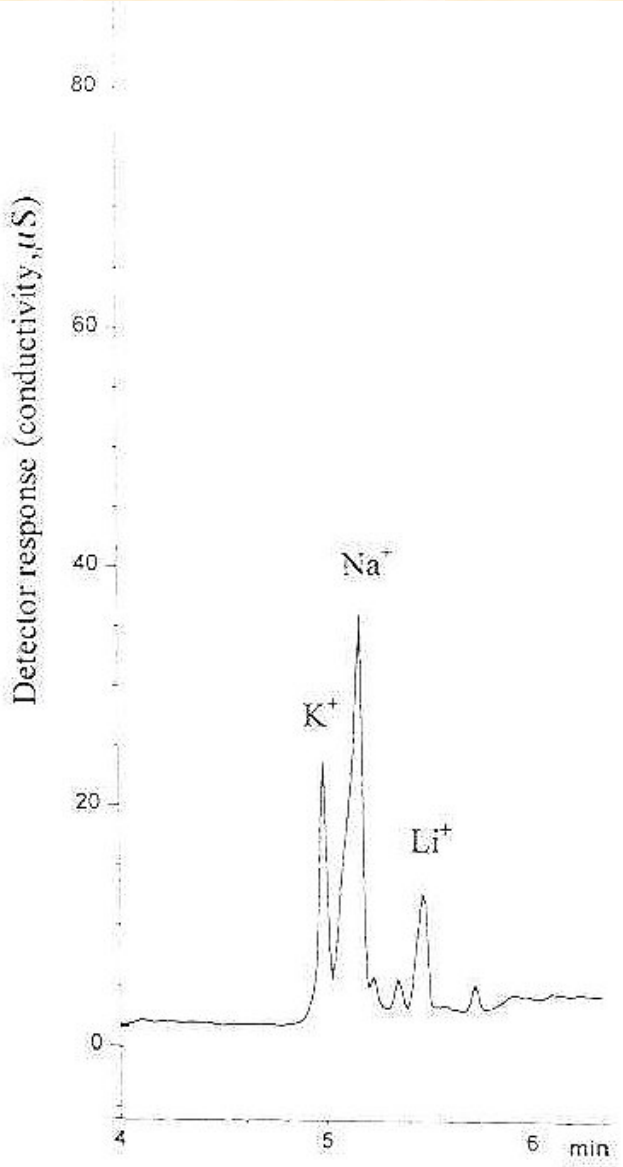
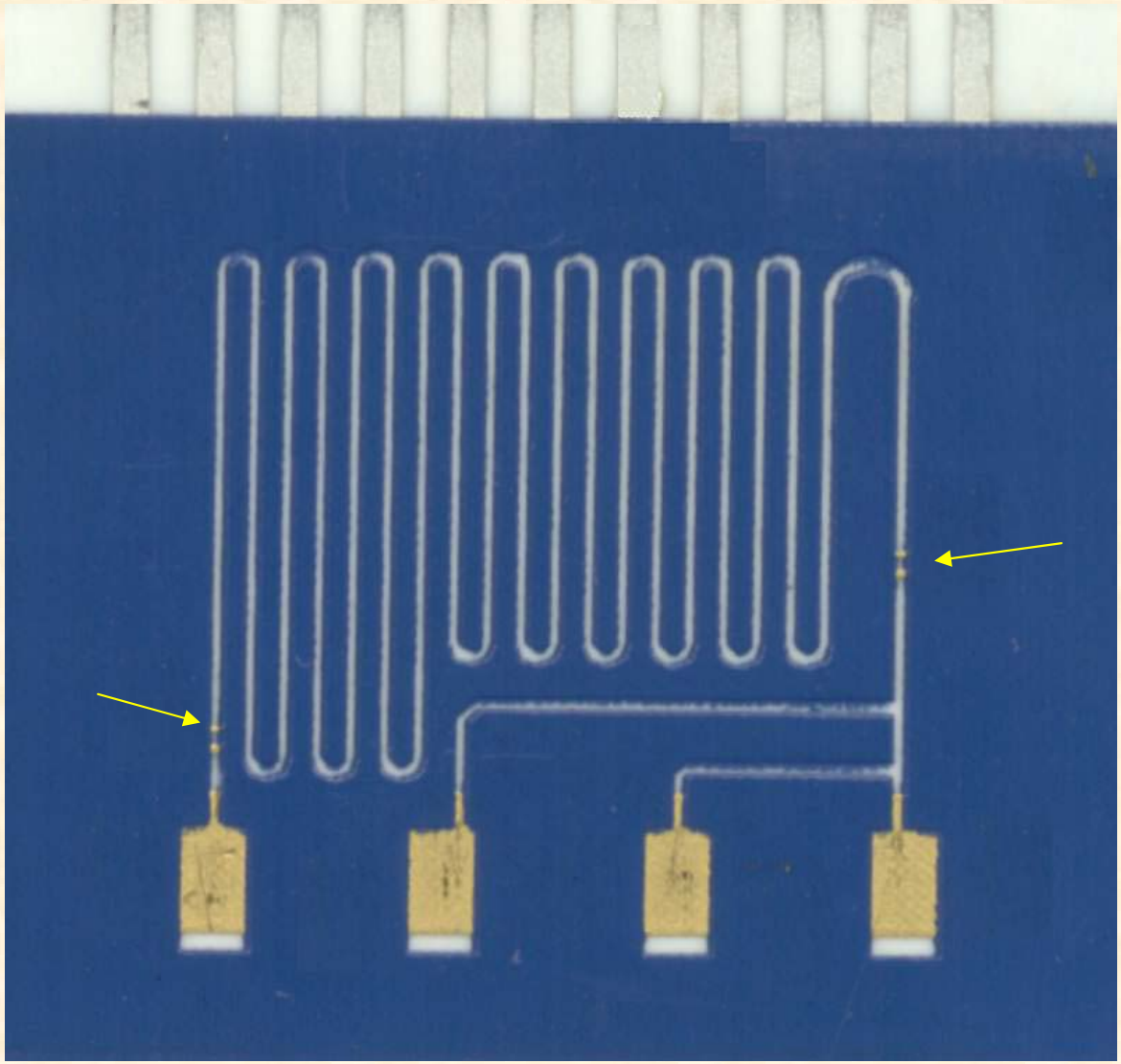


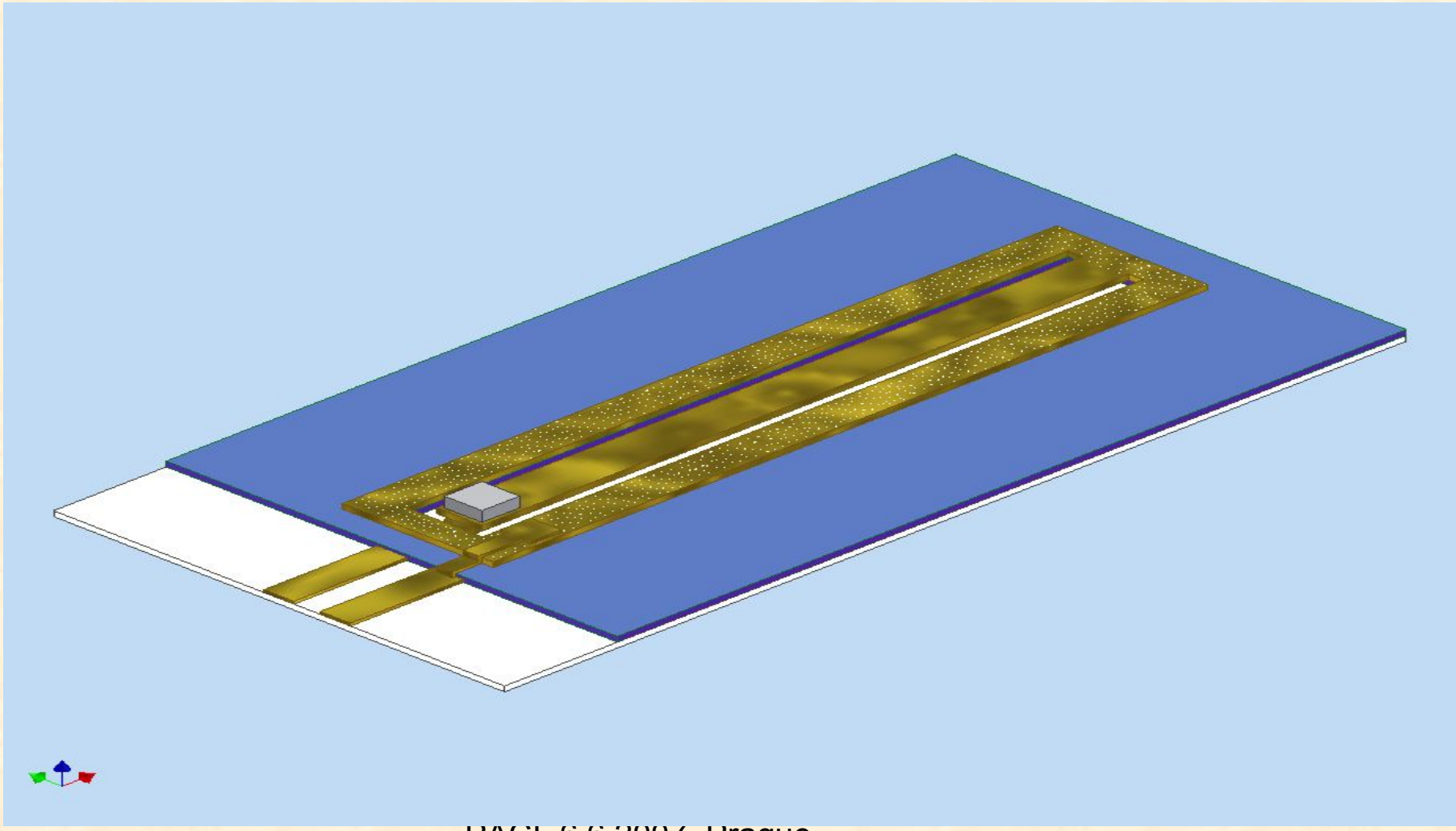
Fig. 5. Separation of Na, K and Li (as chlorides) in 20 m*M* MES–20 mmol His, pH 5.5; electrokinetic injection: 200 V/5 s; separation voltage: 600 V. Cathode on the right-hand-side.

Deyl Z., Rohlicek V.: Versatile tool for the manipulation of electrophoresis chips, Journal of Chromatography B, 770 (2002) 19-23

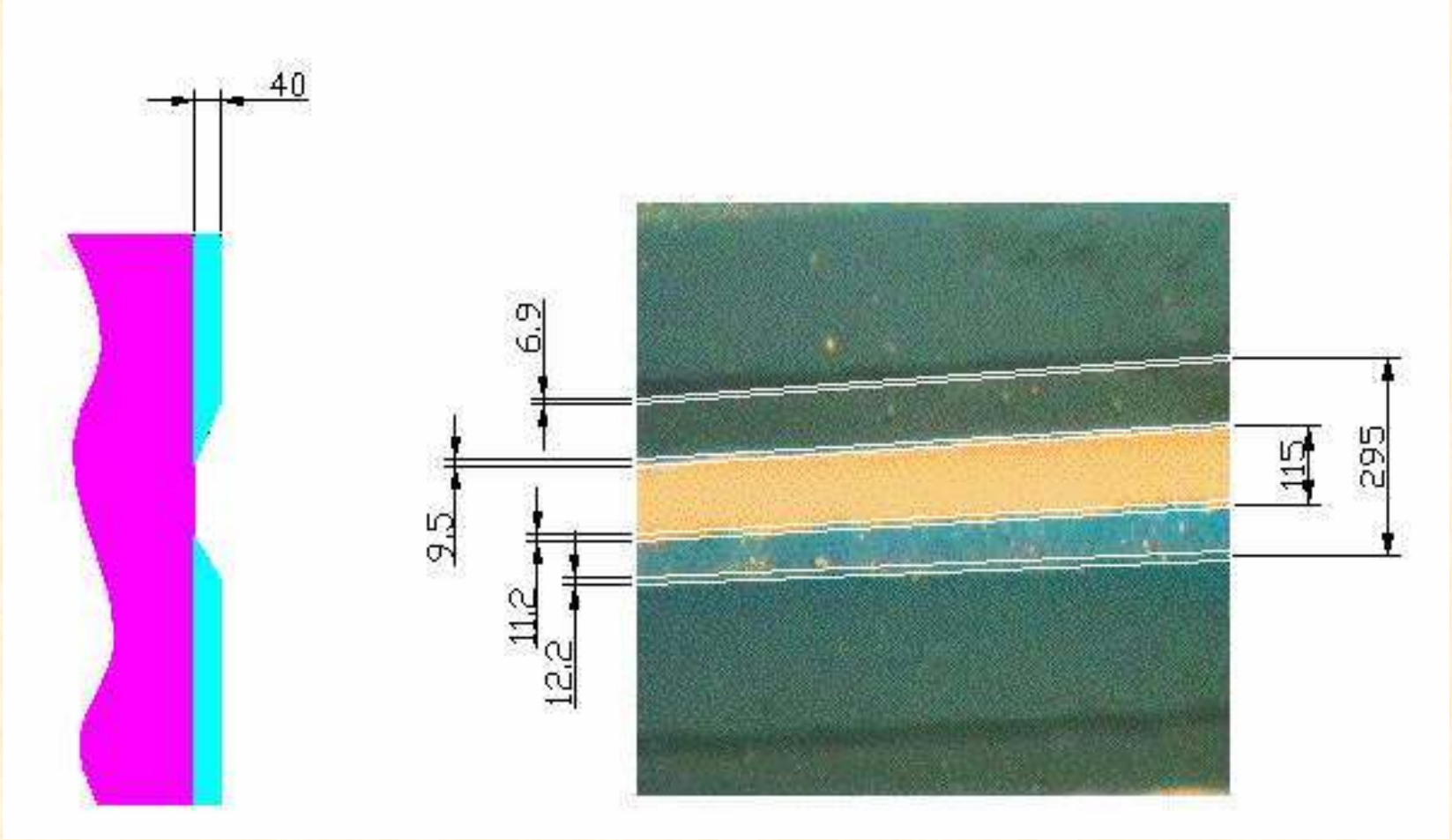
Capillary Electrophoresis



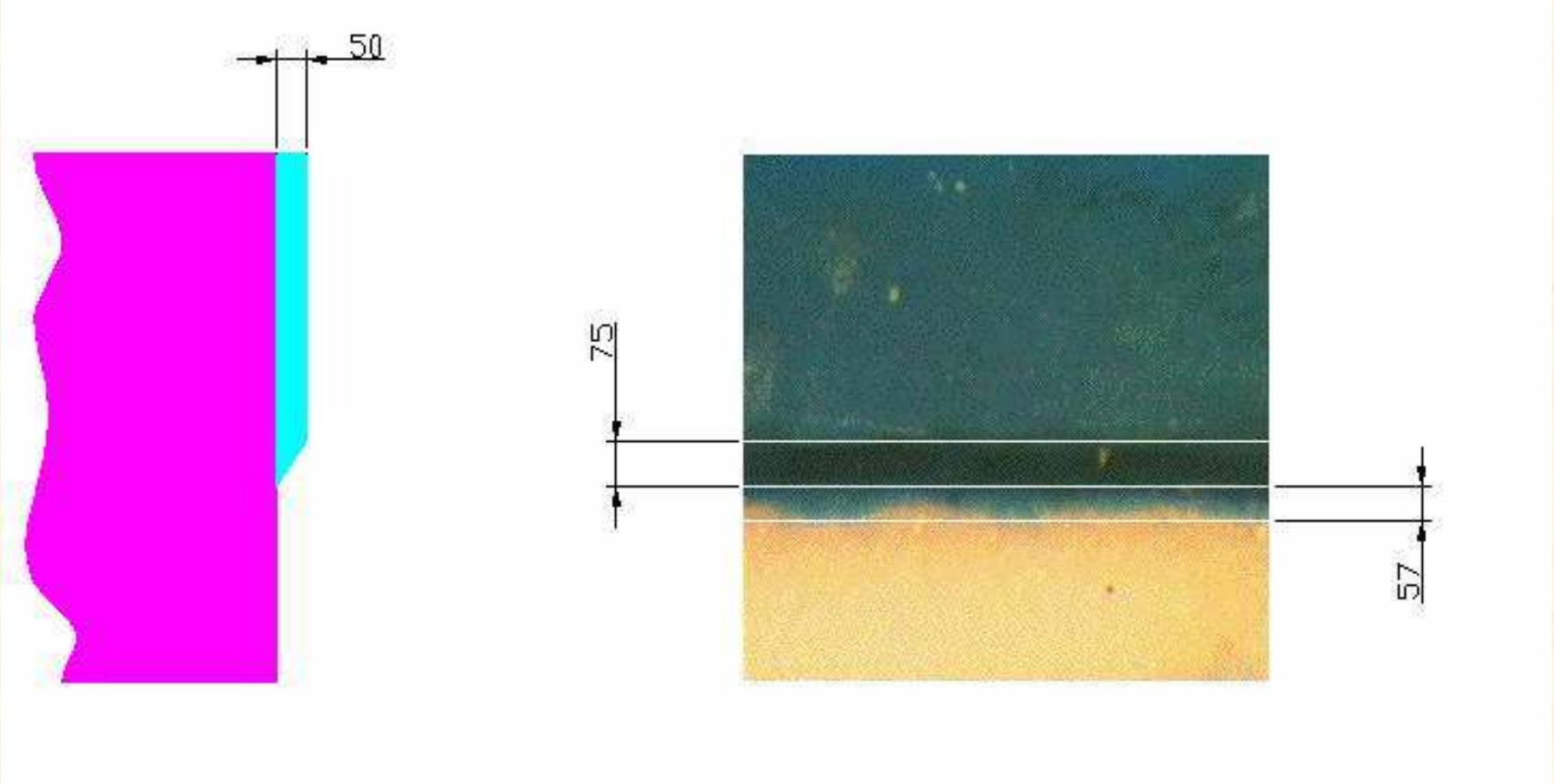
Accelerometer



Real structure of the channel



Channel Imprecision



Screen structure is only partially transferred to the printed object

Types of 3D Structures

Optimum structures for 3D –TFT

- Characteristic width 500 – 100 microns
- Characteristic height 10 – 500 microns
- Structure function does not depend on wall surface quality

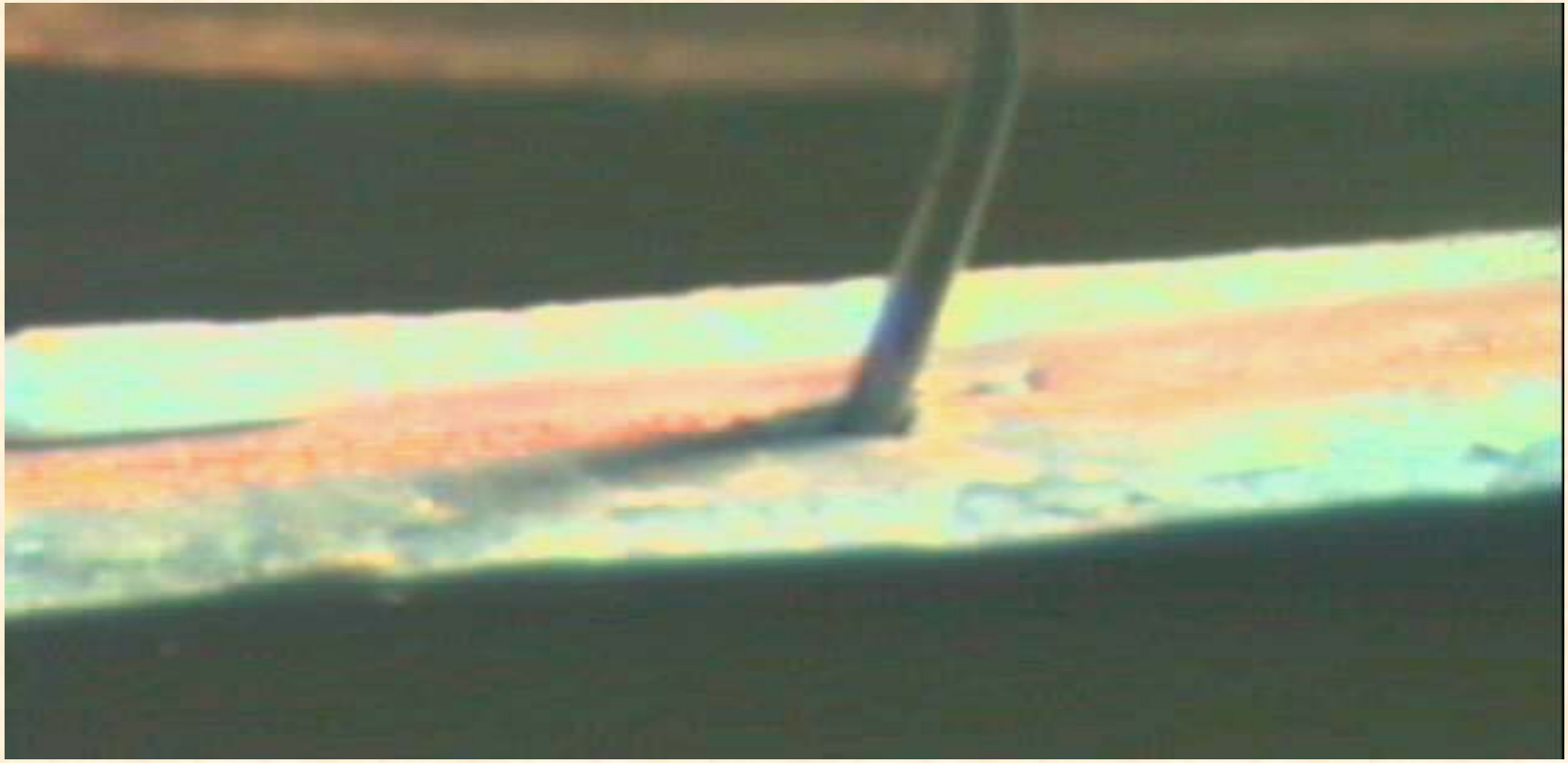
Optimum structures for other technologies

- Characteristic width less than 20 microns
- Characteristic height less than 10 microns
- Structure function depends on wall surface quality

The Future

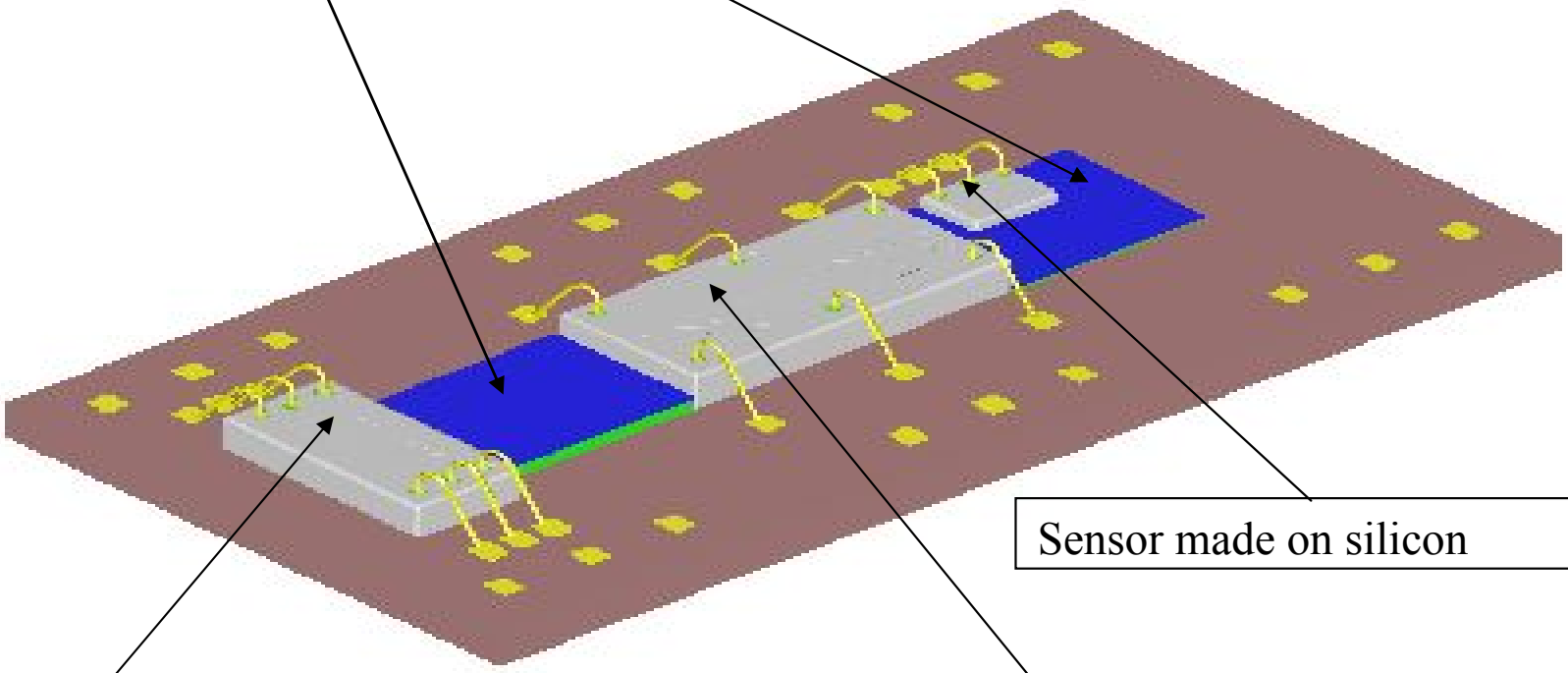
- New TFT Technologies (FODEL, Fine line printing, Photolithography of printed layers)
- Connection with LTCC
- Lab on a Chip

An example of connecting a capillary with LTCC



A 180 micron stainless steel tube is co-fired to LTCC.

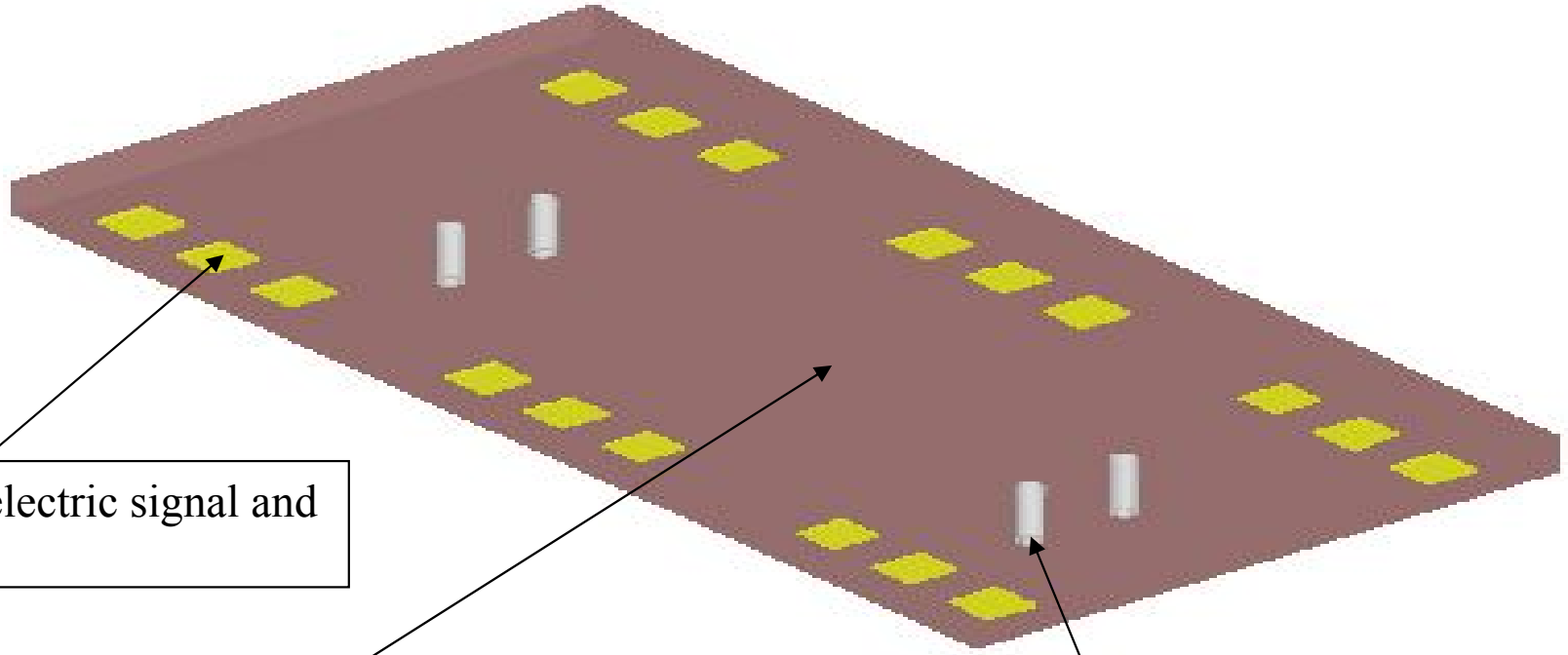
3D-TFT Microfluidic module



Sensor made on silicon

Evaluating electronics, amplifiers,..

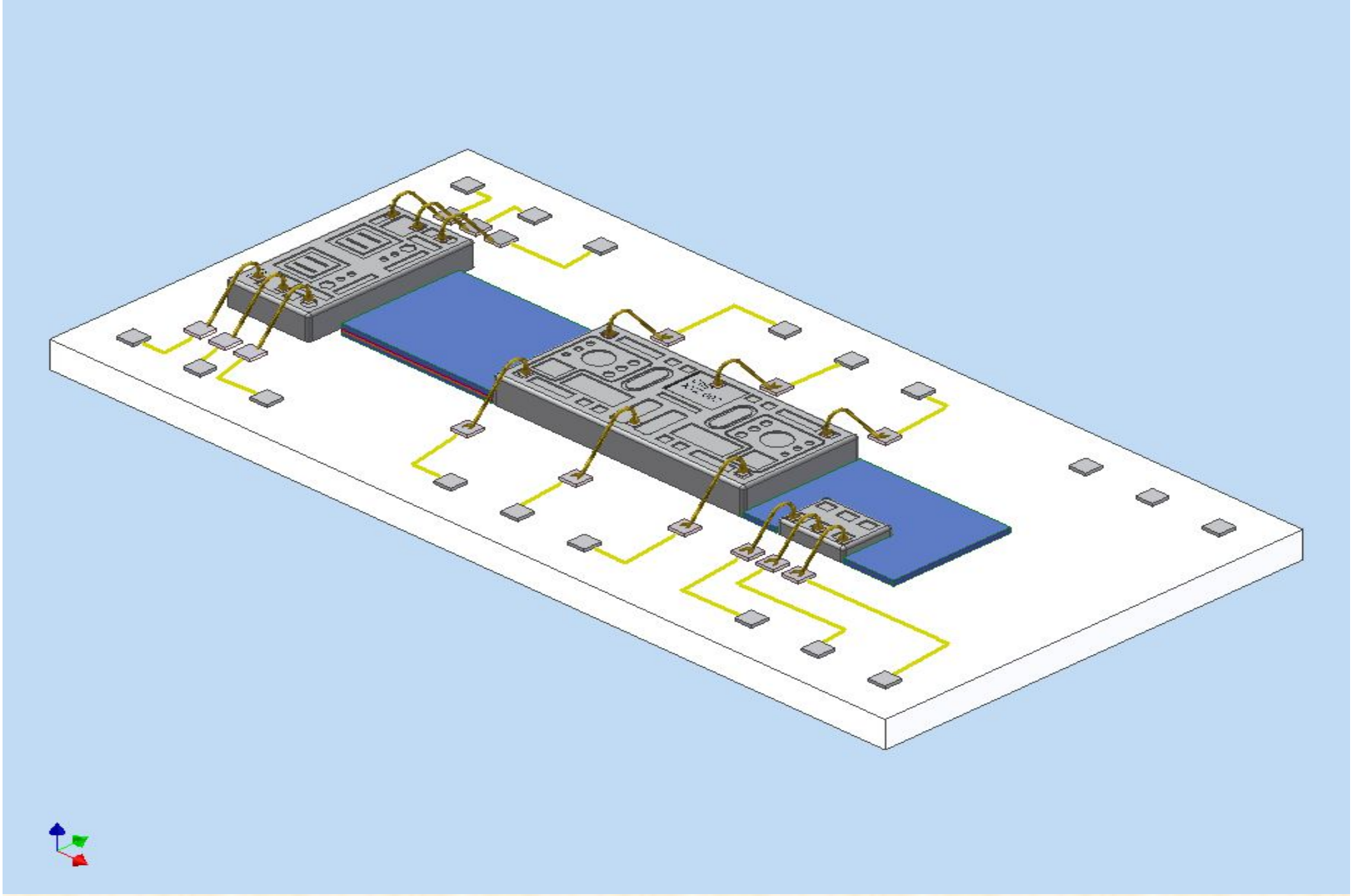
Microfluidics made by nanotechnologies in silicon



Contact for electric signal and supply

Ceramic Base

H ydrodynamic connectors made by LTCC and 3D-TFT



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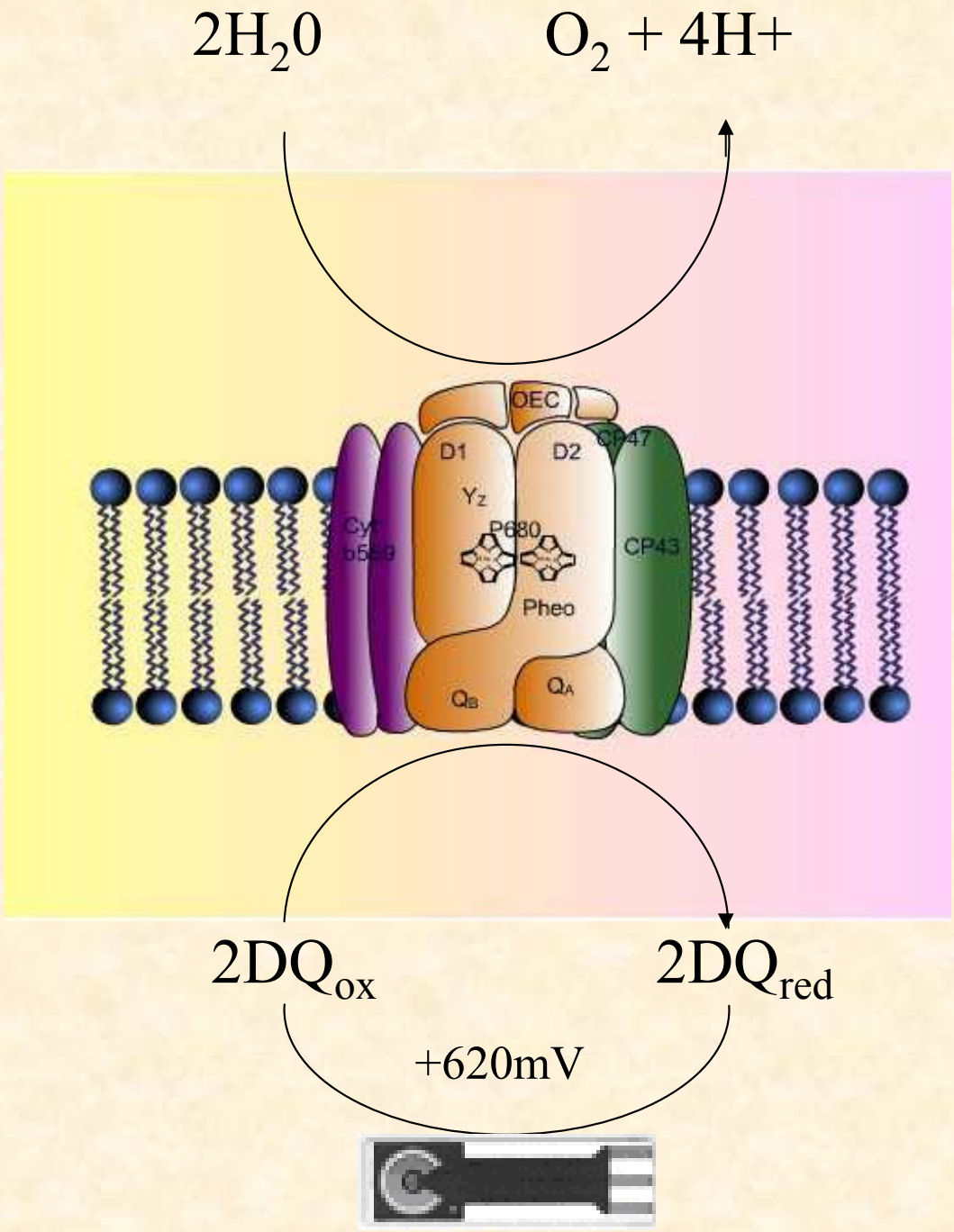
- Program Technos TC 5 – 119, Czech Ministry of Industry
- Project Antope FD-K2-53, Czech Ministry of Industry

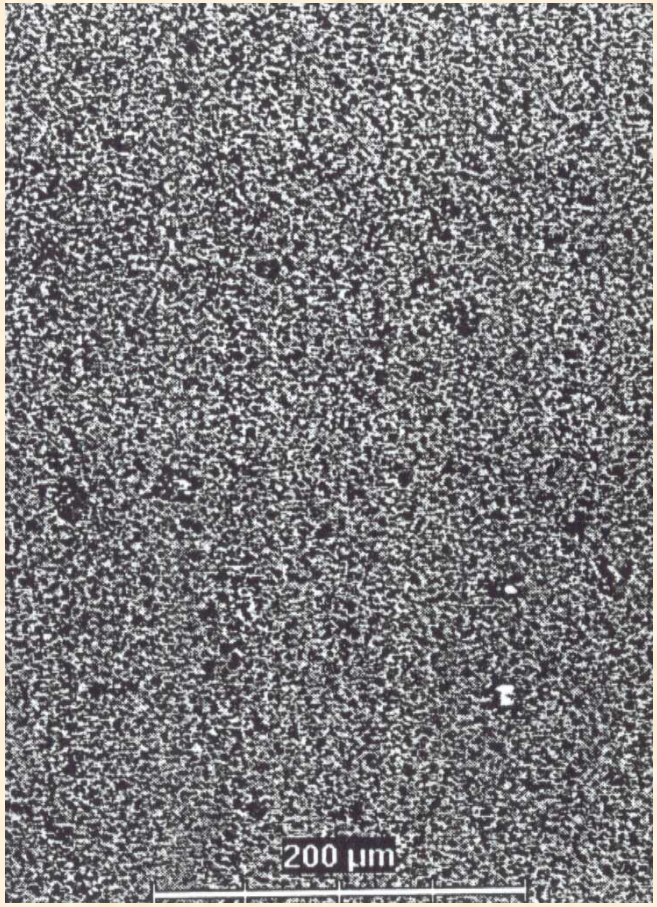


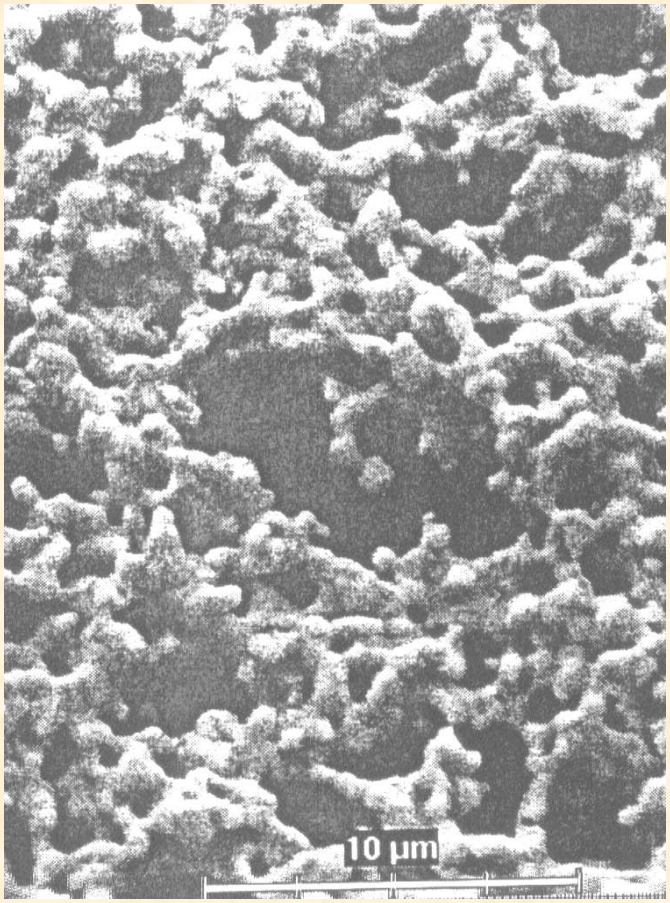
Electrochemical system using oxygen evolving PSII particles from the cyanobacterium *Synechococcus elongatus*

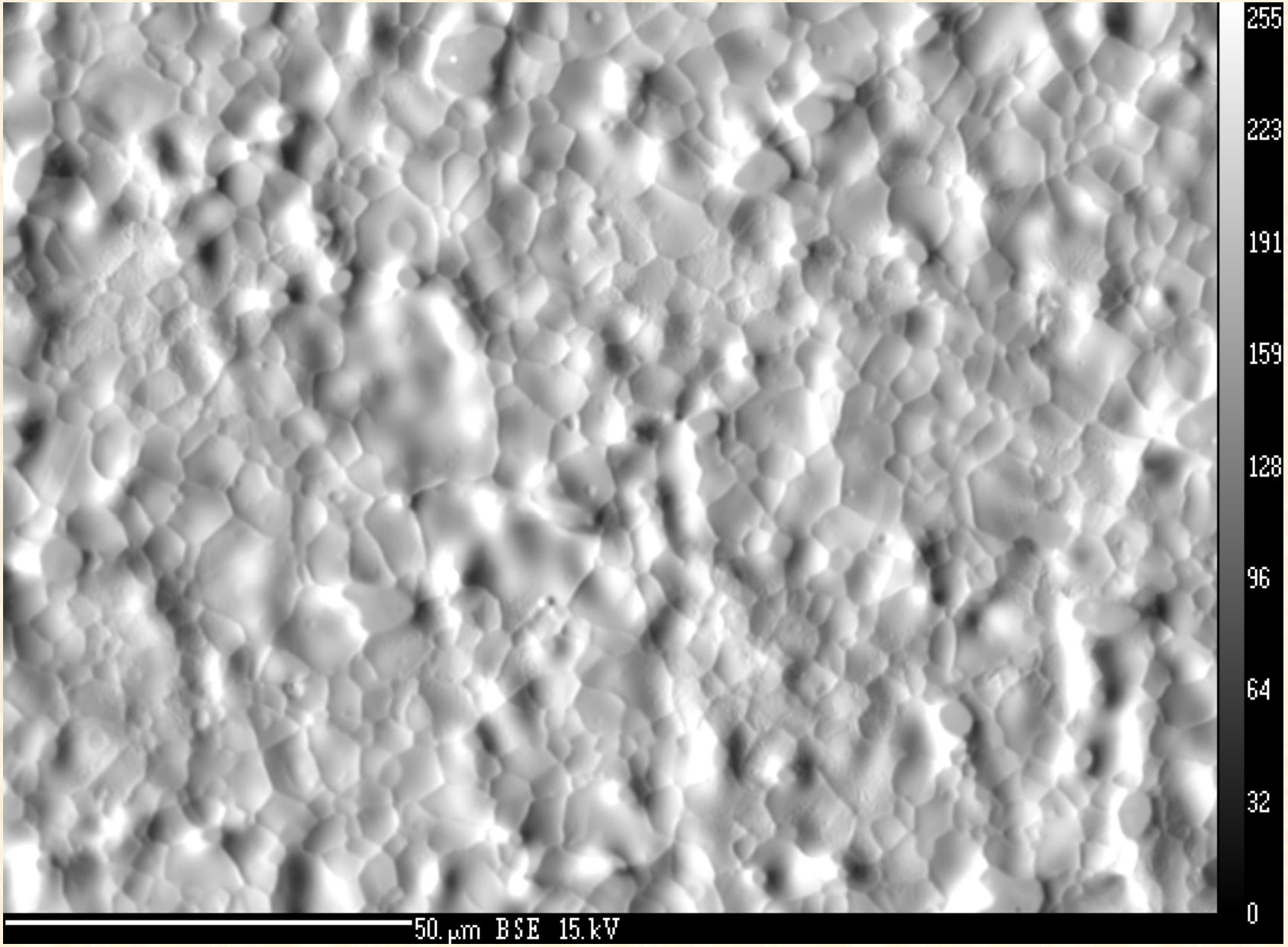
Nanostructured Electrodes

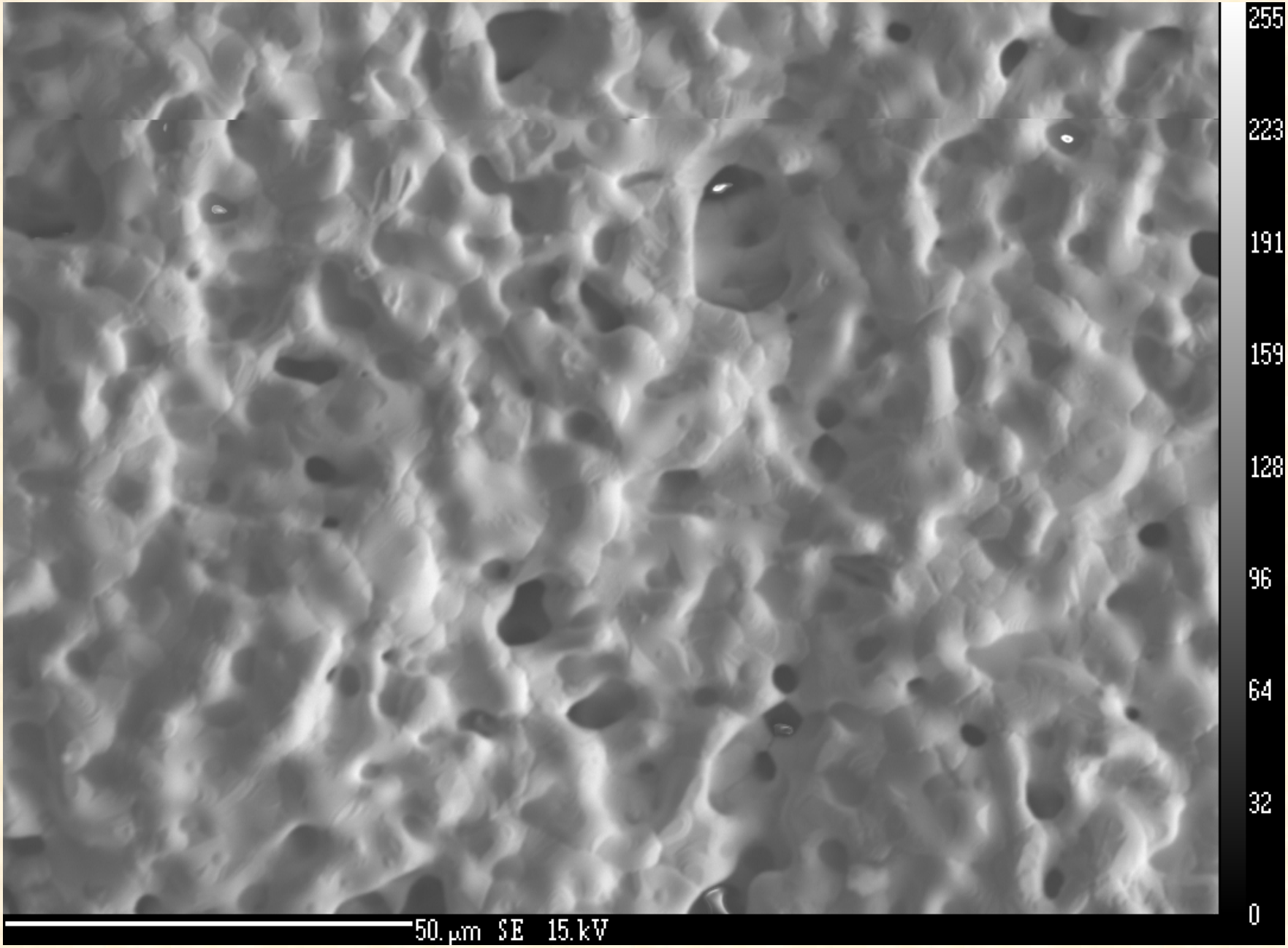
- Krejčí J.#, Maly J., Jakubka L., Pilloton R., Sameh K., Steffan P., Sugiura M.

Princip






255
223
191
159
128
96
64
32
0
50.µm BSE 15.kV


255
223
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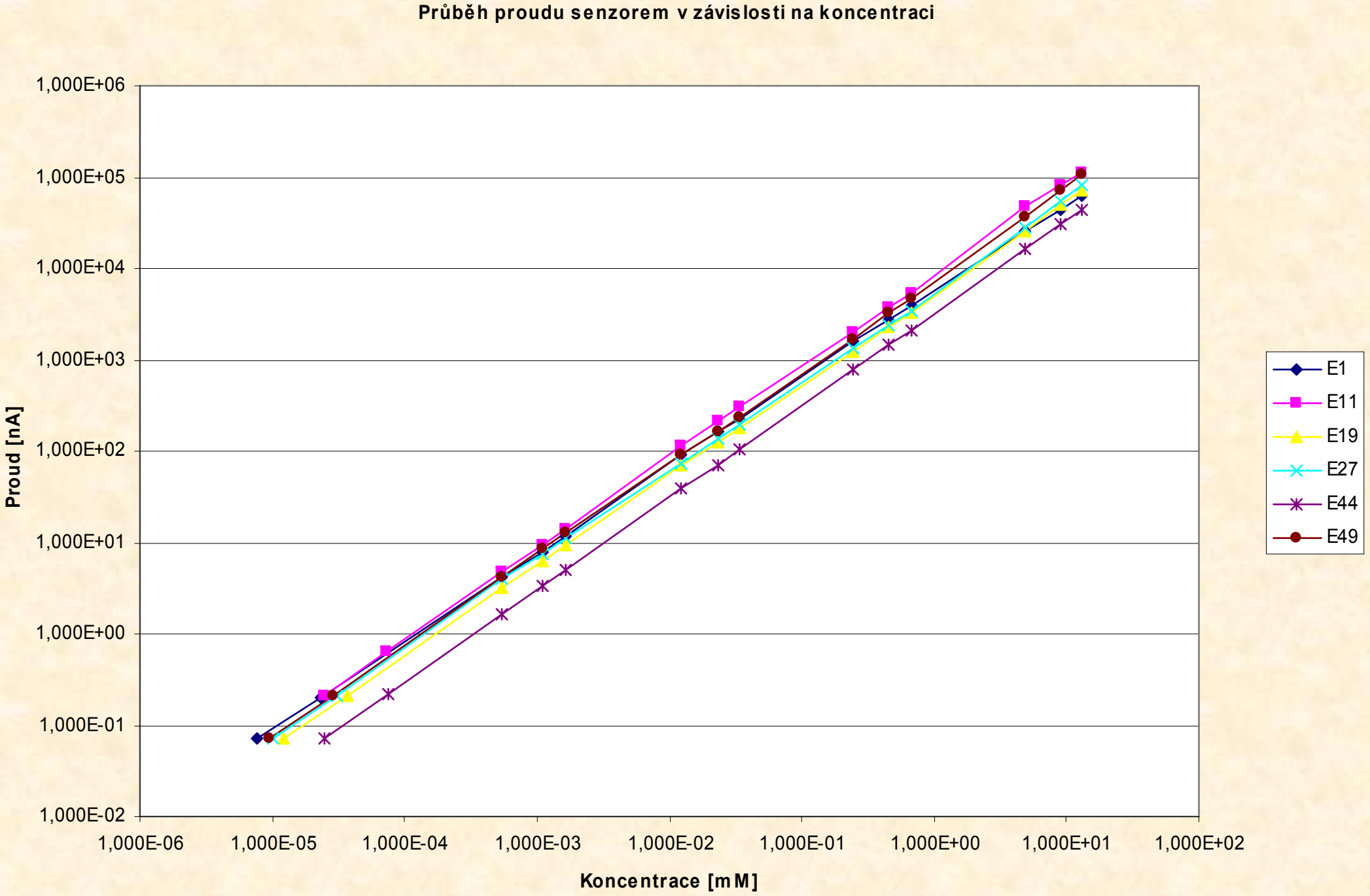
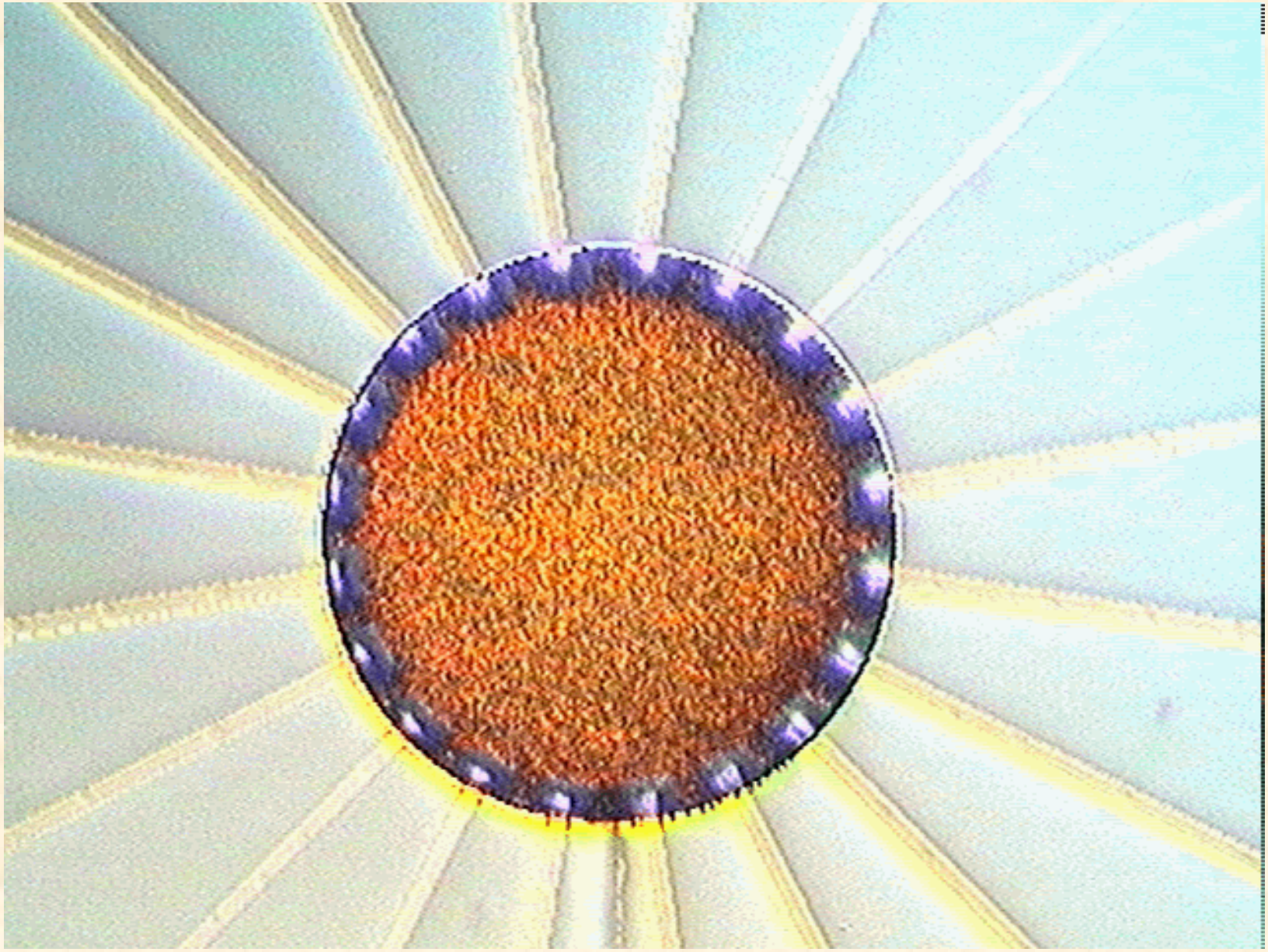
50.µm SE 15.kV



PACI, 6.6.2007, Prague

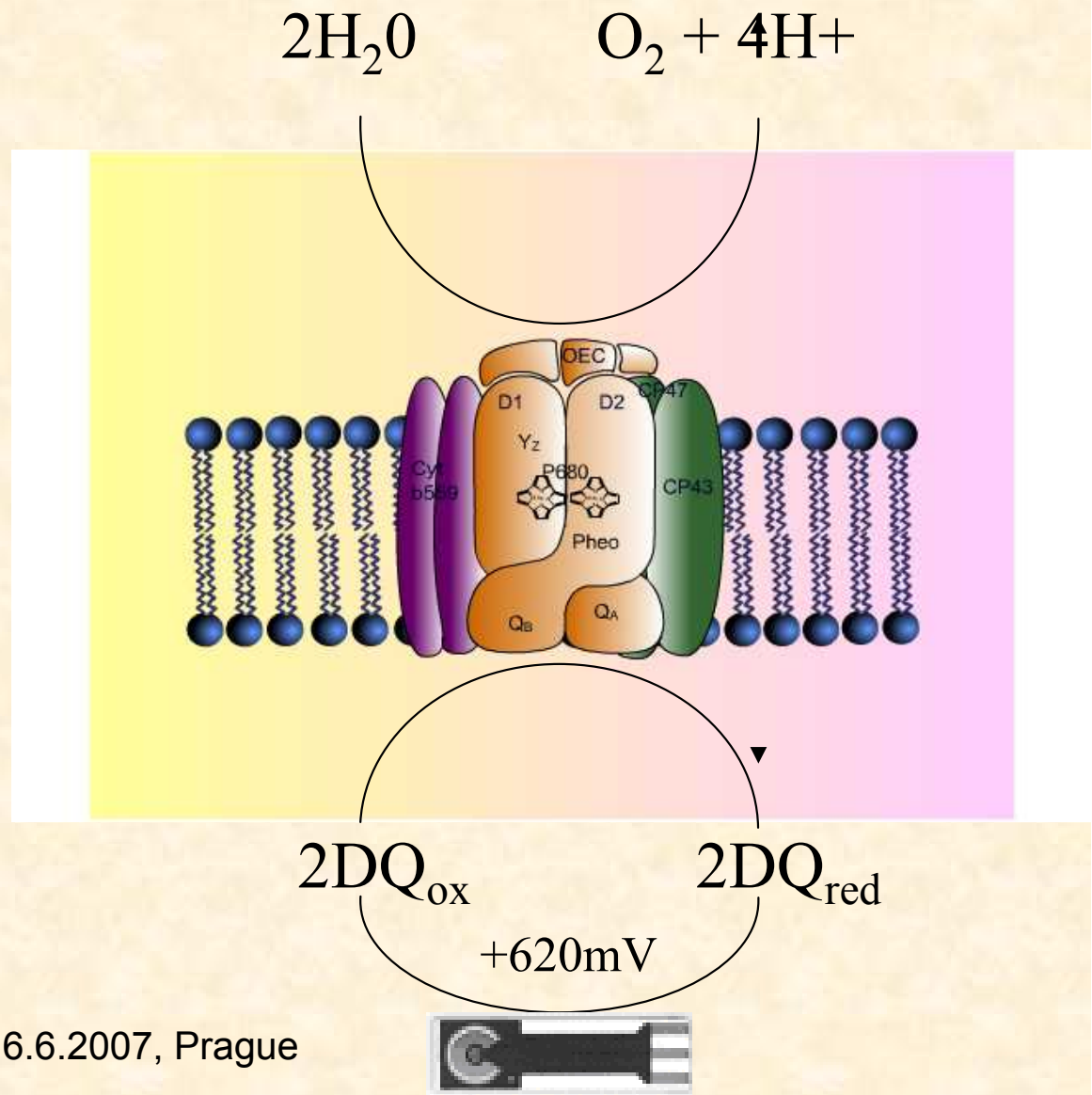
Array of nanoelectrodes



Electrochemical system using oxygen evolving PSII particles from the cyanobacterium *Synechococcus elongatus*

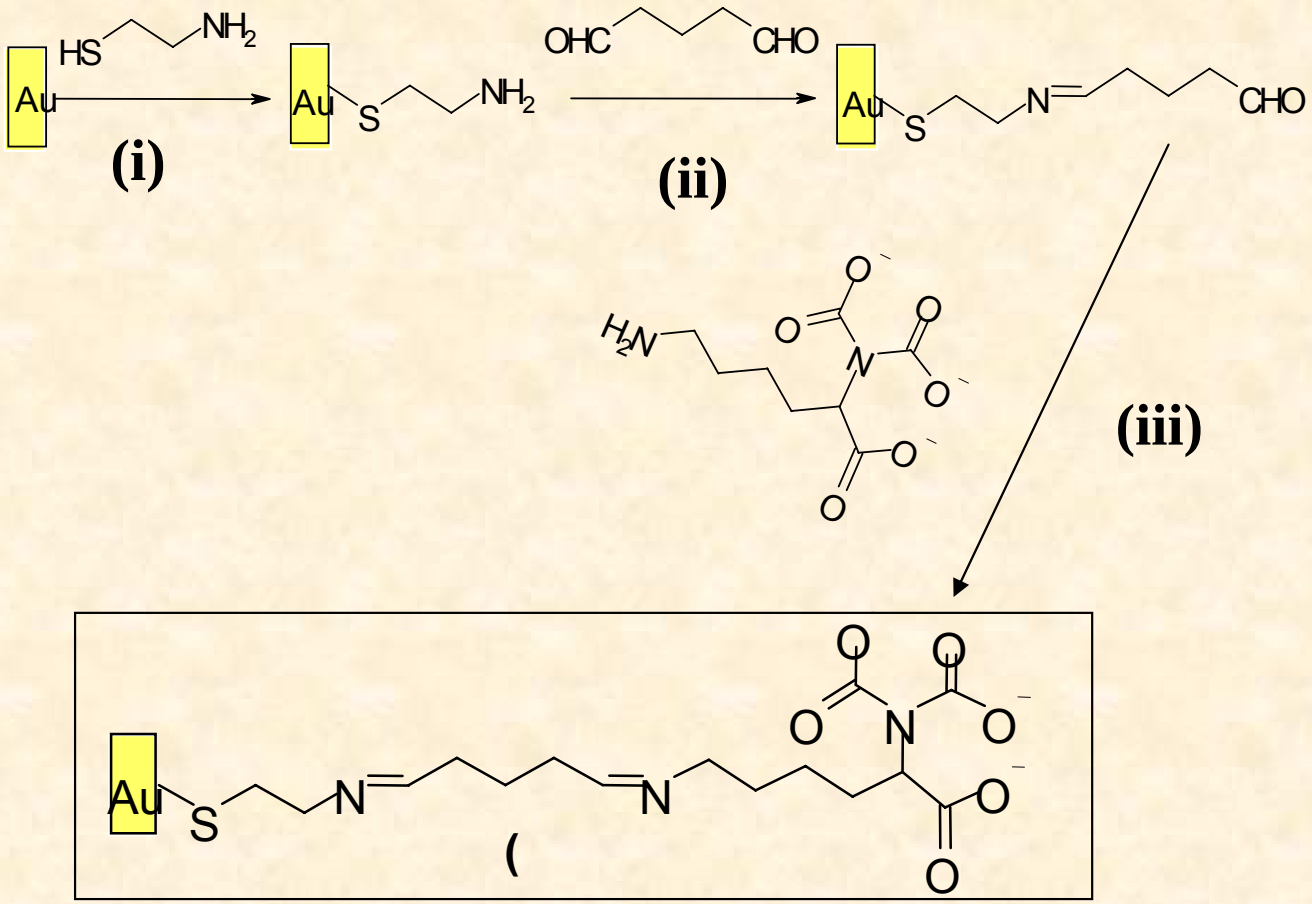
Principle

Electron transport from PSII with functional OEC complex to the platinum working electrode mediated using the artificial electron acceptor duroquinone (DQ). Reduced duroquinone is reoxidised at +620mV (vs. Ag/AgCl reference electrode). Oxidation current is proportional to the electron transport activity of PSII. Electric current generated by PSII is lower in the presence of herbicide. Screen-printed Pt:Ag/AgCl electrodes in three electrode arrangements are used.



Synthesis of self assembled monolayer of Ni-NTA chelator on gold electrode

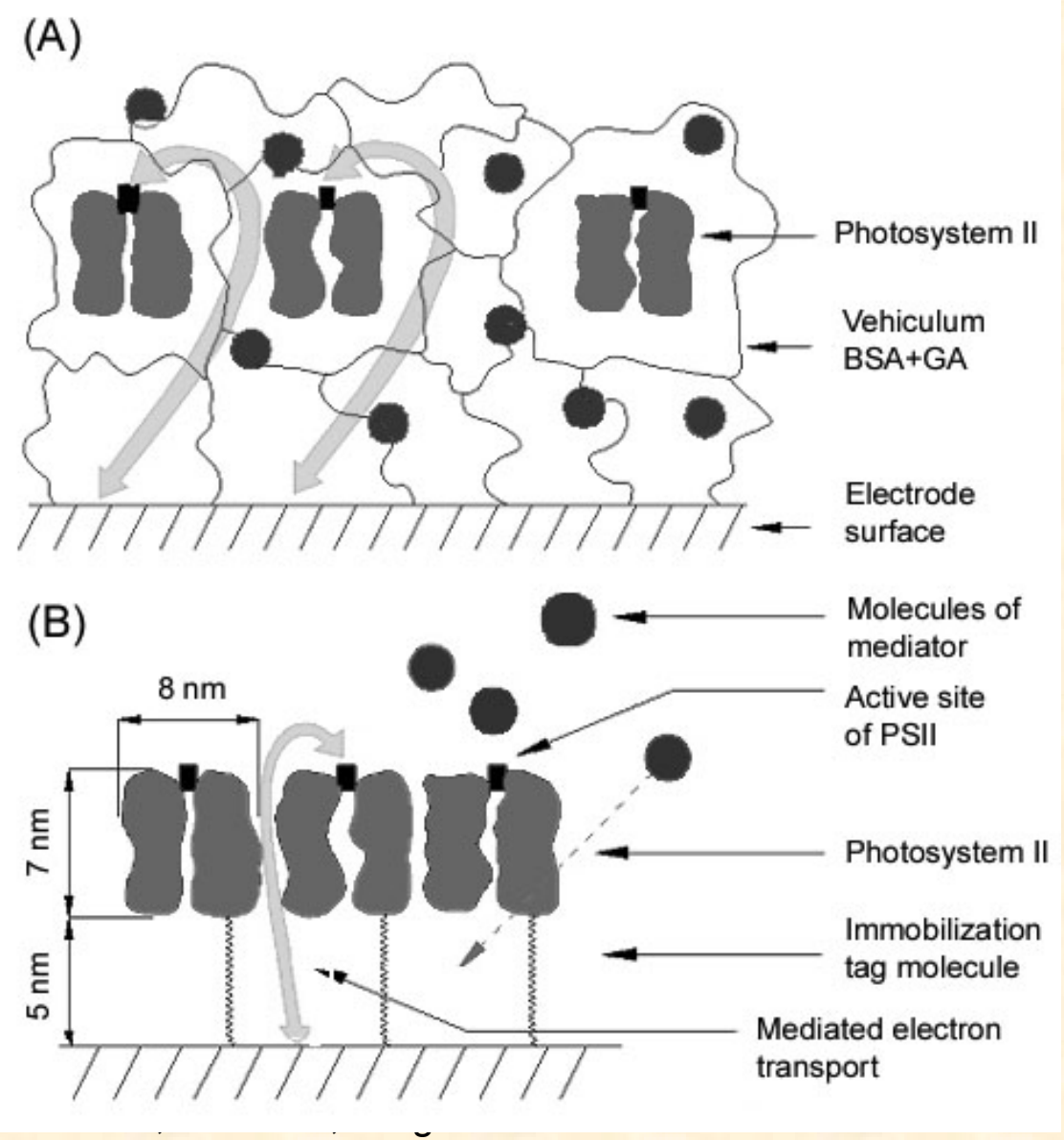
(i) selfassembled monolayer (SAM) of cysteamin is deposited on gold electrode, modified **(ii)** with glutaraldehyde and finally with nitrilotriacetic acid (NTA) **(iii)** (Maly J. et al. 2002).



The mass transport is influenced by immobilisation strategy of enzyme

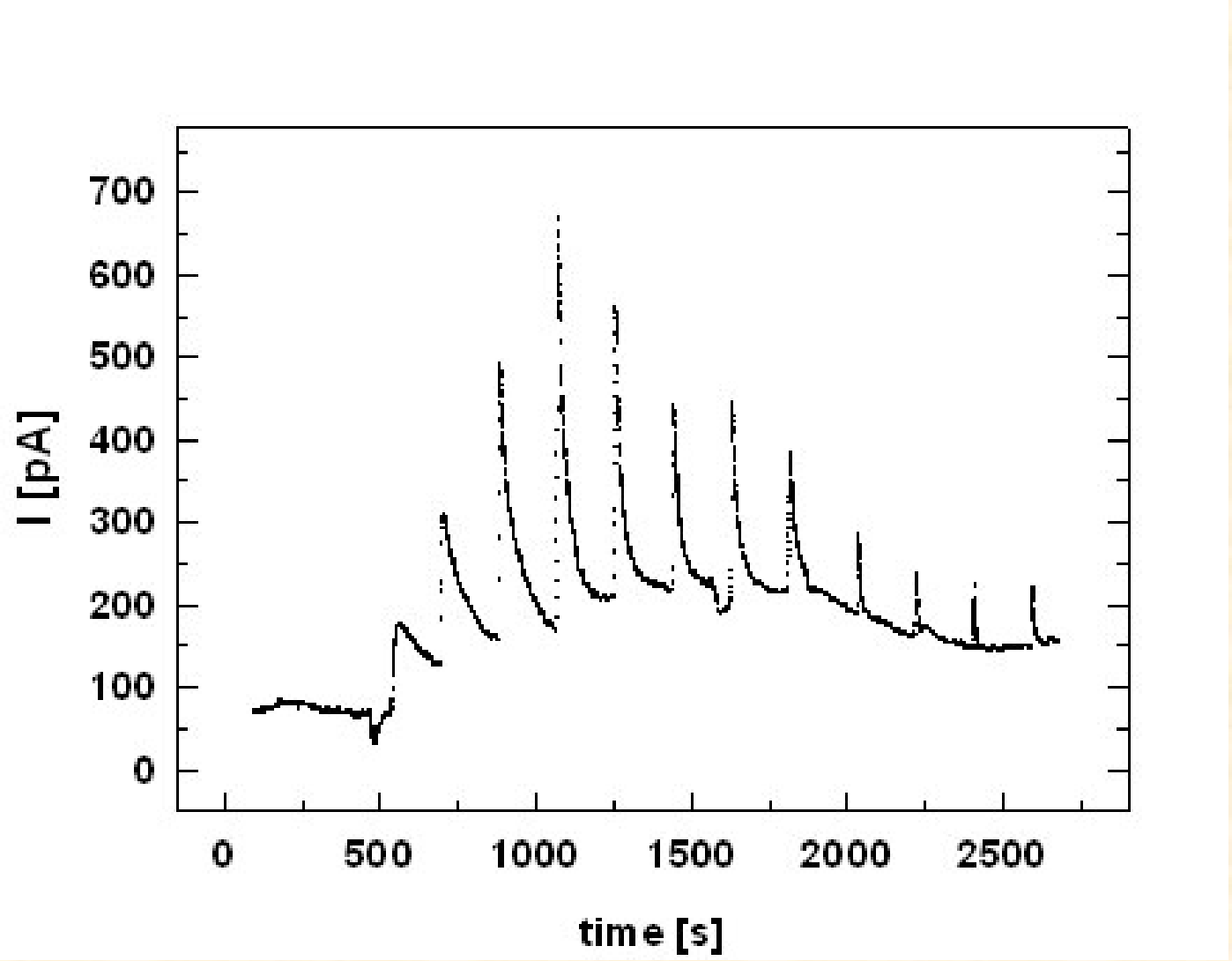
Panel A:
The inner structure of BSA-GA gel matrix with immobilized photosystem II.

Panel B:
The structure of the oriented monolayer of photosystem II.



Assembling of PSII on gold electrode monitored on-line during process

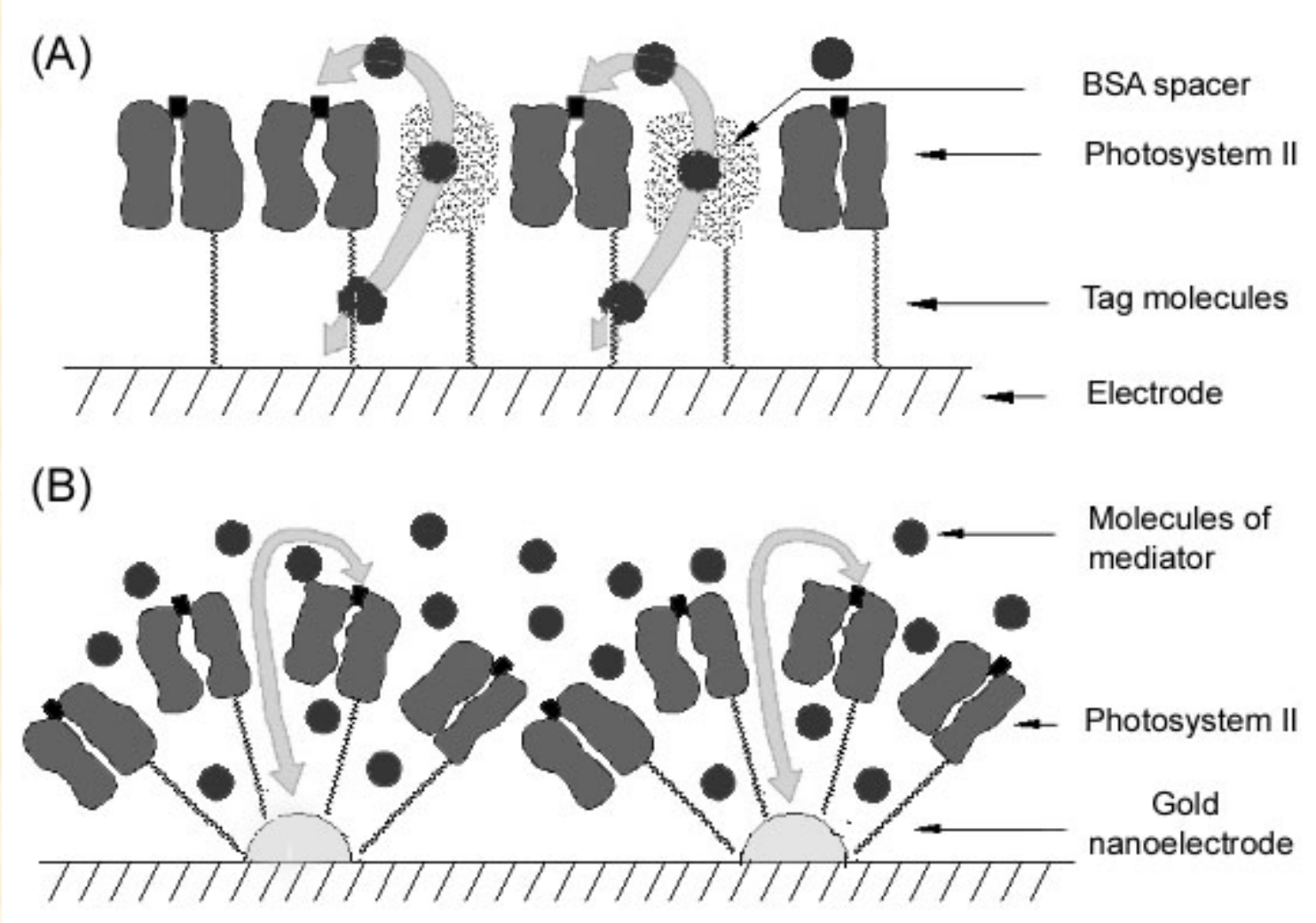
Electric current response of the electrode monitored on-line during the loading of electrode with His-tagged PSII



Influence of spacer BSA biomolecule in monolayer of PSII on biosensor activity

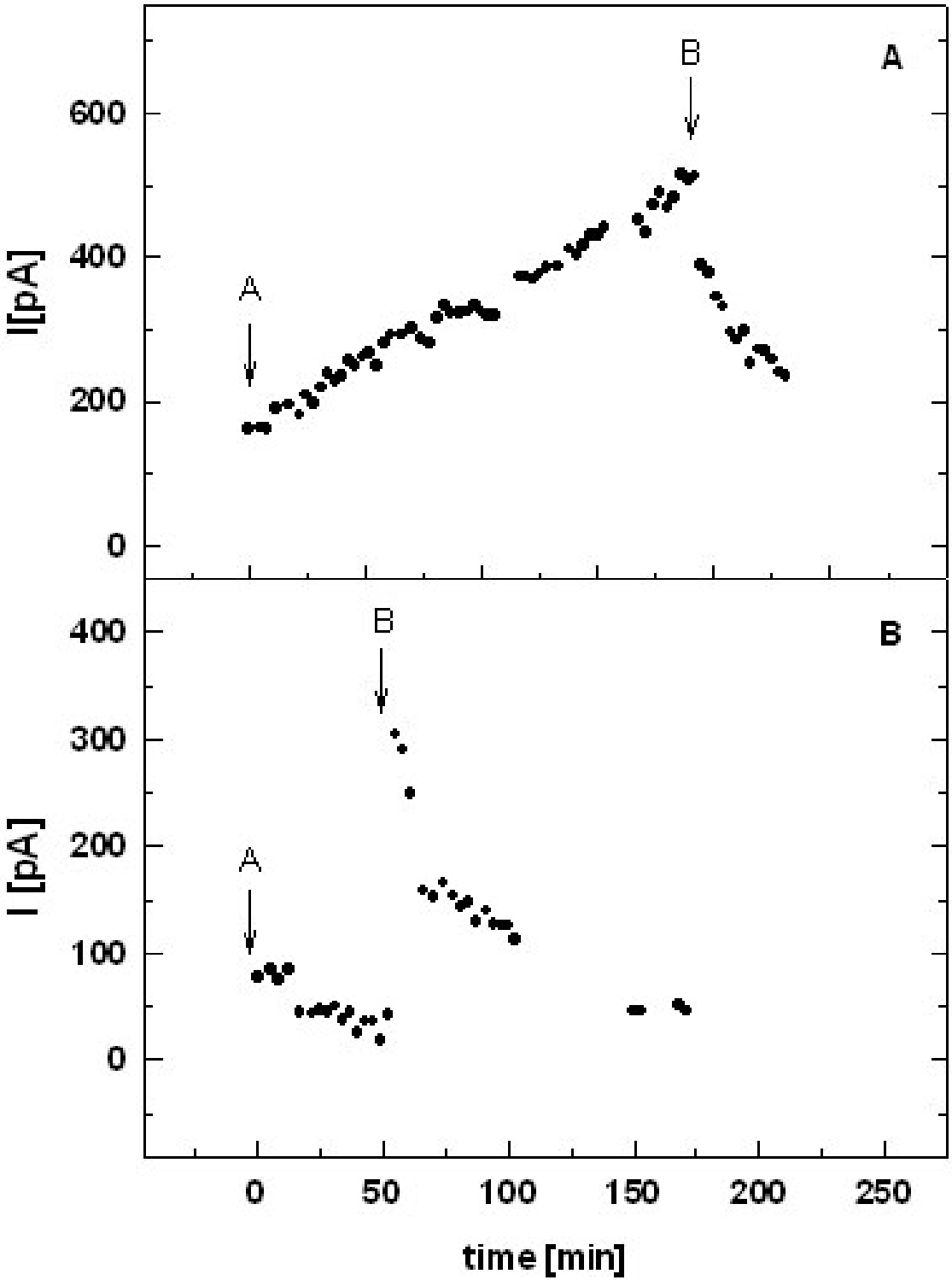
Panel A:
The structure of oriented monolayer of PSII mixed with the BSA spacer

Panel B:
The structure of electrode with the nano-structured active surface.



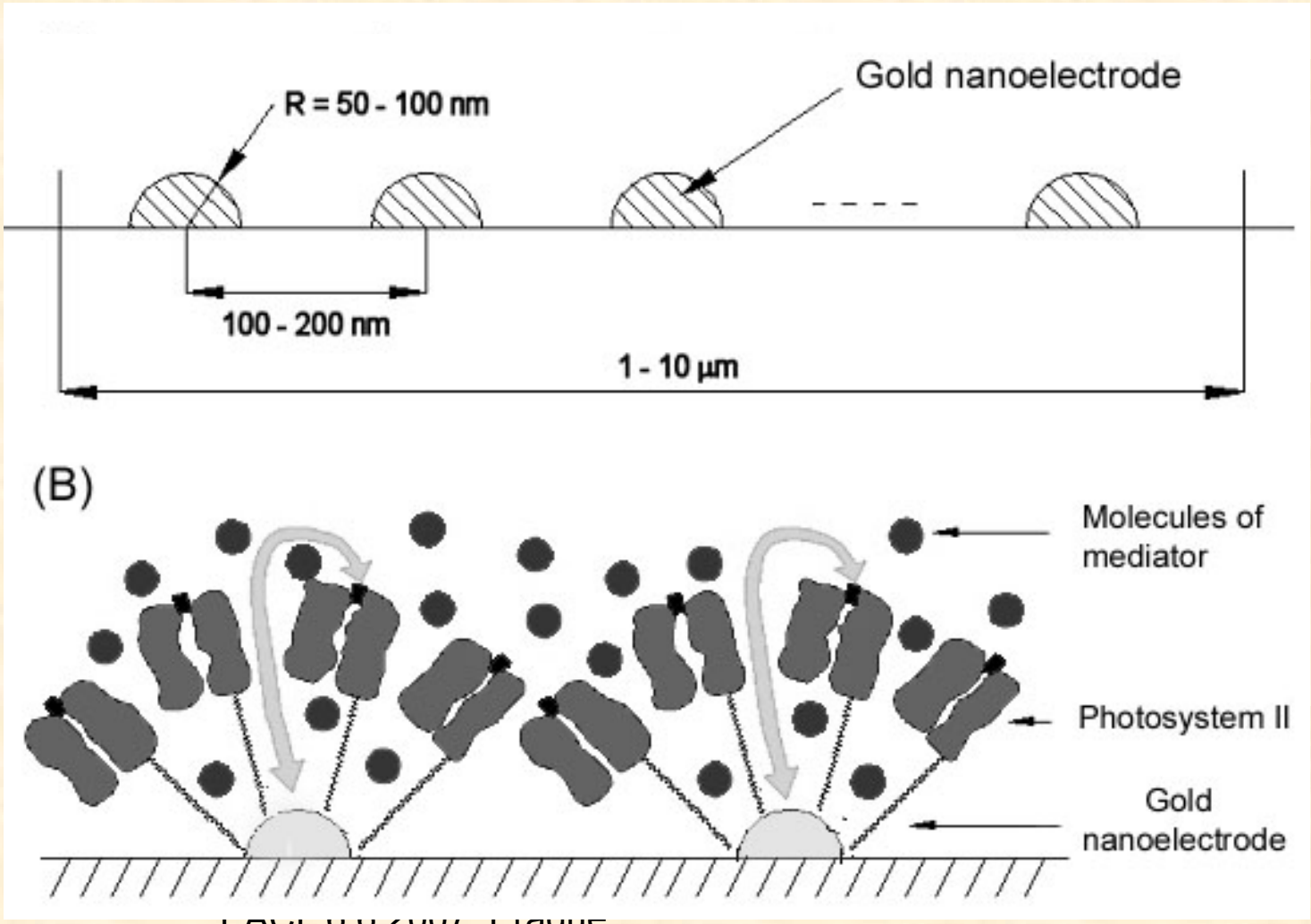
Influence of spacer BSA biomolecule in monolayer of PSII on biosensor activity

Signal obtained during the time-course of measurement from electrode with the monolayer of His-tagged PSII mixed with BSA **(Panel A)** and with the monolayer of pure His-tagged PSII **(Panel B)**.



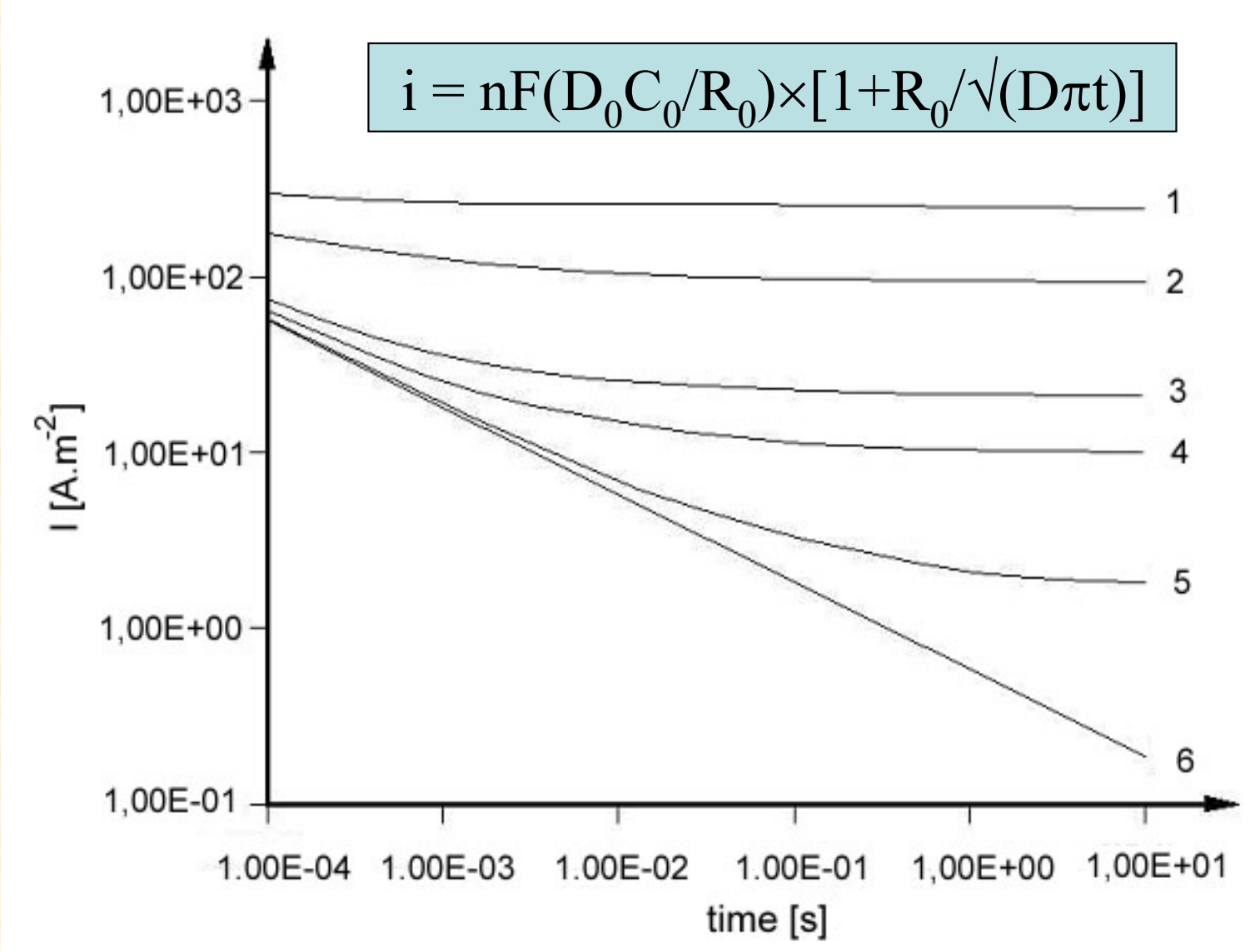
Nanostructured architecture of electrodes for improvement of mediator diffusion

The proposed parameters of the electrode with nano-structured active surface.



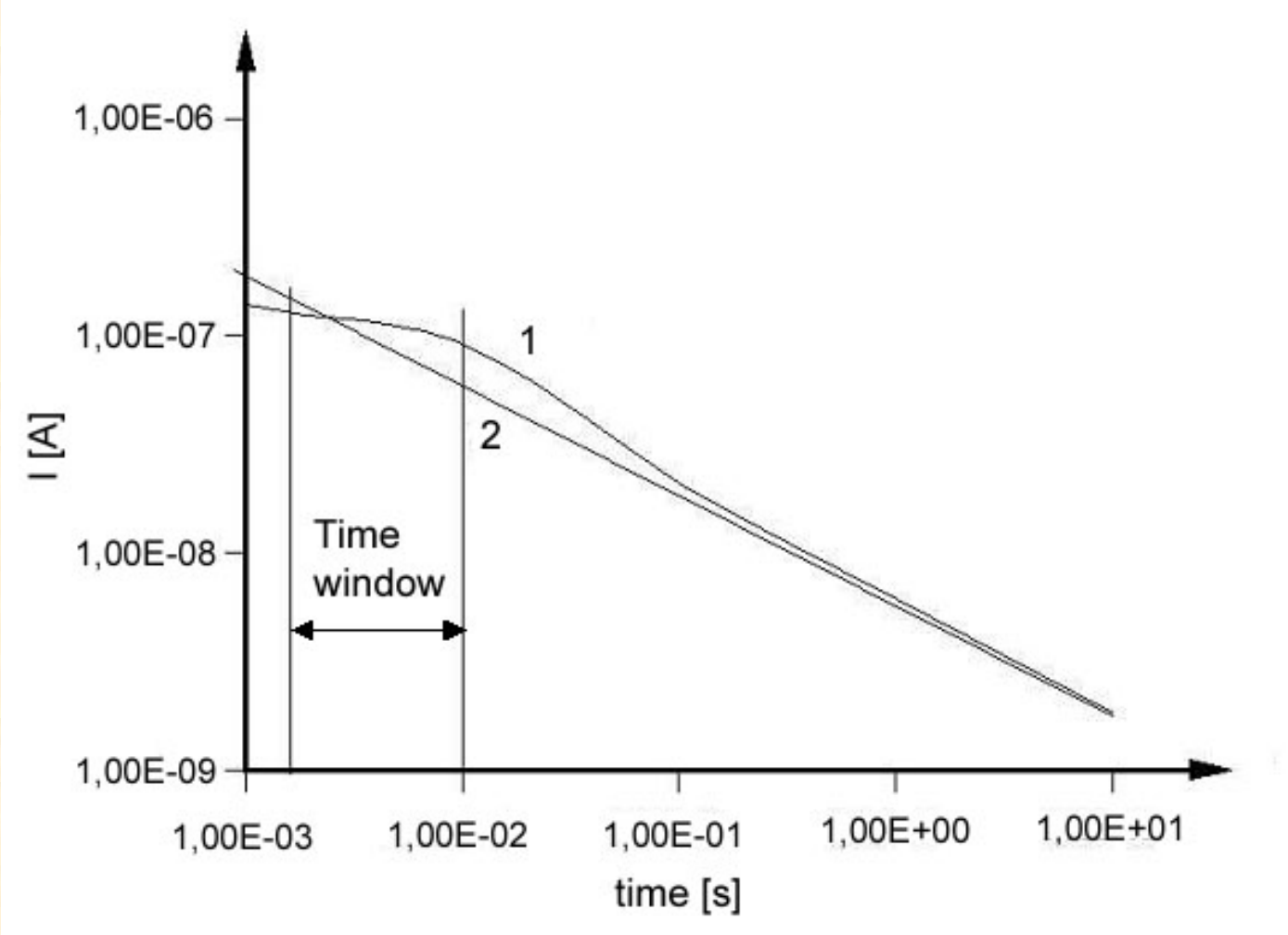
Comparison of time dependent current densities obtained by simulation for spherical and planar electrode

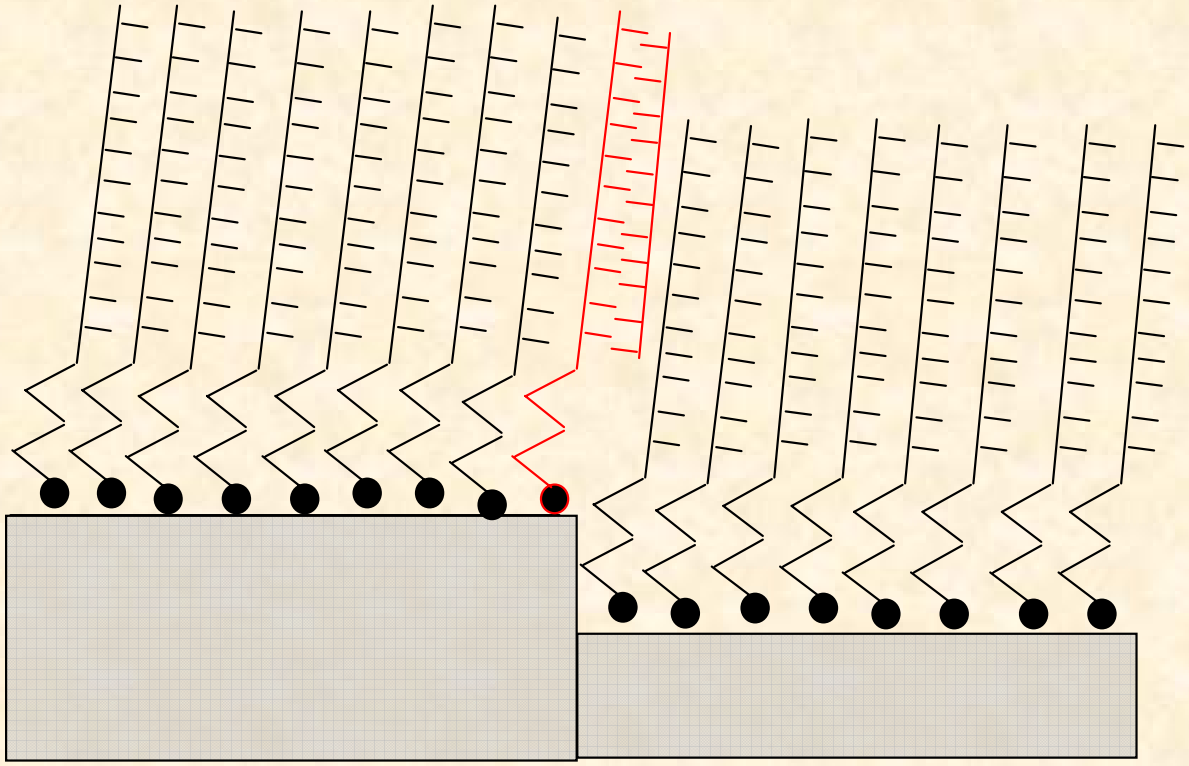
1: R = 50 nm
2: R =100 nm
3: R = 500 nm
4: R = 1 μm
5: R= 5 μm
6: planar electrode
R: radius of the nanoelectrode



Comparison of the current response of planar (2) and nanostructured (1) electrode

The surface of macroelectrode is 1 mm^2 . It consist of electrodes with diameter 1μm and distance 2 μm. The time window optimal for increasing the measured output signal is marked.





E. Huang, M. Satjapipat, S. B. Han, and F. M. Zhou, Langmuir 17:1215 (2001).

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THANK YOU FOR YOUR ATTENTION !