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COST Action TD1105

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New Sensing Technologies and Methods for Air-Pollution Monitoring

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POSTER SESSION

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CMOS-BASED CAPACITANCE MEASUREMENTS FOR CELL ADHESION SENSING APPLIED IN EVALUATING THE CYTOTOXICITY OF NANOMATERIALS

M.Sc. Niina Halonen

ESR (early stage researcher)

University of Oulu / Finland

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Scientific Context and Objectives

- Nanoscale materials compared to bulk may be harmful to health.
- EU banned cosmetics with animal tested ingredients → **New, additional, ethical methods are needed to evaluate biological effects of nanomaterials.**
- Here we introduce the **IC chip designed for charge-based capacitance measurements for sensing cell adhesion to the substrate surface to evaluate the cytotoxicity of nanomaterials.**
- Adherent cells normally spread out on the surface, but stressed cells “ball up” and finally detach as they die; this **change in attachment can be sensed via a change in capacitance.**

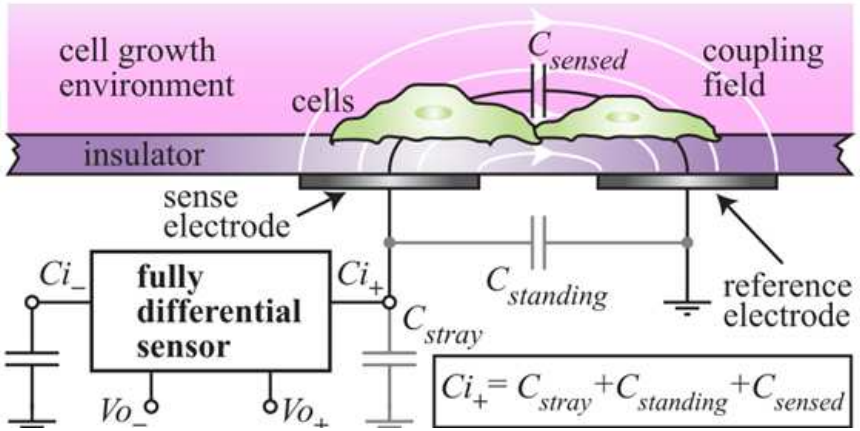


Figure 1. Fully differential rail-to-rail capacitance measurement circuit, a sensor block diagram .

S. B. Prakash, P. Abshire, “A Fully Differential Rail-to-Rail CMOS Capcitance Sensor With Floating-Gate Trimming for Mismatch Compensation”, *IEEE Transaction on Circuits and Systems-I: Regular Papers*, 56 (2009) 975-986.

S. B. Prakash, P. Abshire, M. Urdaneta and E. Smela, ”A CMOS capacitance sensor for cell adhesion characterization” 2005 IEEE International Symposium on Circuits and Systems (ISCAS) Vols 1-6, Conference Proceedings, Pages: 3495-3498 DOI:10.1109/ISCAS.2005.1465382

RESULTS

- The IC chips consisted of **capacitance sensors arrays** and readout circuitry.
  - The arrays were subdivided into four different sections for calibration, planar sensors, and two different types of interdigitated sensors.
- The capacitance sensors were **fully differential to increase dynamic range and suppress noise.**
- Adherent kidney cells of *Cercopithecus aethiops* were cultivated on the surface of the chip and exposed to TiO_2 nanowires earlier report as cytotoxic*).

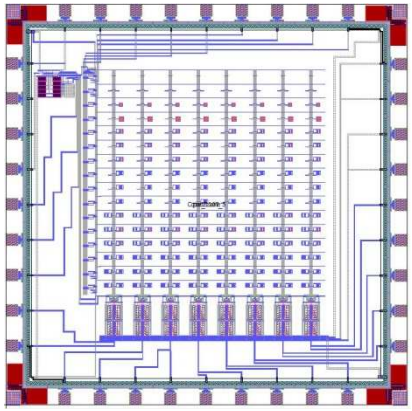


Figure 2. Layout of the IC chip with capacitance sensor arrays and readout circuitry.

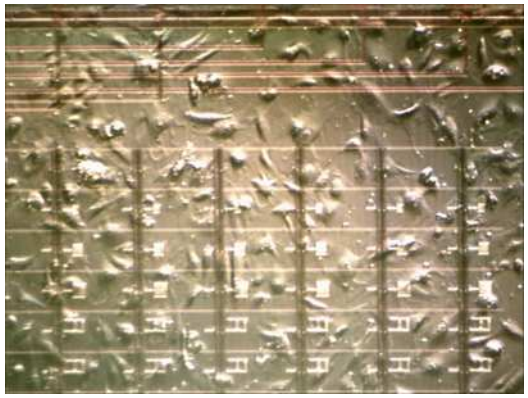


Figure 3. Microscope image of viable adherent kidney cells of *Cercopithecus aethiops* on the surface of the IC chip.

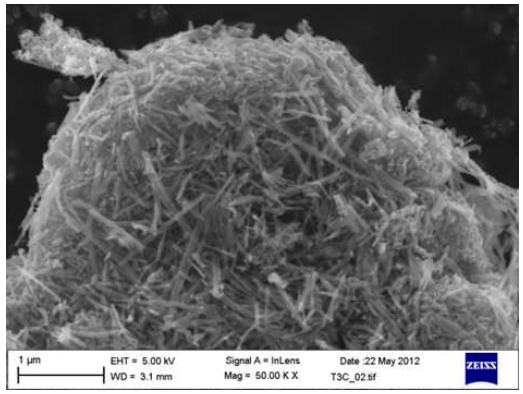
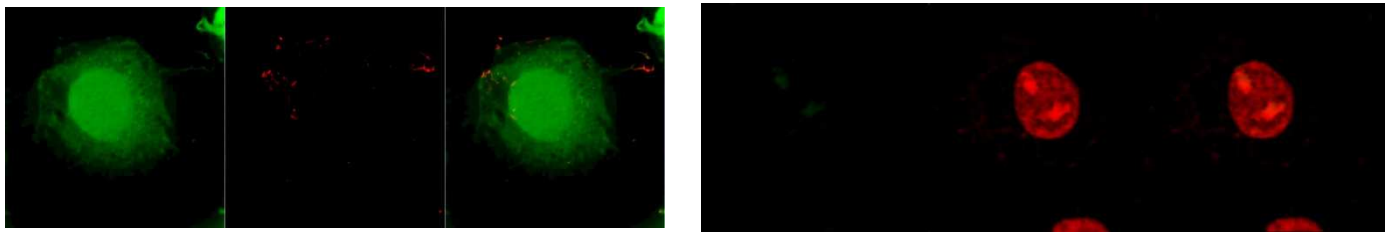


Figure 4. FESEM image of TiO_2 nanowires.

*) A. Magrez. L. Horváth, R, Smajda, V. Slicio, N. Pasquier, L Forró, B. Schwaller, "Cellular Toxicity of TiO_2-based Nanofilaments", *ACS Nano* 3 (2009) 2274-2280.

CONCLUSIONS and Future Activities

- Preliminary results indicate that for the interdigitated sensors the optimal sensor layout closely matches the cell size in terms of finger width and spacing.
- At the moment we are gathering reference data with commercial cytotoxicity kit**) to verify and interpret the capacitance signal and cell behaviour from the chip reflecting the cell viability after exposure to nanomaterials.
- This work in done in close collaboration with
  - **University of Maryland**: Ph.D. Student Timir Datta, Dr. Someshekar Prakash (currently working for Intel Corporation), Prof. Elisabeth Smela, Assoc. Prof. Pamela Abshire
  - **Linköping University:** Research Engineer Peter Möller, Prof. Anita Lloyd-Spetz
  - **University of Oulu:** Dr. Antti Hassinen, Dr. Sakari Kellokumpu, FiDiPro Anita Lloyd-Spetz



**)LIVE/DEAD® Viability/Cytotoxicity Kit from Life Technologies

Figure 5. Viable COS-7 cells on the left (green) and dead cells on the right (red) stained with LIVE/DEAD® Viability/Cytotoxicity Kit.