Emilia Kaivosoja
Report from visiting at Universitat Politècnica de Catalunya (UPC), Barcelona, Spain
February 28th – March 21st 2009

Effect of surface charge (zeta-potential) on interactions between cells and biomaterials used in regenerative medicine

The purpose of the visit

The purpose of the visit was to study to use of an electrokinetic analyzer (SurPASS, Anton Paar GmbH, Austria, Figure 1) available in Universitat Politècnica de Catalunya (Department of Materials Science and Metallurgical Engineering, Barcelona, Spain) in the meaning of measuring surface charge (zeta-potential) of some present and novel biomaterials and to measure zeta potentials of these biomaterials which already have been or will be tested with osteoblasts, mesenchymal stem cells, bacteria and neural interfaces.

Description of the work

The work was done at UPC in Institut de Bioenginyeria de Catalunya (IBEC) at laboratory of prof. Maria Pau Ginebra. PhD. Montserrat Espanol-Pons helped us in using this machine and making these measurements. During the first week I was working with Katja and Sami Myllymaa and we managed to find suitable electrolytes, chemicals, processing parameters and mathematical models what we needed to make reproducible measurements with our new materials which were not tested with this machine earlier. After the first week we had already faced most of the problems and gotten some promising results and I was able to continue the measurements by myself. The tested materials were smooth or lithographically patterned thin films, which were coated with magnetron sputtering, filtered pulsed plasma arc-discharge method and pulsed laser deposition techniques. Altogether 24 different materials, such as some novel materials like amorphous diamond (AD), AD-hybrids (PDMS, Teflon, Ti etc.), photolithographically patterned metallic and ceramic surfaces and polyimide-based microelectrode surfaces, were measured during these three weeks.

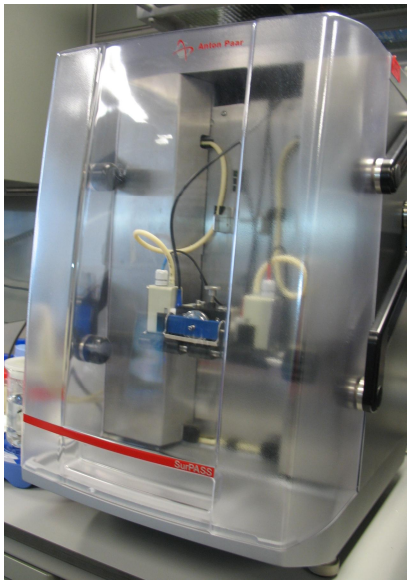

Figure 1: SurPASS *Zeta potential analyzer*

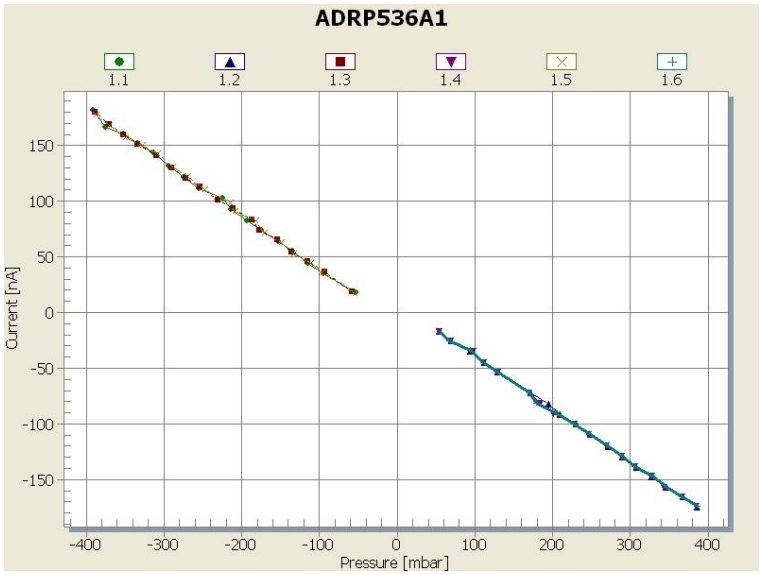

Figure 2: *Streaming current results for reverse patterned amorphous diamond surface*

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Description of the main results

The very important result of this visit was the know-how about the use of SurPass zeta potential instrument, because getting reliable results from challenging biocompatible thin film materials is so not easy. Altogether zeta potential of 24 different biomaterials was measured in pH 7 in 1mM KCl. One of the streaming currents measured is presented in Figure 2 and Figure 3 represents the zeta potential of chromium, titanium, tantalum and amorphous diamond with smooth surface and with two different patterned surfaces and also the zeta potential of silicon, which is the background of the patterns. These patterned biomaterials are in the focus of my current study and the differences observed in zeta potential can explain some of the differences observed previously in cell behavior.

Future collaboration with host institution/projected articles resulting from my grant

I am going to write a scientific article in co-operation with host institute. The topic is related to the effect of zeta-potential on osteogenic differentiation of human mesenchymal stem cells. In this article, we can use these measured zeta potential values besides of cell studies. Also an article concentrated on the topic "Influence of ceramic thin films zeta potential on osteoblast adhesion" and the measurements with materials which will be tested in neural applications will be published. We also discussed many other biomaterial-related projects what we will plan and perform together in the future. These projects cover also other material characterization methods (in addition of zeta potential) that can be performed by utilizing the facilities of both institutions.

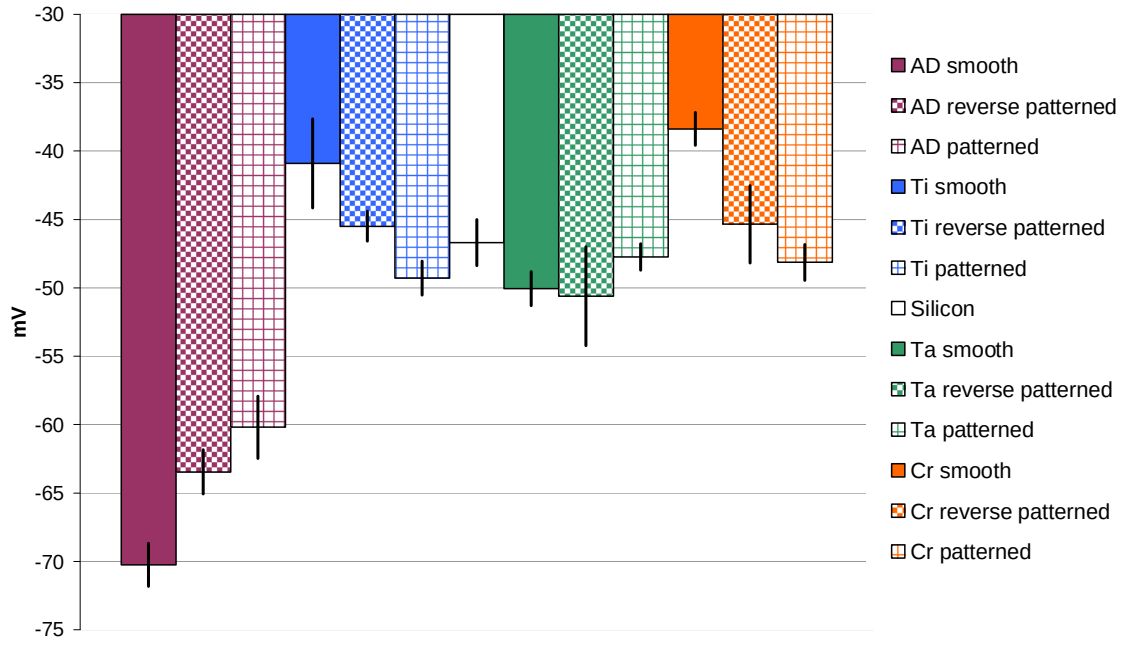

Figure 3*: Zeta potential of patterned biomaterials.*

Other comments

The visit was very educative in means of understanding the background behind of surface charge/zeta potential. Via the experiments we understood better all the aspects that needed to be considered to achieve reliable results. Together with the host institute we solved many problems according to the machine and measurement values so I believe this visit was fruitful for the host institute as well and this was very good starting point to future co-operation.

We assume that the knowledge of the zeta potential of the conventional and novel biomaterials is of primary importance in the development of neural interfaces and new generation implants for regenerative medicine. Optimized surface charge and surface energy parameters in the view point of protein adsorption and cell adhesion, proliferation and differentiation are essential aspects in development of intelligent implants for regenerative medicine.

As a conclusion, the visit was educative, successful and enjoyable.

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