

Cell detachment using electric discharge plasmas



I.E. Kieft, J.L.V. Broers, D.W. Slaaf, F.C.S. Ramaekers, E. Stoffels

Biomechanics and Tissue Engineering, Bone Biomechanics
and
Elementary Processes in Gas discharges

Introduction

The interaction between a small atmospheric discharge and living cells is studied. A novel plasma source the “plasma needle” is used [1]. A sub-millimetre plasma appears as a glow at the end of a metal pin.

The effects of this plasma are studied on both CHO K1 and human epithelial NSCLC MR65 cells. When the cells are exposed to the plasma, instantaneous detachment of cells from the surface and loss of cell-cell interaction are observed. Cells that detached during plasma exposure remain alive. Within several hours cells reattach to the surface.

The plasma treatment can be performed with high precision with spot-sizes smaller than 1 mm. Neighbouring cells are left unaffected.

Material and methods

Plasma generation

- We ignite the RF plasma in helium. The frequency we use is about 10 MHz.
- Plasma appears at the tip of a metal pin. It appears as a pink glow.

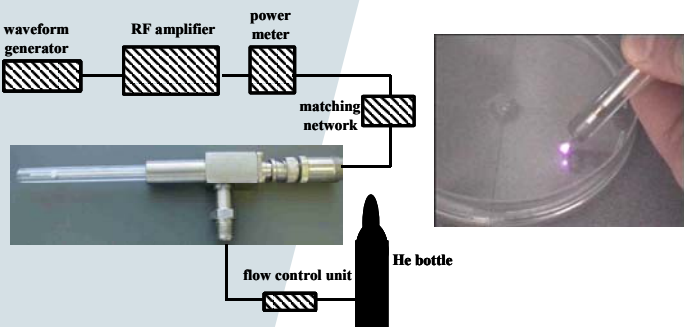


Figure 1 Left: A scheme of the experimental setup
Right: Plasma

Methods

Plasma treatment

- Plasma power is 0.1 to 0.2 W
- Plasma temperature is below 30°C
- Total irradiation time of sample is 1 minute, individual cells are irradiated for 5 to 10 seconds

Viability assays

- PI and CTG are used to distinguish dead and living cells.

Results and discussion

Treatment of cells with high dose can cause necrosis. If the right dose is applied, cells detach. A void can be created with dimensions sub-mm, see figure 2.

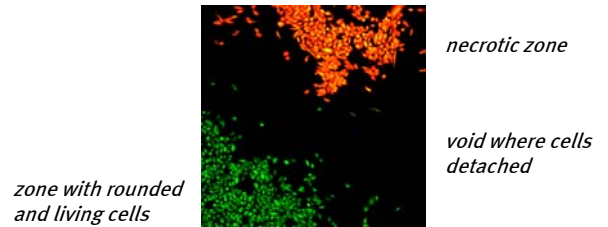


Figure 2 Treatment with high dose. Dead cells in red on top, then a void caused by detached cells, the green cells at the bottom are alive. Sharp boundaries!

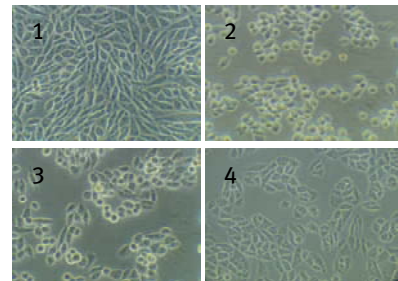


Figure 3 Cell detachment in time. 1: control sample, 2: 15 min. after treatment, 3: 1 hours after treatment, 4: 4 hours after treatment.

Cells start attaching one hour after treatment. We see the same effect for the fibroblasts and the epithelial cells, which indicates that the cell detachment is a general effect. Most likely the cell adhesion molecules are destroyed by plasma radicals.

Conclusions

Cells detach after plasma treatment, and remain alive. They are capable of reattachment and cytokinesis. The plasma treatment can be performed with sub-millimetre precision. Neighbouring cells are not affected.

References:

- [1] Stoffels, E., Flikweert, A.J., Stoffels, W.W., Kroesen, G.M.W., 2002, *Plasma Sources Sci. Technol.* 11: 383-388