AC field assisted deposition of influenza viruses on nanoelectrodes

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Introduction

A rapid characterization of viruses and virus subtypes is of great biomedical interest. Here we present the use of AC electrokinetic forces, like dielectrophoresis and AC electroosmosis, as a simple and fast method to functionalize nanoelectrode arrays as a potential biosensor. The permanent immobilization of polystyrene nanoparticles, antibodies and other proteins on electrodes has already been demonstrated. The sensor itself consists of four individual arrays, each built up of 6256 tungsten nanoelectrodes with a diameter of 500 nm each. The immobilization, detection and characterization of influenza material is done without any prior chemical modification of the electrode surface.

Results and Discussion

The accumulation of virus material over time has been observed, showing that the largest amount has already been drawn to the electrodes within 60 seconds and reached a saturation after 180 seconds of applied AC electric field. Due to side effects such as fluid streaming, a concentration gradient is created decreasing from the outer to the inner electrodes. It has been demonstrated, that the virus material is permanently immobilized even after switching off the electric field. Furthermore, each functionalized electrode can be considered as a single event. Comparing these single events it seems like the virus material is distributed randomly across the nanoelectrodes. But after deconvolving the fluorescence image and merging the images of around 100 electrodes it reveals that the major part of virus material is collected at the electrode edge. This is in line with theory, as this is the region of the highest field gradient, and thus here the AC electrokinetic forces have the greatest impact on the sample.

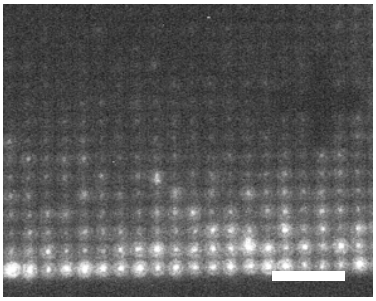

Figure 1: *Fluorescently labelled influenza virus material immobilizes on a nanoelectrode array; scale bar 10 µm*

Conclusions

The universal chip design does not limit the application to influenza viruses but also works for different viruses, bacteria, parasites or any other object that can be manipulated by AC electrokinetic forces. Each electrode can be used as part of an on-chip resonant circuit, whose frequency changes with surface coverage of the electrode and, hence, serves as a measure of the amount of viruses attached to the electrodes. So in future, the evaluation by fluorescence microscopy can be changed to an electrical evaluation. Thus, combined with microfluidics this chip has the potential for a small and rapid Point-of-care system.

References

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