NANO-IMMUNO-ASSAY (NIA) - A CANTILEVER-BASED NANOSENSOR TECHNOLOGY FOR POINT-OF-CARE MEASUREMENT OF PROTEINS IN BIOLOGICAL SAMPLES

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Background

Nanosensors for direct protein determination by means of a nano-immuno-assay (NIA) are composed of a cantilever structure with a surface that has been functionalized by binding of specific antibodies directed against the desired target protein. Binding of the antigen results in a change of the surface tension and leads to bending of the cantilever. A metallo-carbonated nanosensor element 3D-printed on the basis of this cantilever transfers this micromechanical bending into an electrical signal. The timing of the binding process until completion in a defined sample volume is directly related to the concentration of the analyte in the sample.

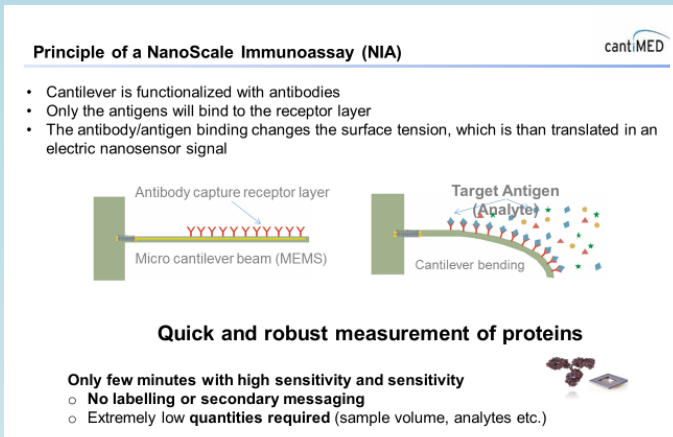
Methods

A proof of concept study was performed to specifically measure human IgG contaminations in an artificially produced solution containing human and chicken IgG. The NIA-sensors were functionalized with protein A to enable human IgG antibody binding. The artificially produced samples (50 % human IgG and 50 % chicken IgG) were tested for IgG presence by means of NIA and also by common anti-human IgG ELISA as laboratory reference method. Each experiment was carried out in triplicate..

Results

The ELISA reference method was shown to have a 100 % specificity within an observed linear detection range from 10 ng/mL to 1000 ng/mL With similar specificity, the linear detection range of the NIA was shown to be between 0.01 ng/mL to 1 ng/mL, i.e. the NIA was 1000fold more sensitive than the reference ELISA. Minor unspecific binding of IgG was observed with the NIA technology at chicken IgG concentrations > 1000 ng/mL

Figure 1.: Principles of the Nano-Immunoassay (NIA)



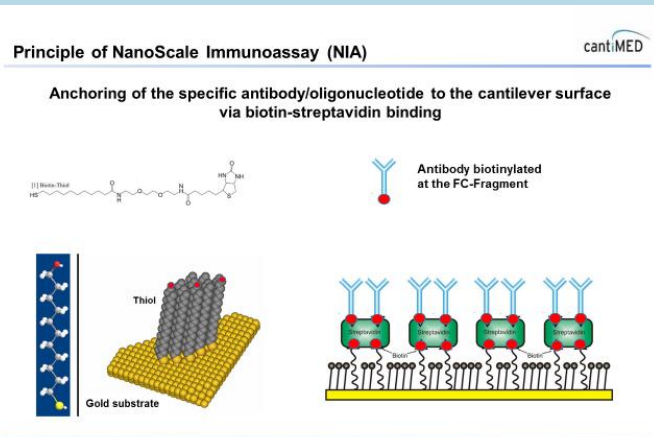


Figure 2.: Results of the Benchmark Experiment

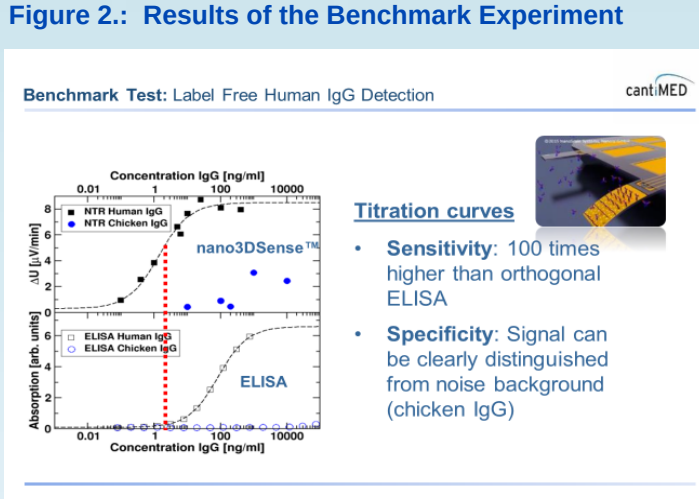
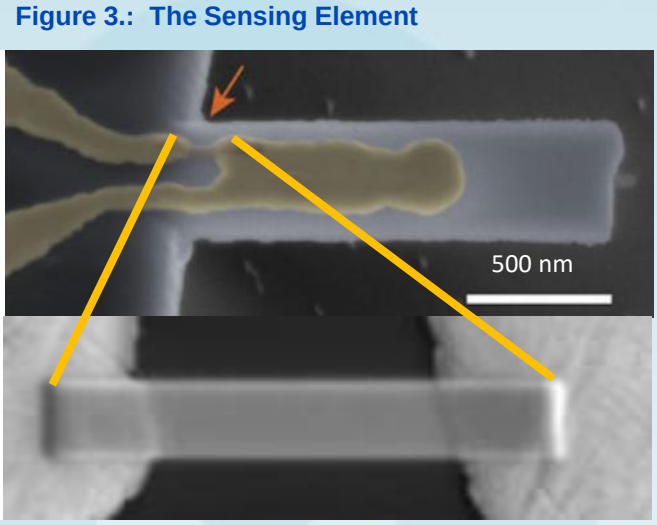


Figure 3.: The Sensing Element



Conclusions

In our proof-of-concept experiment, the NIA in comparison to the classic ELISA was shown to be substantially more sensitive, less time and resource consuming. With the NIA it is possible to determine the analyte-binding directly within minutes and without any further labeling requirement. In addition, the small size of the NIA sensors allows for integration into Lab-on-a-Chip technologies, which will enable point-of-care testing with a laboratory quality level.

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