Real time bioaerosol detection by Surface Plasmon Resonance

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Over the last decades biosensors attracted much interest in the field of microbial detection due to their capability of direct determination of target analytes (proteins, small organics, microbes, viruses, or toxins) via interaction with specific bio-recognition elements (e.g. antibodies) immobilized on the sensor surfaces. Considerable research has been carried out on surface plasmon resonance (SPR) technology allowing analyte detection without specific labelling usage. The major advances of such technology are its capability of direct measurements without labelling, continuous non-destructive operation, and real-time data acquisition on biomolecular interactions with simple optical device.

The current study was designed to explore the possibility of the SPR chip utilization in conjunction with our previously developed personal bioaerosol sampler (Agranovski et al., 2005) for rapid/real-time determination of general existence of a particular targeted microorganism in the ambient air. To prove the concept, the simple viral model - MS2 phage, was used in this investigation. Special attention was given to the chip functionalizing and its time related efficiency of operation.

The targeted microorganism was aerosolized by a 3 jet Collison nebulizer (BGI, Inc., Waltham, MA) from microbial suspension into the rotating aerosol chamber capable of keeping airborne particles for up to 24 hours (Fig. 1). Optical aerosol spectrometer (Model 4705, Aeronanotech, Moscow) was used to monitor concentration of airborne mircoorganism in the chamber over the entire duration of experiment.

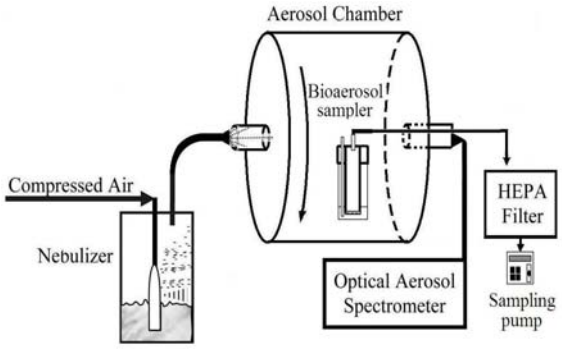

Figure 1. Laboratory setup

For each experimental run the aerosol chamber was preloaded with bioaerosol for 3 minutes achieving concentration equilibrium monitored by optical aerosol spectrometer. The aerosol samples were then acquired by three samplers operated in parallel after 1, 5 and 25 minutes time periods at a flow rate of 4 L of air per minute. Aliquots of collecting liquid from the samplers were taken for SPR assay. The final results were corrected to account for dilution of the air in the chamber by HEPA filtered ambient air due to sampling related displacement of 12 liters of air every minute.

The results of the bioaerosol detection by the personal sampler in the air are shown in Figure 1. Here, response curves represent the MS2 phage association with immobilized anti-MS2 antibody for 1, 5 and 25 minutes of the sampler operation for collection of airborne microorganisms. Response levels for the 100 μL of the samplers' collecting liquid passed through the cell were found to be in correlation with the sampling time. The standard deviation for at least three repeats of all samples did not exceed 10%.

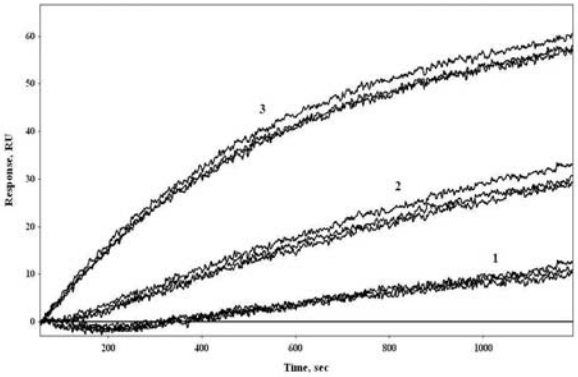

Figure 2. Detection of airborne MS2 by SPR

The combination of SPR technology with the personal bioaerosol sampler was proved to be successful. The SPR based detection of the airborne virus was found to be very fast; the reliable qualitative detection of the viral presence in air was made in less than two minutes and the entire procedure (sampling and analysis) was undertaken in less than 6 minutes, which could be considered as real time detection for this type of measurements. Obviously, for vast majority of biomonitoring applications this issue is crucial and the new technique looks very promising for further technological developments.

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