Real-time separation between aerosolized *Staphylococcus epidermidis* and polystyrene latex particle of similar size distribution

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For rapid and effective detection, various biological and chemical techniques have been developed such as immunoassay, UV-Vis spectroscopy, polymerase chain reaction (PCR), and biosensors. However, each of them still suffers from some deficiencies. Non-target particles and dust are one of these problems that can affect accuracy of measurements and detection, especially in the case of PCR and biosensors.

Recent aerosol studies independently showed that environmental matrix (dust or particulate matter) can significantly inhibit PCR and cause the complete or partial failure of the PCR reaction (Hospodsky et al., 2010). Therefore, an additional step is required to obtain a target microbe before the quantitative and accurate identification.

In the following, we introduced a methodology to separate bacterial and non-bacterial aerosols of the same mean size due to the difference in their electrical mobilities. In this sense, 0.8 – 0.9 μm *Staphylococcus epidermidis* (*S. epidermidis*) and polystyrene latex (PSL) particles were chosen, respectively, as target and non-target particles. By passing these particles through a corona region, *S. epidermidis* and PSL particles gained different electrical charge values (340 and 165, respectively) since the number of charges obtained by aerosol particles depends on their relative permittivity. The PSL particles and *S. epidermidis* were separated from each other when an external electric field was applied to the direction perpendicular to the flow. For this purpose, a mobility analyzer developed by Mainelis et al. (2002) was used.

The schematic of the rectangular-shaped separator is shown in Fig. 1 where the X-axis denotes the gravitational direction. The separator consisted of two parallel plates and had two inlets and two outlets. Air flow containing charged PSL and *S. epidermidis* particles entered through one inlet (0.3 LPM) while clean sheath air that entered through another inlet (0.9 LPM). Then the external electrical field in the direction of Y-axis caused the negative charged bacteria to be deflected toward the anode so that they could exit through the 'Outlet 1'. The PSL particles were also deflected toward the anode. However, their charge number (165) was much lower than that of *S. epidermidis* (340). Therefore, the PSL particles were supposed to exit through the other outlet, 'Outlet 2'. A rectangular pin was embedded at the end of the separator to increase the separation efficiency.

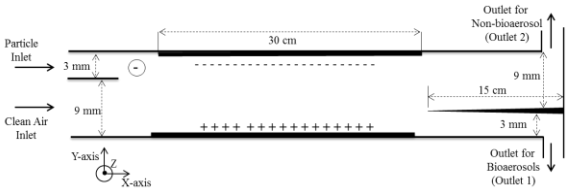

Figure 1. Schematic of the separator

However, the wall losses for bacteria and PSL were quite high with the voltage of 300V; 25.5% and 51.2%, respectively. For PSL particles, about 13.8% of particles left through 'Outlet 1' and around 35% passed through 'Outlet 2'. For *S. epidermidis*, about 55.7% of particles left through 'Outlet 1' and around 18.8% passed through 'Outlet 2'.

The aerosol number concentrations were measured at the inlet and outlet to determine the separation performance. The purity is defined as the fraction of particular species to the total species exiting through an outlet. The purities for *S. epidermidis* and PSL particles are defined as follows,

$$P_{Bacteria} = \frac{N_{Bacteria-outlet\ 1}}{N_{PSL-outlet\ 1} + N_{Bacteria-outlet\ 1}}$$

$$P_{PSL} = \frac{N_{PSL-outlet\ 2}}{N_{PSL-outlet\ 2} + N_{Bacteria-outlet\ 2}}$$

The purity of the bacteria in 'Outlet 1' was 80.1% and the purity of the PSL in 'Outlet 2' was 65%.

The experimental results of separation revealed the possibility of the real-time separation of between charged bio and non-bio particles with having different charge numbers.

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