

# Advanced electrostatic technologies for sampling airborne biological particles

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## SUMMARY

We recently developed two novel electrostatic samplers for biological aerosols: 1) a bench scale sampler with a very high concentration rate and 2) a low-power personal sampler. The first sampler, electrostatic precipitator with superhydrophobic surface (EPSS), collects airborne biological particles onto a narrow electrode covered by a superhydrophobic substance. The collected particles are then removed and collected by rolling water droplets (20 to 40 microliters). This novel sampling concept allows achieving very high sample concentration rates. The second sampler, personal electrostatic bioaerosol sampler (PEBS) charges airborne incoming biological particles using a novel wire-to-wire charger design, and deposits them onto a dual-sided metal plate. This wearable sampler is a self-contained and battery operated unit, and is suited to assess personal exposures to airborne biological agents.

Keywords: Electrostatic; Bioaerosol; personal sampler

## I. INTRODUCTION

Airborne biological particles could be found in almost any indoor or outdoor air environment (Prussin et al., 2015). Because of negative health effects caused by exposure to them, it is important to be able to accurately and quickly quantify bioaerosol concentrations with efficient and reliable sampling devices that feature high collection efficiency at low agent concentrations. For this purpose, we are currently working on further developing the EPSS sampler. The upgrade will have a redesigned charger and collector and that will reduce sampler's impact on viability and culturability of the samples while maintaining high sample concentration rate. While there are many stationary and portable samplers that collect biological particles, rather few samplers are available to assess personal exposures to bioaerosols, and there are none that do not require cumbersome personal pumps. In order to satisfy this demand, we have been developing a personal electrostatic sampler (i.e., PEBS), which uses a novel wire-to-wire particle charger and a double-sided and removable metal collection plate. The main goal of these studies is to develop advanced electrostatic biosamplers, which have high

collection efficiency without any substantial ozone production so as not to negatively affect the collected microorganisms..

## II. METHODOLOGY

The EPSS and PEBS were tested with polystyrene latex (PSL) particles and microorganisms (*Bacillus atrophaeus* and *Penicillium chrysogenum*) at 10-240 min collection duration. The collected samples were analyzed using multiple analysis methods such as optical particle counting, microscopy, the adenosine triphosphate (ATP)-based bioluminescence, flow cytometry, and culture-based methods.

## III. RESULTS

We achieved collection efficiencies in the 60-75% range for the investigated particle sizes (i.e., 0.1 – 3  $\mu\text{m}$  PSL) when the EPSS was operated at 20 L/min sampling flowrate and +6/-6 kV charging/collection voltage. The ozone production was very low: ~3 ppb or less above background. At +5.5 kV/-7 kV voltages for charging/collection of particles and 10 L/min sampling flow rate, the sampler exhibited collection efficiency of ~80% and produced low ozone concentration (< 10 ppb). Even after 4 hours of continuous operation, PEBS showed high collection efficiency (~77%) and low ozone emission concentration (< 8.6 ppb). Experiments with bioaerosols (e.g., *B. atrophaeus* and *P. chrysogenum*) also show high collection efficiency (65 - 75%).

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## REFERENCE

1. Prussin, A.J., Garcia, E.B. and Marr, L.C., "Total Concentrations of Virus and Bacteria in Indoor and Outdoor Air," Environ. Sci. Technol. Lett, Vol. 2, 84–88, 2015.

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