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A High-Efficiency Condensation Growth Sampler for Collecting Concentrated Aerosol Particles on a Solid Substrate and in Liquids

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INTRODUCTION

The new **Spot Sampler™** collects airborne particles down to 5nm with high efficiency using a moderated, three-stage, laminar-flow, water-condensation growth tube (Figure 1).

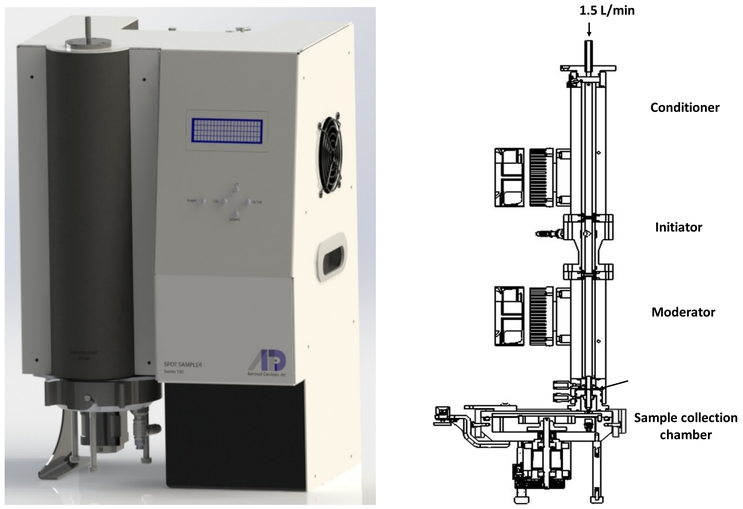


Figure 1. Aerosol collector and schematic of the three-stage growth tube

This new approach enables airborne particle collection at close-to-ambient temperatures, reducing sampling artifacts for a more accurate characterization of their chemical properties. The system is fully field-deployable and can run unattended for several days.

INSTRUMENT DESIGN

The three-stage, moderated laminar-flow condensation method grows aerosol particles to ~3µm droplets and collects them by bounce-free, soft impaction into the collection substrate[1,2] (Figure 2). Under standard operating conditions, the sample airflow does not exceed 30°C (Figure 3).

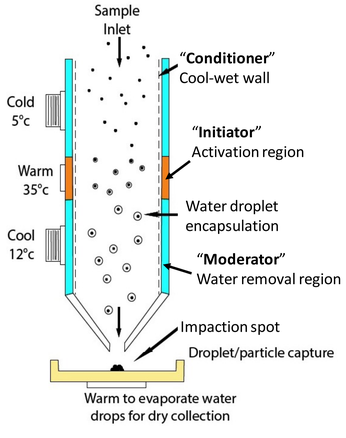


Figure 2. Three-stage water condensational growth approach

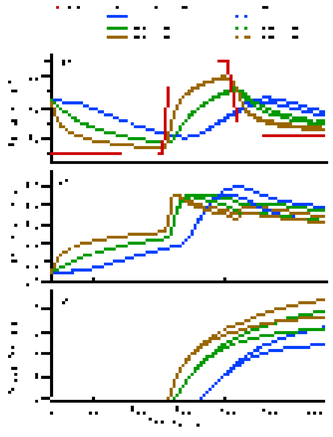


Figure 3. Temperature, saturation ratio, and droplet size under standard operating conditions[1]

INSTRUMENT CAPABILITIES

The system collects particles via impaction on a solid substrate or into a small volume of liquid.

Dry collection (Figure 4a, 4b):

- Time-resolved collection: minutes to hours
- Uninterrupted collection of concentrated "spots" (1-mm) in a 33-well disk
- Automated extraction and injection by autosampler for analysis (i.e. IC, HPLC)[3]

Liquid collection (Figure 4c):

- Concentrated suspensions (~200-400 µL)
- Changeable collection medium: water, culture media, virus growth medium
- Ready for chemical, toxicological, and virus viability analysis

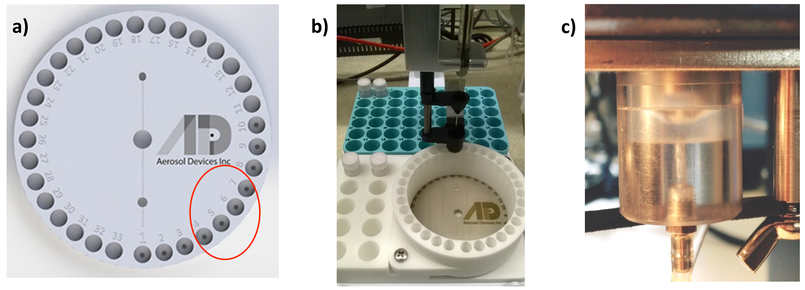


Figure 4. a)Multi-well collection disk; b) automated extraction and analysis; c) Liquid collection

EXPERIMENTAL SETUP

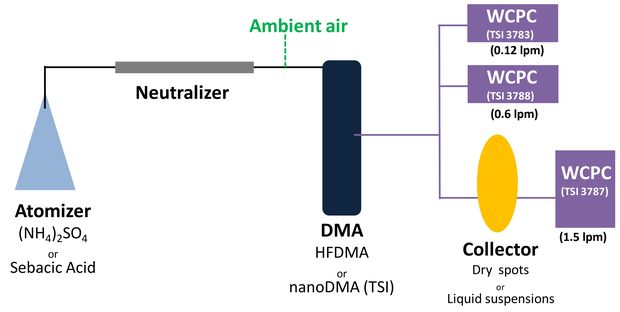


Figure 5. Schematic of the experimental set up in our laboratory

RESULTS: AMBIENT DATA

Ambient Aerosol Data from Two Weeks of Unattended Operation, with automated extraction and analysis of the well plate

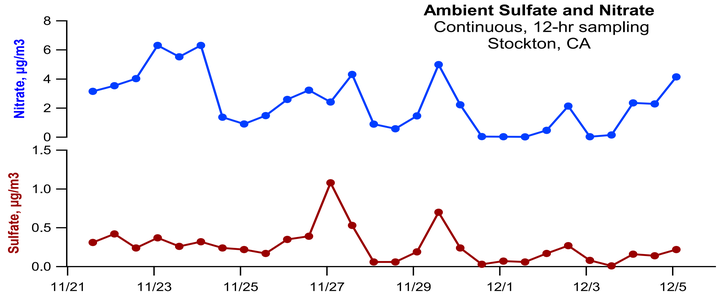
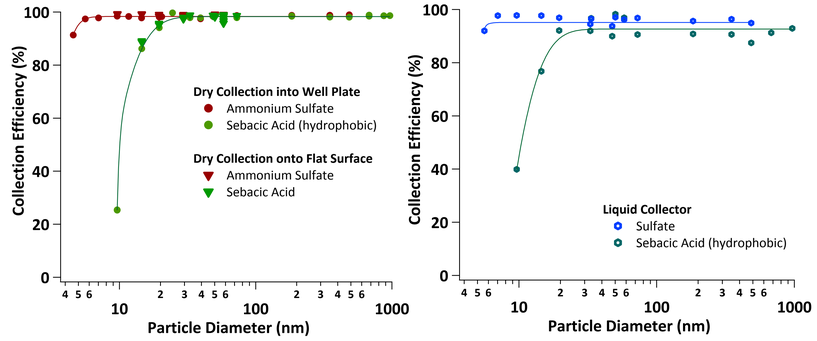


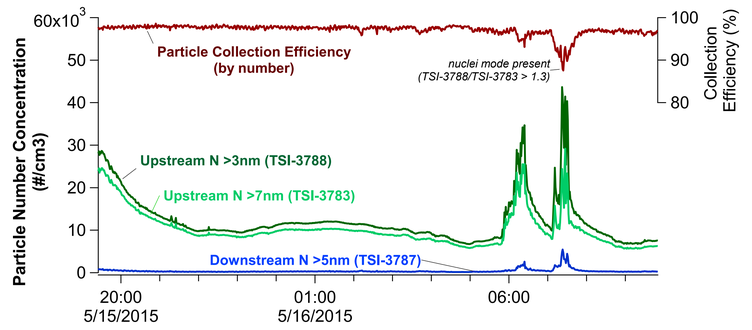
Figure 6. Ambient Concentrations of Sulfate and Nitrate (from prototype, see references 2 & 3)

RESULTS: CALIBRATION

Calibration with Monodisperse Hydrophilic and Hydrophobic Aerosols



Ambient Aerosol Capture Efficiency using the Dry Collector



CONCLUSIONS

1. The Spot Sampler provides a new approach to efficiently collect airborne particles as concentrated, ready-to-analyze dry samples or liquid suspensions.
2. High collection efficiencies are obtained for both dry and liquid collections, down to 5nm for hydrophilic particles, and 15nm for highly hydrophobic aerosols.
3. Ambient particle collections are achieved with efficiencies >90% for both configurations.
4. Unattended, time-resolved collection allows better characterization of the aerosol properties and dynamics.

REFERENCES

1. Hering, S.V., S.R. Spielman and G.S. Lewis. (2014). Moderated, Water-Based, Condensational Particle Growth in a Laminar Flow. *Aerosol Science & Technology* 48:401-408.
2. Eiguren Fernandez, A., G.S. Lewis, and S.V. Hering. (2014). Design and Laboratory Evaluation of a Sequential Spot Sampler for Time-Resolved Measurement of Airborne Particle Composition, *Aerosol Science &Technology*, 48:6, 655-663.
3. Eiguren-Fernandez, A., G.S. Lewis, S.R. Spielman, and S.V. Hering. (2014). Time-resolved Characterization of Particle Associated Polycyclic Aromatic Hydrocarbons using a newly-developed Sequential Spot Sampler with Automated Extraction and Analysis. *Atmospheric Environment* 6: 125-134.

ACKNOWLEDGEMENTS

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