Establishment of an Aerosol Sampling Protocol Using Passive Air Sampler (PAS) and Scanning Electron Microscopy (SEM)

Jurate Virkutyte and Sergey Grinshpun
Department of Environmental Health, University of Cincinnati, Cincinnati, OH
virkutje@ucmail.uc.edu

PRP, Cincinnati, OH 2018

University of CINCINNATI

Background

The state-of-the-art for personal sampling devices for aerosol particles is constrained by issues of personal sampler **cost** and **complexity of operation.**

There is a need to develop **effective** and **easy-to-use** sampling device (with acceptable sampling and analytical protocols), which would adequately represent environmental factors and the workplace specifics of health care settings.

UNIVERSITY OF Cincinnati

Purpose

The **overall goal** of the project is to develop a **reliable** and **effective** personal air sampling device that includes analytical as well as sampling protocol, especially relevant for the health care industry:

- **Pilot study** (to ensure that SEM stubs have a capacity to retain aerosol particles and can be used as PAS; SEM can be utilized as an analytical instrument for aerosol particle research)
  - Analytical procedures - ***PRP funding (2017/2018)***
- **Engineering approach –** sampling device (casing, particle retention efficiency, ease of use) **–** ***funding application (R03 NIOSH)***
- **Sampling protocol development** (efficiency comparison to conventional sampling devices; criteria for particle quantification)– ***funding application (R21 NIOSH)***

UNIVERSITY OF Cincinnati

Hypothesis: SEM, PAS and experimental setup provides adequate data to develop analytical procedures for aerosol (NaCl) particles quantification.

Specific aim 1: To assess the behavior of saline aerosol particles used by Health Care Workers (HCW) at various exposure times, humidity and the distance to the emission source.

Criteria for particle quantification: 1) Sampling time (up to the 8 hour shift and 1 week for extreme case scenario) and 2) Particle count on the SEM stub (> 100 particles in a selected area).

Relevance and importance to HCW: Nanoparticles can be retained and analyzed by the SEM, which is challenging using conventional approaches; ease of operations in terms of the device size and other properties as well as virtually non required training.

UNIVERSITY OF Cincinnati

Experimental setup

Figure 1. Scanning Electron Microscope

Figure 2. SEM stubs

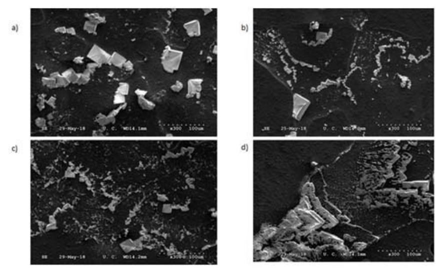
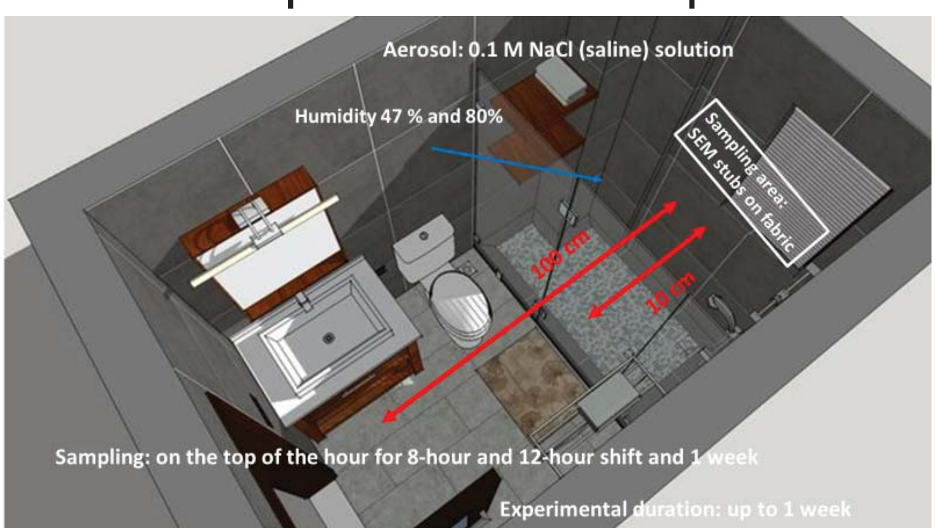


Figure 3. The initial particle sizes, shapes and distribution prior experiments a) 10cm and b) 100cm from the source at 47% humidity; c) 10cm and d) 100cm from the source at 80% humidity

UNIVERSITY OF Cincinnati

Experimental setup



UNIVERSITY OF Cincinnati

Results

- ❖ Particles: cylinders, cones, rectangular prisms and spheres and were single or aggregated.
- ❖ There were from **150 to 4500 particles** on average in each micrograph that diffused onto the surface of a sticky carbon tape.

UNIVERSITY OF Cincinnati

Results

- ❖ SEM for passive samplers are still in their infancy, and relatively little is known about the measurement precision considering spatial distribution of particles.
- ❖ The initial saline particles appeared as cubes with well-defined edges at 47% humidity.
- ❖ There was no significant difference in particle shape and sizes with distances from the source, however, particles were more aggregated, when the humidity was 80%.

UNIVERSITY OF Cincinnati

Results

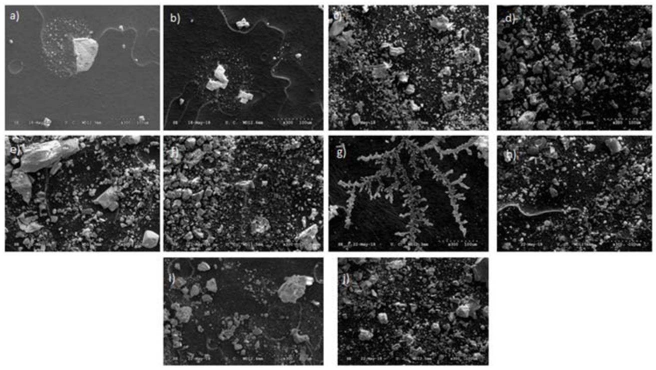


Figure 4. Representative micrographs of experiments conducted at 10 cm from the source and 47% humidity.

Results

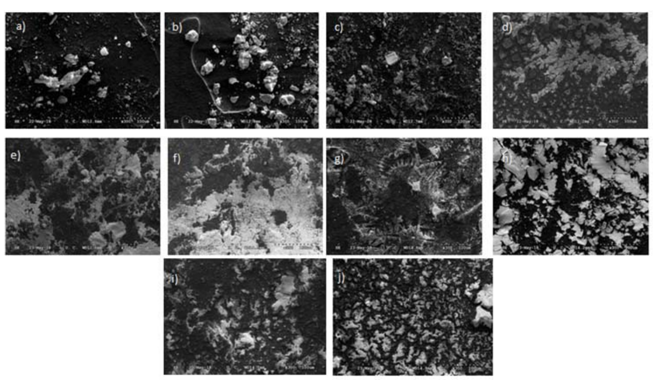


Figure 5. Representative micrographs of experiments conducted at 100 cm from the source and 47% humidity.

Results

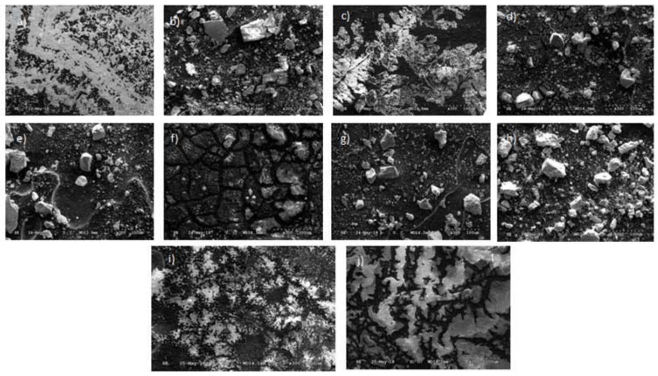


Figure 6. Representative micrographs of experiments conducted at 10 cm from the source and 80% humidity.

UNIVERSITY OF Cincinnati

Results

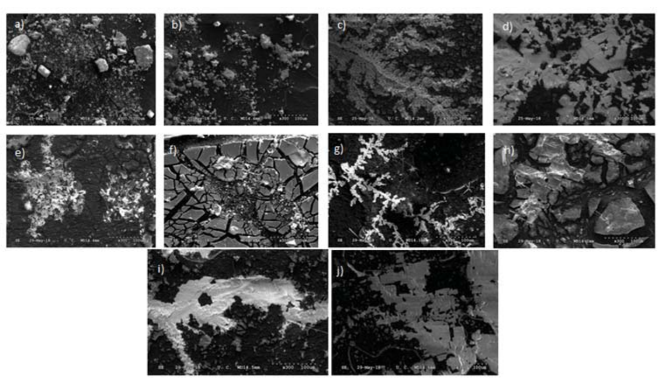


Figure 7. Representative micrographs of experiments conducted at 100 cm from the source and 80% humidity

UNIVERSITY OF Cincinnati

Results

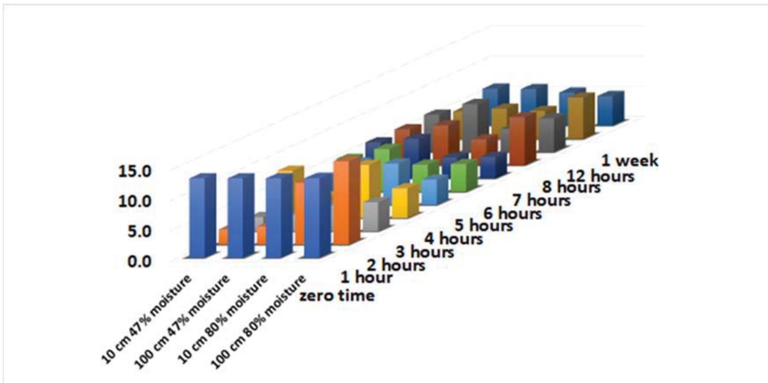


Figure 8. Feret diameters (FD) for all the experimental conditions (pixels).

University of Cincinnati

Results

Increased humidity from 47% to 80% resulted in smaller aerosolized saline particles.

This is an issue in protecting the home health care workers, since the usual respiratory protective of disposable masks can be ineffective in retaining particles of small size.

University of Cincinnati

Conclusions

1) Data and insights gained could be further expanded to improve estimates of exposure to particles within a hospital and/or home healthcare setting with heterogeneous compositions of aerosolized particles, particularly in exposure-health outcome studies.
2) Sticky carbon and SEM analytical approach along with ImageJ software guaranteed the accuracy of the measurements.
3) However, speedy calculations and faster acquisition of results from more samples could be improved using automated SEM analysis.

UNIVERSITY OF Cincinnati

Conclusions

4) Limitations: results were limited to one week in one season and may not represent particle concentrations more generally.

5) No federal reference method (FRM) samples were available in this study for validation of passive sampler results.

UNIVERSITY OF Cincinnati

This study was supported by the National Institute for Occupational Safety and Health through the Pilot Research Project Training Program of the University of Cincinnati Education and Research Center Grant #T42OH008432.

QUESTIONS?

Thank You!

UNIVERSITY OF Cincinnati

PRPS
pilot research project symposium

University of Cincinnati
19th Annual
Pilot Research Project Symposium
October 11-12, 2018

eRC
University of Cincinnati Education and Research Center

Thursday, October 11, 2018

Presenter	Presentation Title
Alison Pecquet University of Cincinnati Environmental Health	"Immunotoxicity of PFCs (perfluoroalkyl compounds) Found in Fire-Fighting Foams" (Presentation PDF)
Cody Morris, PhD University of Alabama at Birmingham Kinesiology	"Comparing Health Status and Exposure Risk in Career Vs. Voluntary Firefighters" (Presentation PDF)
Claire Smith presenting on behalf of Haylee Min Bowling Green State University Industrial Organizational Psychology	"Negative Responses to Workplace Incivility in Home Care Workers" (Presentation PDF)
Jagjit Yadav, PhD University of Cincinnati Environmental Health	"Microbiome Changes as Markers of Exposure and Stress in Firefighters" (Presentation PDF)
Jennifer Perion University of Toledo Health Education	"Well-being of Youth Caregivers and its Effect on Pursuing a Career in Geriatrics" (Presentation PDF)
Weylin Gilbert presenting on behalf of Jooyeon Hwang, PhD Western Kentucky University	"Assessment of Diesel Particulates in Fire Departments using Different Exposure Metrics" (Presentation PDF)
Moderated by Gordon Gillespie, PhD, DNP, RN University of Cincinnati College of Nursing	"Poster Session I Q&A"

Friday, October 12, 2018

Presenter	Presentation Title
Jurate Virkutyte, PhD University of Cincinnati Environmental Health	"Establishment of an Aerosol Sampling Protocol using Passive Air Sampler (PAS) and Scanning Electron Microscopy (SEM)" (Presentation PDF)
Paa Kwasi Adusei University of Cincinnati Mechanical and Materials Engineering	"Lightweight, Wearable Energy Storage Devices for Firefighters and First Responders" (Presentation PDF)
Sathya Narayan Kanakaraj University of Cincinnati Mechanical and Materials Engineering	"Fabric Integrated Gas Sensors for First Responders and Miners" (Presentation PDF)

Vianessa Ng University of Cincinnati Mechanical and Materials Engineering	"Flame Resistant Nanofabric to Protect Firefighters Against Heat and Toxins" (Presentation PDF)
Moderated by Gordon Gillespie, PhD, DNP, RN University of Cincinnati College of Nursing	"Poster Session II Q&A"
Moderated by Gordon Gillespie, PhD, DNP, RN University of Cincinnati College of Nursing	"Panel Discussion of the Podium Presentation Topics"
Diana Schwerha, PhD Ohio University Industrial and Systems Engineering	"BEST Award Presentations and Closing Remarks"

Return to Main Menu