Fine particulate and chemical emissions from FFF/desktop 3D printers

Rodney Weber, Qian Zhang, Jenny Wong
School of Earth and Atmospheric Sciences, Georgia Institute of Technology; Atlanta, GA/USA

Aika Davis, Marilyn Black
Underwriters Laboratories Inc.; Marietta, GA/USA
Presented for Additive Manufacturing Users Group, Chicago, March 2017

Motivation

Consumer 3D printers are used in environments where exposures to unknown emissions can occur. Exposures include susceptible populations.

Objectives

Identify and characterize chemical and particle emissions; develop standard method for characterizing and assessing including exposure; evaluate potential human toxicity of emissions.

Outline

Part 1: Emissions
- Background
- Measured Emissions: <u>systematic evaluation</u> of:
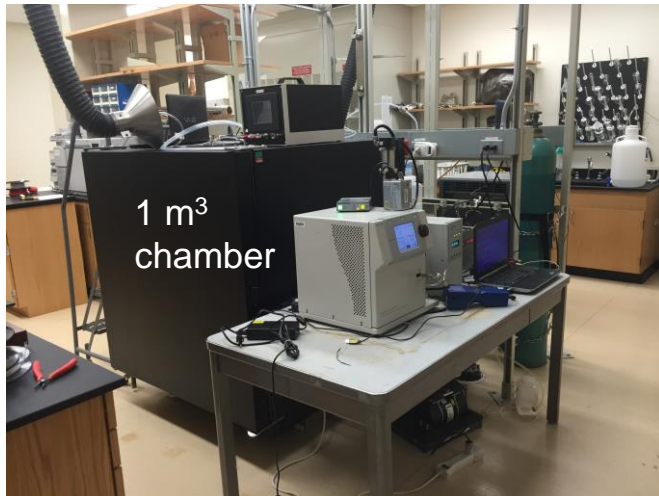 - Printer and filament brands, filament material, filament color…

Part 2: Toxicity and Exposure
- Estimates of exposures
- Toxicity of 3D printer particles (initial exploration)
- Summary

Overall Approach

Work Spaces, Classrooms, Library's, etc.
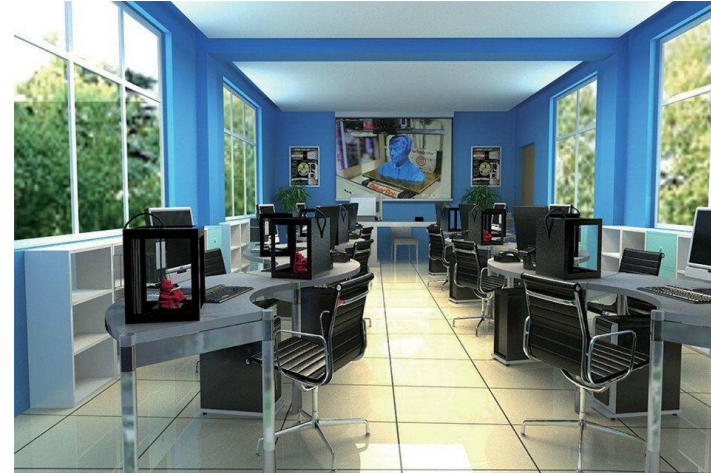

Standardized testing method to understand emissions

1 m³ chamber

Similar to testing laser printer emissions

Exposure Assessment

Apply results to determine exposure in various settings

Part 1 of this talk

Part 2 of this talk

Summary

1. Consumer 3D printers emit non-engineered nanoparticles and VOCs. Exposures will depend on printer/filament and operating environment.

2. Significant variability in particle emissions are a function of:
   - **Filament material: large effect (related to nozzle T)**
   - **Filament brand: large variability**

3. Chemical composition of emitted particles can be similar (PLA) or differ from filament polymer (ABS).

4. Preliminary toxicity assessment show 3D printer particles produces adverse responses consistent with oxidative stress paradigm.

5. Exposure assessments
   - **"Office Environment"**
     - Number, Mass and Oxidative Potential at **low end** or below typical ambient exposures for particles, some VOCs higher than CREL limit
   - **"Personal Exposure"**
     - Number, Mass and Oxidative Potential **at or above typical** ambient exposures for**,** except PLA filament
     - Many VOCs exceed reach levels known to cause adverse health effects

Importance of operating in ventilated space

Next Steps

The complexity of emissions from 3D printers is significant, compounded by the impact of numerous operating parameters and potential health implications.

The need exists for the development of a standardized method for measuring and assessing these emissions for accuracy and consistency.

UL will be reaching out for stakeholder involvement in the development of a consensus ANSI standard.

The research was conducted by the Georgia Institute of Technology under a grant from Underwriters Laboratories Inc., a not for profit organization dedicated to research, education, and stakeholder outreach.

Working for safe working , living, and learning environments.