Technical Brief

A Strategic Research Initiative for Extended Research on 3D Printing Emission Studies

Investigation of 3D Printer Emissions

Introduction

Previous research on consumer level fused filament fabrication (FFF) 3D printers shows that the operation of a 3D printer with thermoplastic filaments emits high levels of ultrafine and fine particles, as well as volatile organic compounds (VOCs). This reveals the importance of understanding emission characteristics and potential health impacts, and mitigation of exposure levels. A consensus standard on testing and evaluating particle and VOC emissions, ANSI/CAN/UL 2904, was developed based on research and third-party data from desktop extrusion-based 3D printers with thermoplastic filaments. As the 3D printing market continues to grow, new printing materials and technologies are applied for small scale environments, where potential health impacts are especially of concern, while yet not well-known.

This research will continue to study potential hazardous emissions from various 3D printer technologies and will characterize particle and VOC emissions and their health impact. Printing materials to be studied include metal or other components contained in thermoplastic filaments, mechanically-strengthened thermoplastic filaments, and metal powder.

Study Objectives

1. Characterize particle and chemical emissions from emerging 3D printing materials and technologies based on chamber exposure studies,
2. Analyze potential health related speciation in emissions and settled dust, such as metals and flame retardants,
3. Update ANSI/CAN/UL 2904 Standard based on the extended 3D printer emissions data with additional printer and filament combination variations,
4. Evaluate exposure hazards of emissions using toxicity-related assays and exposure modeling.

Science Outcomes

This research will lead to additional data and knowledge to minimize the human health impact of operating 3D printers. Findings will lead to:

1. Reliable particle and chemical emission profiles from 3D printers following ANSI/CAN/UL 2904,
2. Evaluation of additional 3D print technologies and compatibility to standard requirements,
3. Understanding relationships between metal components and flame retardants in raw filament material and in emitted particles,
4. Identifying the health impact of particles assessed by a chemical assay and comparison to ambient air,
5. Measuring exposure hazards of VOCs predicted by a human exposure model,
6. Evaluating the health impact of metal 3D printing using nanoparticle coated metal powder during material handling and post-processing processes.

Research Partners

- EPA, Office of Research and Development, National Risk Management Research Laboratory, Land and Materials Management Division, Emerging Chemistry and Engineering Branch
- Georgia Institute of Technology, Department of Earth and Atmospheric Sciences
- National Institute for Occupational Safety and Health/Centers for Diseases Control
- NASA Jet Propulsion Laboratory, Additive Manufacturing

Chemical Safety & Human Health, Underwriters Laboratories Inc.
2211 Newmarket Parkway, Suite 106, Marietta, Georgia 30067
W: ulchemicalsafety.org | E: ChemicalSafety@ul.org