

Summary of 3D Printing Exposure Research

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CIAQ Update

October 4, 2017

Estimating Exposure and Health Risks From 3D Printing

- Consumer at-home use of 3D printing is increasing rapidly and is expected to reach USD 30 billion by 2022.
 - Adult hobbyists and home-based manufacturers account for most home use
 - Some 3D printers are being marketed for use by children.
- Broad range of filaments available such as:
 - acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), polylactic acid (PLA), thermoplastic elastomer (PCTPE), transparent polycarbonate, nylon
- Consumers can also make their own filaments using blended materials and home filament extruders.

CPSC Report on Emerging Consumer Products

- Released January 2017
- Brief overview of potential emerging consumer products and technologies
- Technological and societal trends likely to influence marketplace for consumers
- Potential consumer safety issues
 - Opportunities for enhancing product safety



Staff Report

Potential Hazards Associated with Emerging and Future Technologies

January 18, 2017

The views expressed in this report are those of the CPSC staff, and they have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

PRELIMINARY HUMAN HEALTH RISK ESTIMATES FROM 3D PRINTER EMISSIONS

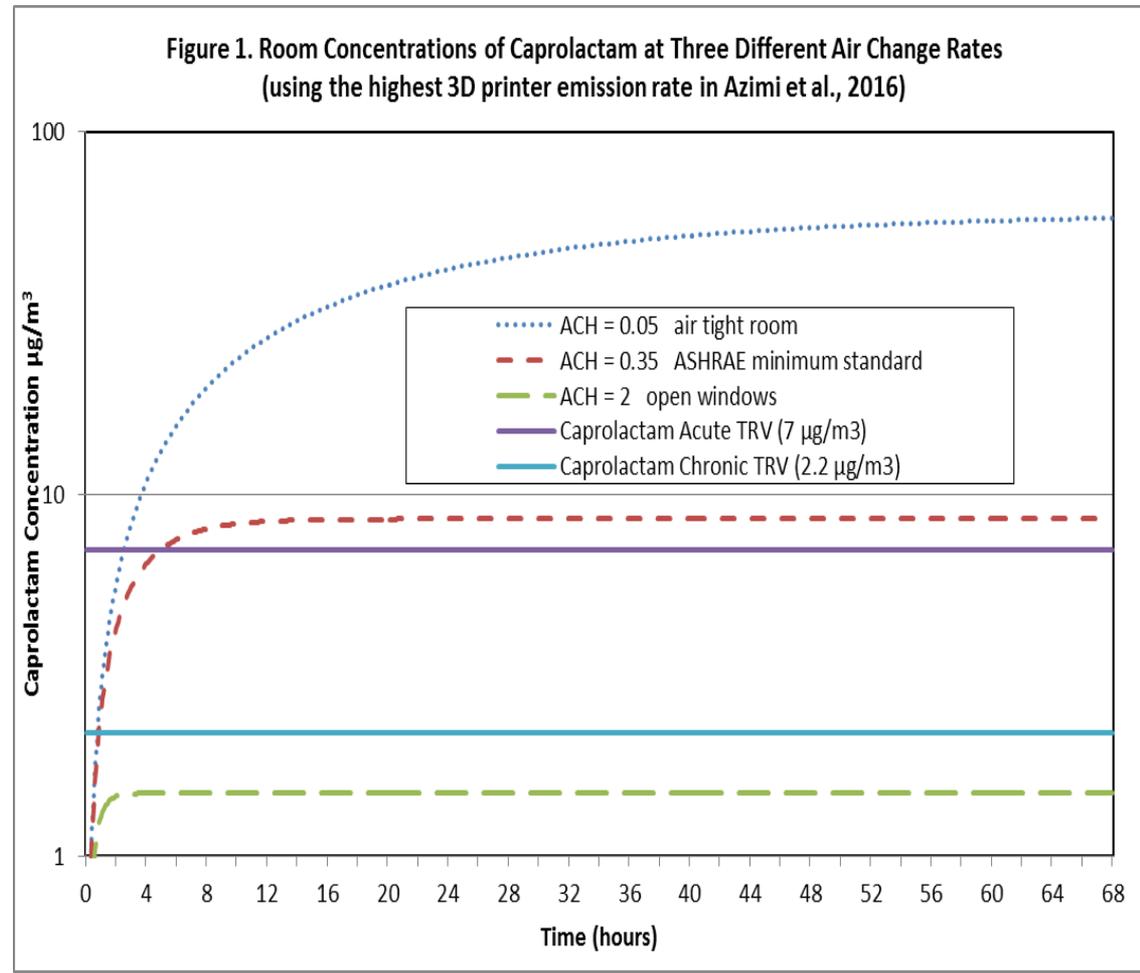
CPSC staff SOT Poster #2433

Volume = 18.1 m³) with variable air change rates (ACH, 0.05, 0.35, and 2 h⁻¹).

Continuous printing for 68H

- Instantaneously mixed air
- No VOCs entering the room with dilution air
- No reactive decay of VOCs, and no VOC sinks.
- VOC room concentrations compared to acute and chronic TRVs

One-Zone Model. VOC emission rates were used to estimate room VOC concentrations in a one-zone model evaluated at time intervals from 0.1 to 68 hours.



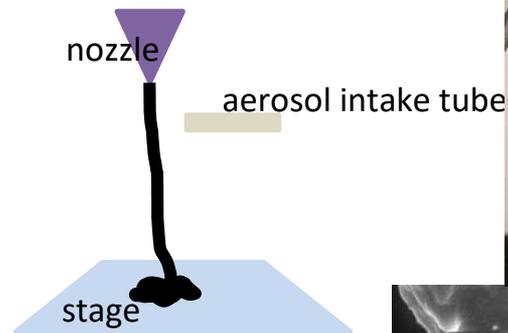
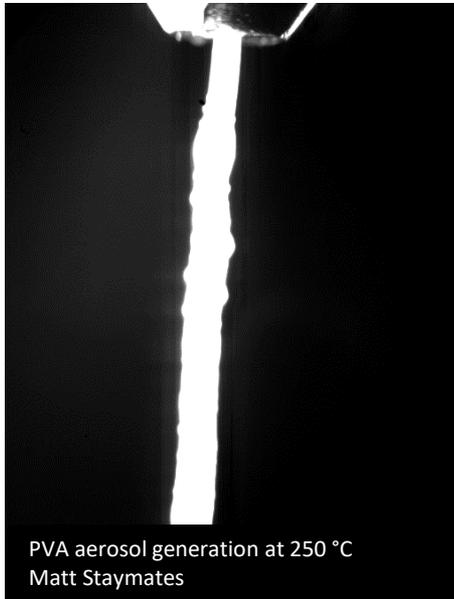
Estimating Exposure and Health Risks From 3D Printing – Modeling Results

- For some emitted VOCs, estimated concentrations exceed non-cancer acute or chronic toxicological reference values (TRVs) after only a few hours of operation.
- Room ventilation rate strongly influences the potential risk from emitted VOCs.
- A ventilation rate above the ASHRAE minimum standard mitigates the risk from most emitted VOCs
- The use of different filament types results in differing VOC emissions.

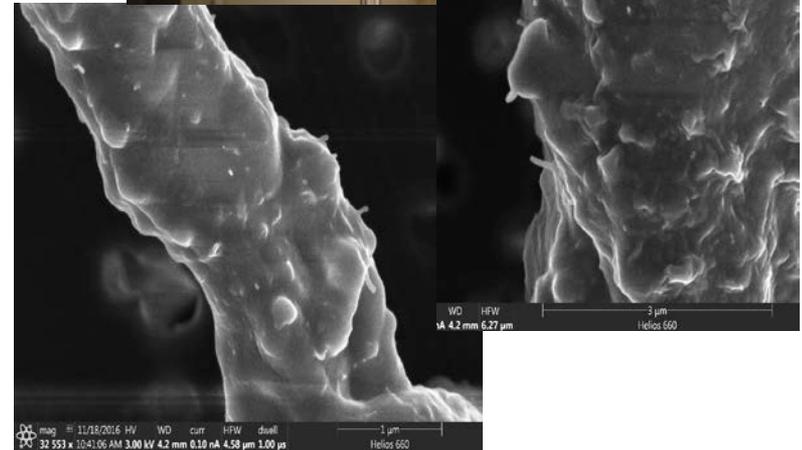
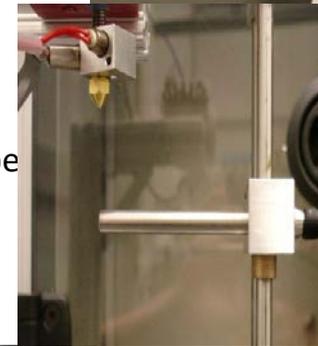
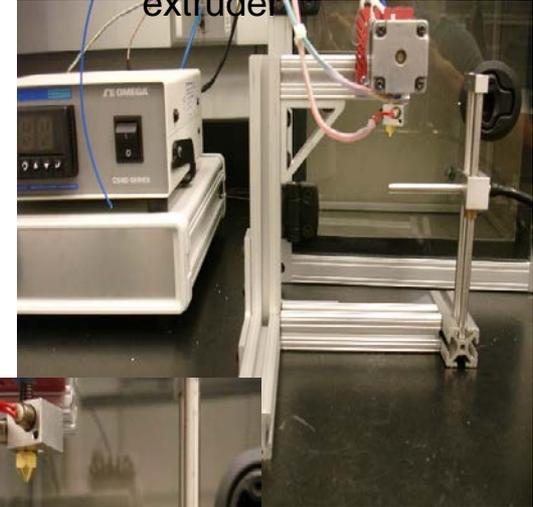
Aerosol Release of Nanomaterials from the 3D Printing Process

Objectives

- Characterize aerosol release of MWCNTs from composite 3D printer filament.
- Develop methods of sampling and quantifying aerosol nanoparticle release.



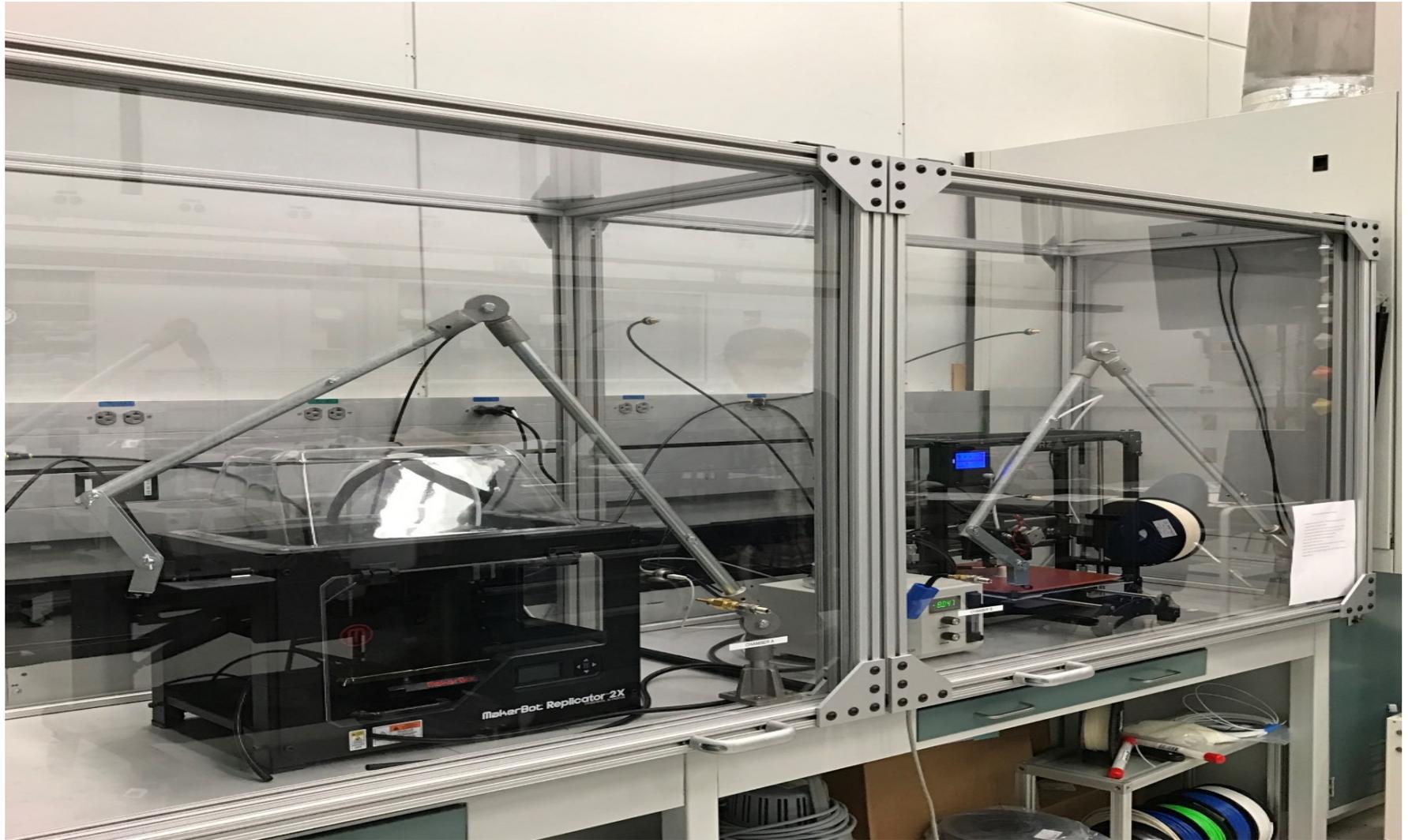
Standalone extruder



Challenges

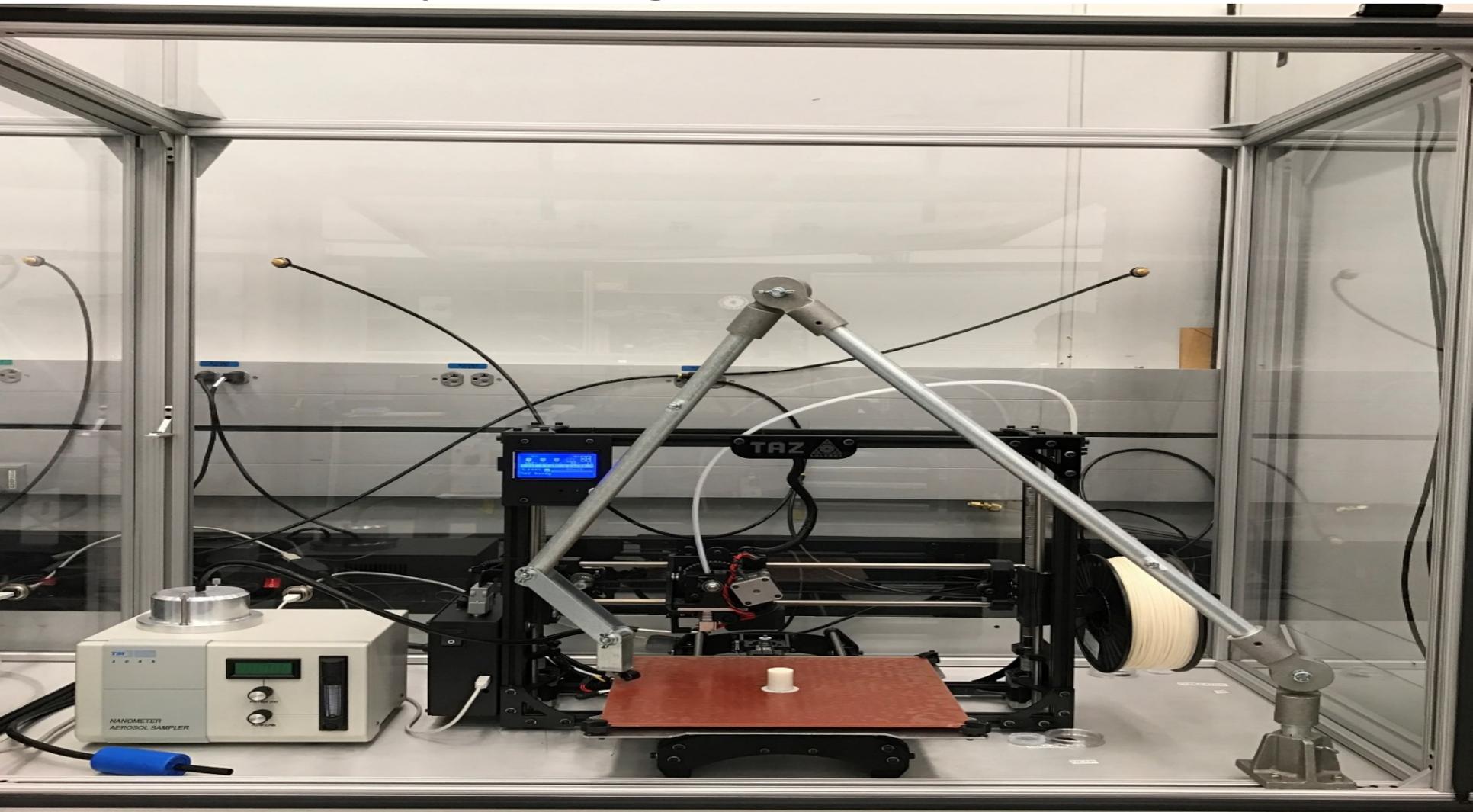
- Many determining factors: temperature, print speed, material, location, etc.
- Extensive imaging required for reliable determination

CPSC-NIST Chamber Testing - Nanomaterials Releases During 3D Printing



2 separate sampling chambers for 2 different printers

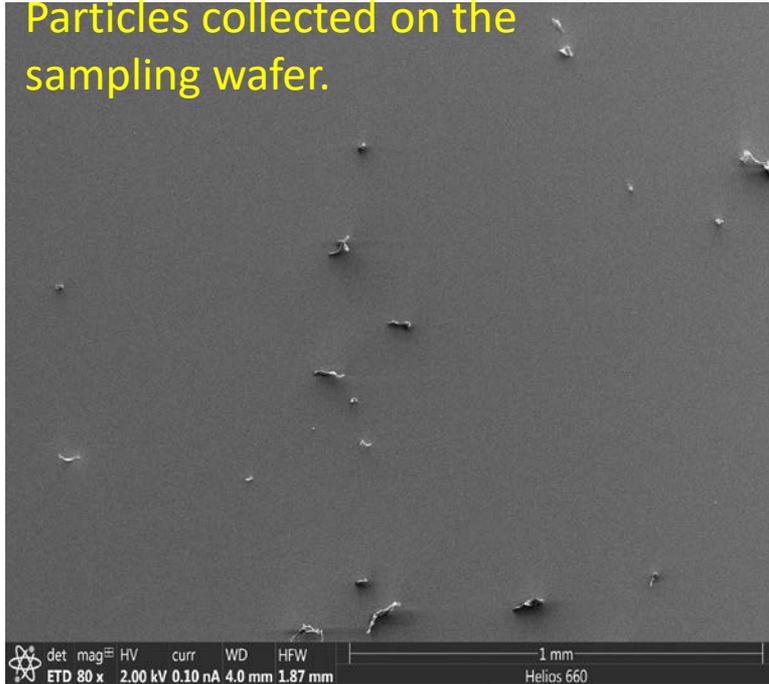
3D printing chambers



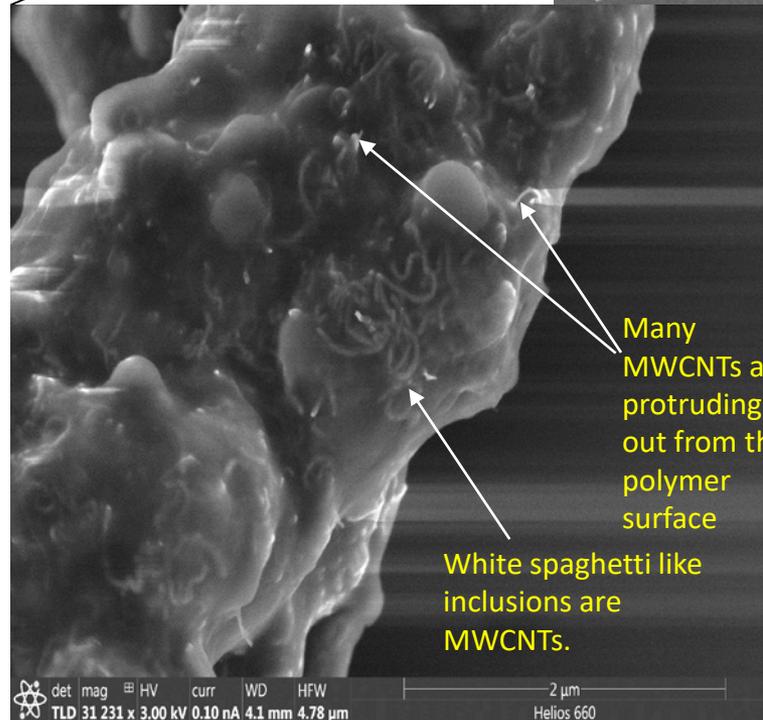
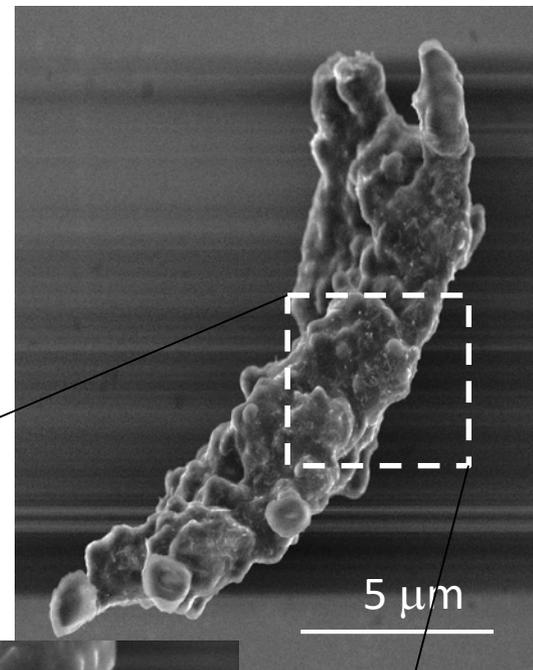
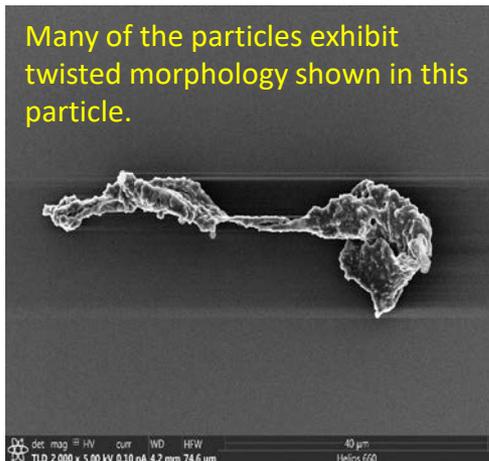
- Adjustable sampling port positions
- Electrostatic precipitator based particle collection

Particles released during 3D printing with MWCNT ABS filaments

Particles collected on the sampling wafer.



Many of the particles exhibit twisted morphology shown in this particle.

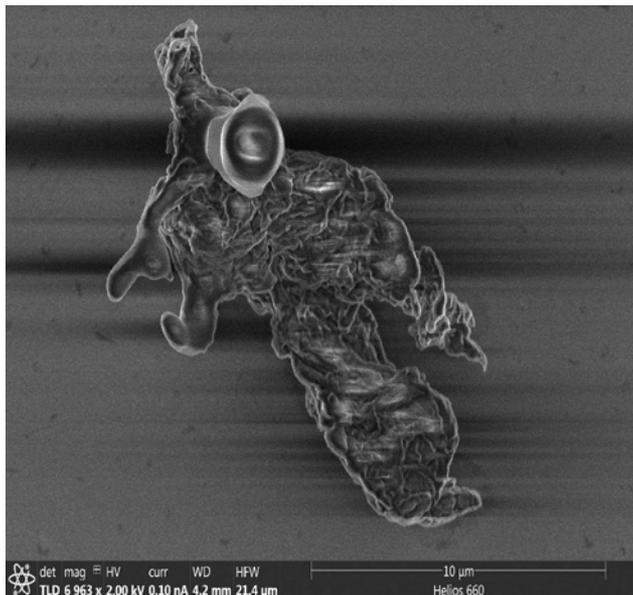


Many MWCNTs are protruding out from the polymer surface

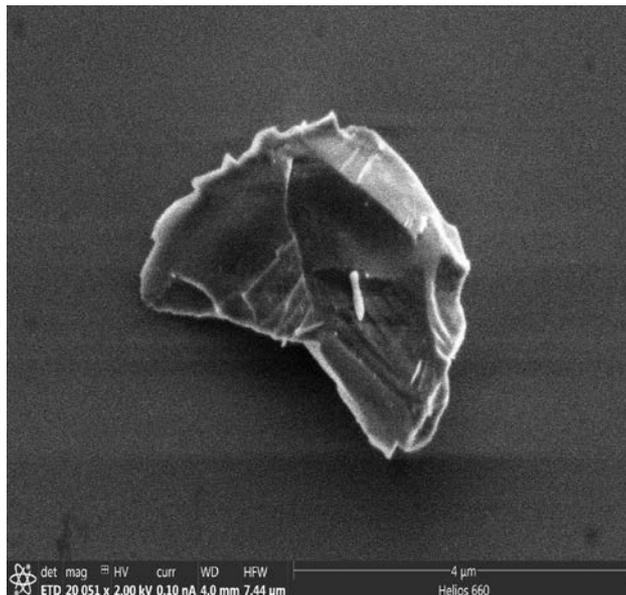
White spaghetti like inclusions are MWCNTs.

Particles released during 3D printing with neat ABS filaments

Overall, fewer particles are collected when printing with neat ABS filament.



Some particles have twisted morphology seen in the MWCNT ABS filament printing but charges more severely. The increased charging is most likely due to the lack for charge dissipation provided by MWCNTs in the nanocomposite filaments.



Some particles show fractured morphology.

Thank You

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CPSC website:

www.cpsc.gov

CPSC New Product

Database:

www.saferproducts.gov

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