Chemical Insights
An Institute of Underwriters Laboratories Inc.

Emissions from Consumer-level 3D Printers and the Health Impacts

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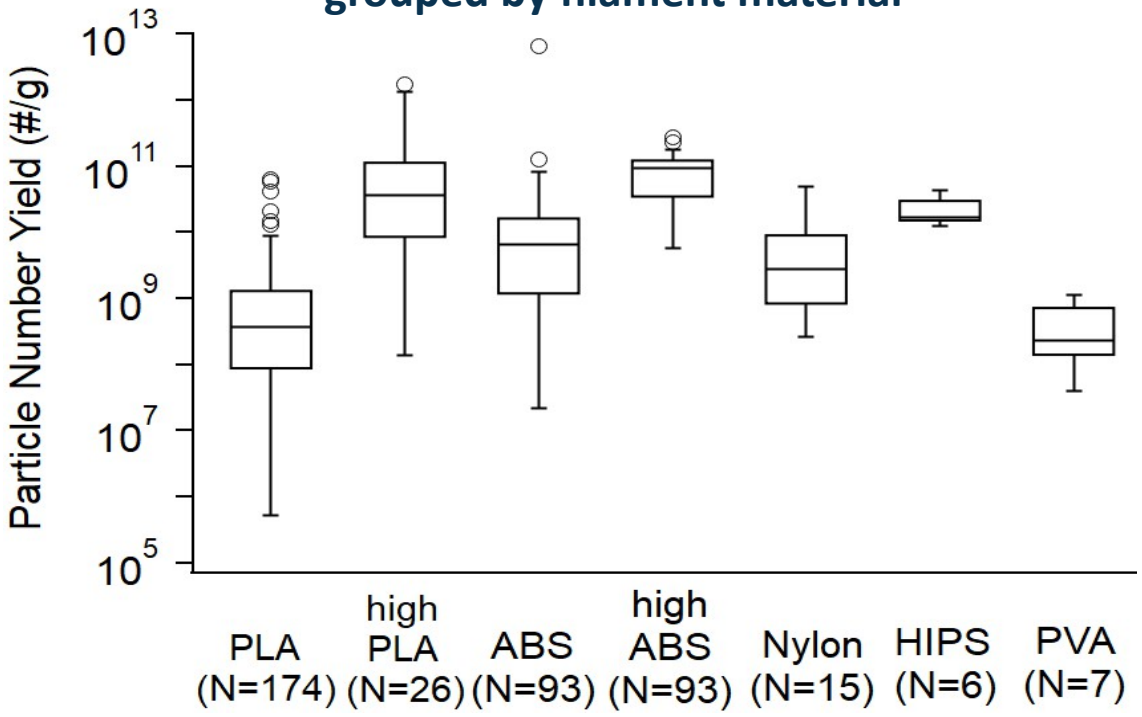
Particle Emissions from FFF 3D Printers

(Zhang et al. 2017; Zhang et al. 2019)

Particle yield from various print conditions grouped by filament material



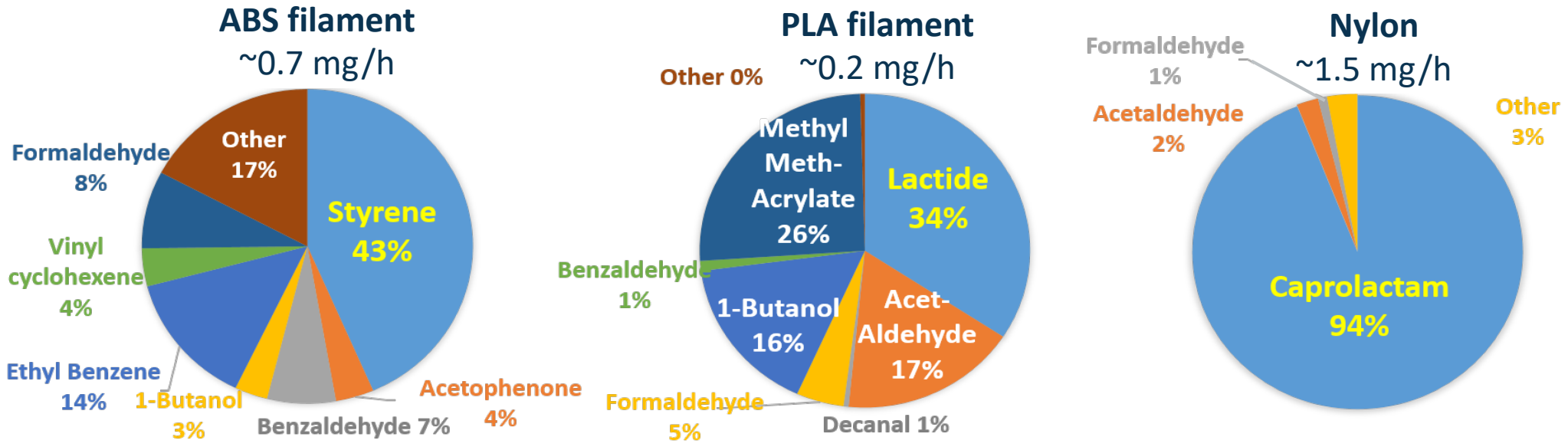
- Significant particle emissions during 3D printing
- Mainly ultrafine particles emitted (size less than 0.1 µm)
- Particle emission mostly depended on extrusion nozzle temperature, filament material and brand
- Particle emission may be driven by filament additives, resulting in particle chemical compositions (from ABS) different from bulk filament material

FFF- fused filament fabrication
PLA- polylactic acid
ABS- acrylonitrile butadiene styrene
HIPS- high impact polystyrene
PVA- polyvinyl alcohol
Yield = total particle emission/ print object mass

Chemical Emissions from FFF 3D Printers

(Davis et al. 2019)

VOC emissions and TVOC emission rates for different filament materials



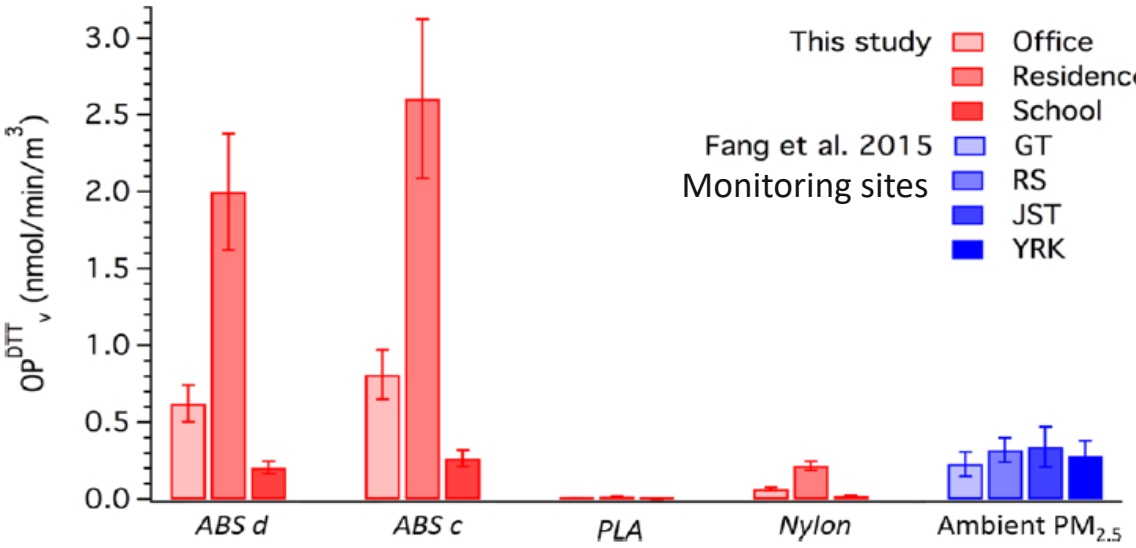
VOC- volatile organic compound
TVOC- total VOC

- Individual VOCs with highest emission rates associated with bulk filament materials
- ABS filaments had higher TVOC emission rates and more numbers of chemicals detected than PLA filaments
- VOC emission varied mostly due to extrusion temperature, filament material and brand

Health Implications of Emissions

(Zhang et al. 2019; Davis et al. 2019)

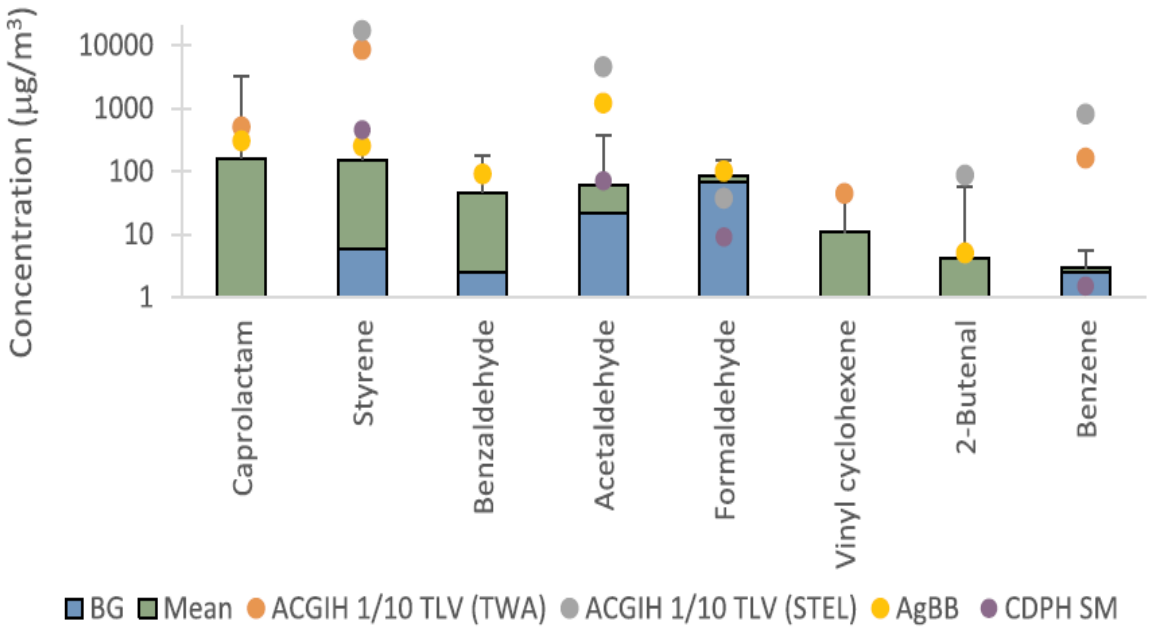
Particle toxicity assessment using a chemical assay



OP- oxidative potential DTT- dithiothreitol

- Exposure study showed particles from various filaments had negative health effects
- PLA-emitted particles induced higher responses in biological assessments
- Exposure to ABS-emitted particles may be more detrimental due to higher emissions

Predicted personal exposure VOC concentrations compared to recommended levels



- 3D printing emitted VOCs with health concerns (formaldehyde, caprolactam, styrene, etc.)
- Some VOCs of concern may exceed indoor recommended levels for personal exposure