**VOC Emissions Influenced by Polymer Additives in 3D Printing**

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**Introduction**

There is a growing concern over hazardous emissions from 3D printing as printers become more affordable and enter more workplaces and consumer households. Printing emissions containing volatile organic compounds (VOCs) and particulate matter (PM) are still a potential threat to user health. While some studies quantify total VOCs, there have been just a few attempts to fully characterize and quantify VOC emissions.

**3D Printer Filaments and Additives**

3D printing filaments often contain additives to adjust their physicochemical properties.

- Common additives include: structural fillers, azo dyes, plasticizers, stabilizers, wood fiber, metal particles, and carbon allotropes. While some of these additives may be advertised to the consumer, many are not and can contribute to VOC formation.

In this work, six commercially-available 3D printer filaments are shown as examples of additives affecting VOC emissions. The filaments are: acrylonitrile butadiene styrene (ABS) with carbon nanotubes (CNTs), polycarbonate (PC), polylactic acid (PLA), PLA + copper, PLA + bronze, and PLA + stainless steel.

**Methods**

All degradation experiments were performed using the System for Thermal Diagnostic Studies (STDS). The STDS is a custom-built, modular instrument shown below.

**Results**

**Reaction Conditions**

- Temperature – 180 - 280°C
- Residence time – 1 & 3 min
- Reaction gas – O₂ and N₂

**Results (cont.)**

**CO₂ Emissions and their Use in 3D Printing**

**PLA with copper, bronze, and stainless steel**

- PLA with no advertised additives
- PLA emissions include various silanols and siloxanes
- Silanol copolymers used in some PLA for increased structural integrity

**Conclusion**

Table 1 shows the inhalation reference concentration (RIC) of five VOCs from various filaments. The amount of filament that would need to be printed to achieve these concentrations in a poorly-ventilated, 37.5 m³ room is also shown. These amounts are easily achieved during any type of residential or industrial printer use.

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**References**