Toxic Gas and Particle Emissions from Combustion of Spacecraft Materials

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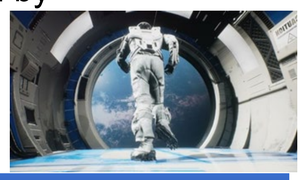
Acknowledgments: Nevada Space Grant 80NSSC20M0043 22-24 and NV Space Grant Fellowship

Purpose & Objectives

- In space travel, the fire risk is greater than in most terrestrial situations because toxic gas and particles can quickly reach dangerous levels.
- Evaluate NASA smoke generator and standard test protocol by testing four common spacecraft materials
- Characterize toxic gas emissions
- Measure particle size and charge distribution



Tested Spacecraft Materials

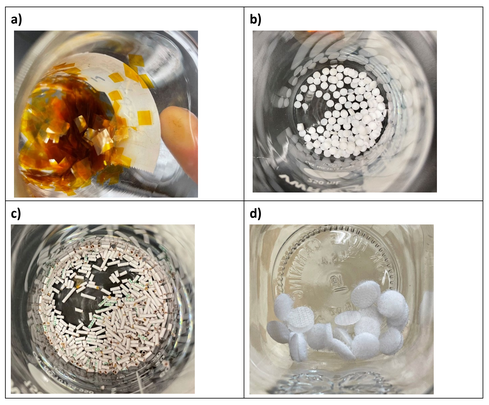


Figure 1. Prepared sample materials a) Kapton, b) PTFE, c) TKT wire insulation, d)Velcro

a) Kapton: a Polyimide film used in electronics, spacesuits, and spacecraft shielding for electrical and thermal uses
b) Teflon (PTFE): used in heat shields, space suits, and cargo holds
c) Kapton Teflon wire insulation: used as thermal/fire resistant wire insulation
d) Velcro: Used widely throughout the ISS for holding things in place. Use is regulated as it is more flammable

Pyrolysis Experiment

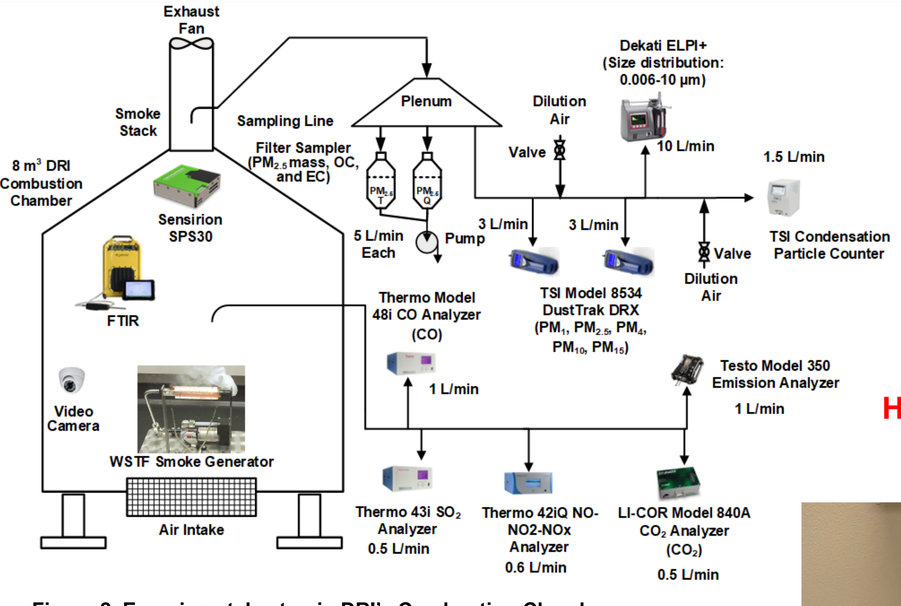


Figure 2. Experimental setup in DRI's Combustion Chamber

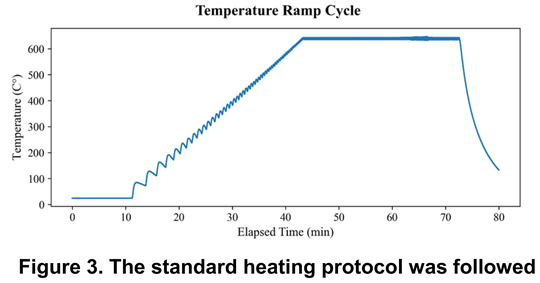


Figure 3. The standard heating protocol was followed in this experiment.

Figure 4. NASA White Sands Smoke Generator

HCl, HF, HCN, C_2F_4, C_3F_6, COF_2, SiF_4, C_6H_6

Gas Concentrations & Particle Size Distributions

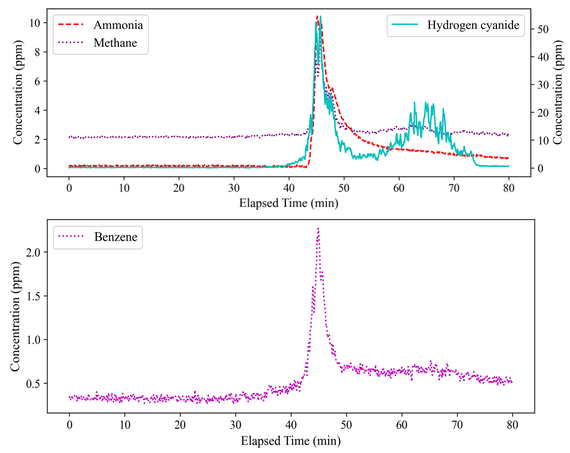


Figure 5. Kapton unique gas emissions

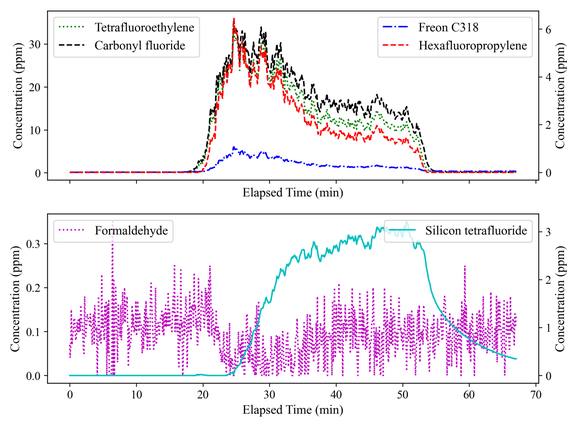


Figure 6. PTFE unique gas emissions

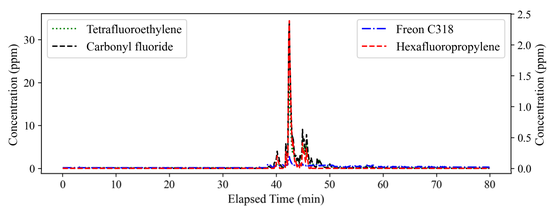


Figure 7. TKT unique gas emissions

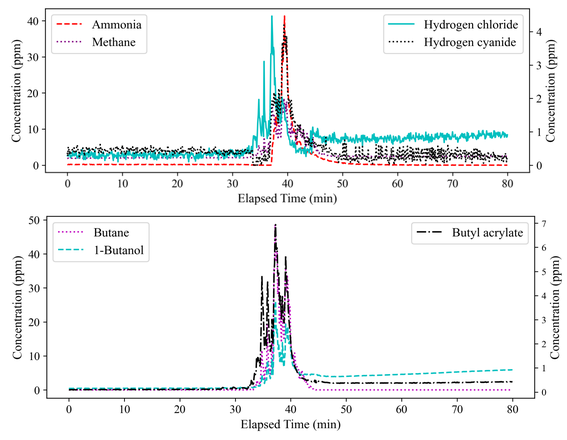


Figure 8. Velcro unique gas emissions

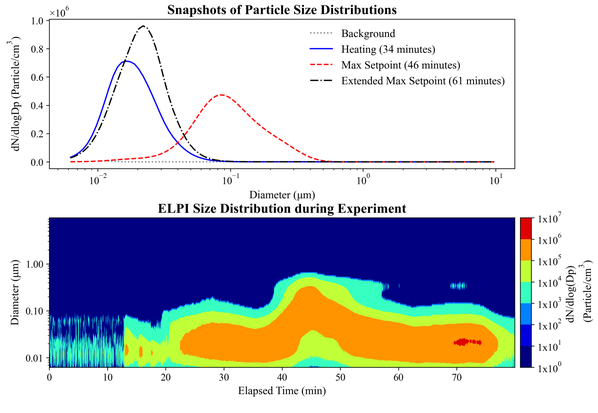


Figure 9. Particle size distribution

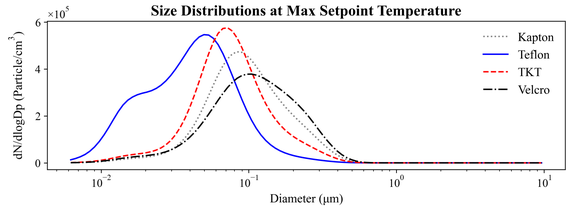


Figure 10. Particle size distribution snapshot plot of test materials at max temperature

Discussion/Conclusions

- The NASA Smoke Generator can be used for standard testing, but it has room for improvement.
- Toxic gas emissions were quantified.
- Pyrolysis generated high concentrations of ultrafine particles.
- Emission factors and charge distributions are being calculated.
- Working with NASA Glenn Research Center for inter-lab comparison.

Figure 11. Chemical etching in a ceramic crucible as a result of burning Teflon