Metropolitan Museum of Art
Gas Chromatography- Mass Spectrometry (GC-MS) Results from Material Analysis

This document includes (1) a mass spectrum and (2) the volatile organic compounds (VOCs) emitted from samples using GC-MS analysis. The data is not interpreted; however, several classes of chemicals are highlighted because they are potential risks for artwork in an enclosed environment. A basic key, provided below, indicates those classes. The amount of each chemical identified has not been determined; similarly, it is not known how much of each chemical is necessary to do damage to art. Finally, peaks may be present that are the result of the sample adsorbing chemicals from the air and reemitting them during testing rather than being inherent to the sample. Research is ongoing to determine specifically which chemicals and amounts are required to negatively affect artifacts.

Highlighted data:

Pink – chemicals currently known to be hazardous to art

Green – amines; can raise the pH, are suspected to react with acids and may form crystals in an enclosed environment

Yellow – chemicals of the following type, which *may* be hazardous to art:

Acids – lower the pH, corrosive to metals, degrade organic materials

Aldehydes – can convert to acids with heat or exposure to UV light

Esters – can hydrolyze into acids with heat and humidity

Sulfur-containing compounds – known to tarnish and corrode some metals

Halogenated compounds – can become reactive with exposure to heat and UV light

Nitrogen-containing, not amine – can react with other off-gassed chemicals

Alkynes – can become reactive when exposed to heat or UV light

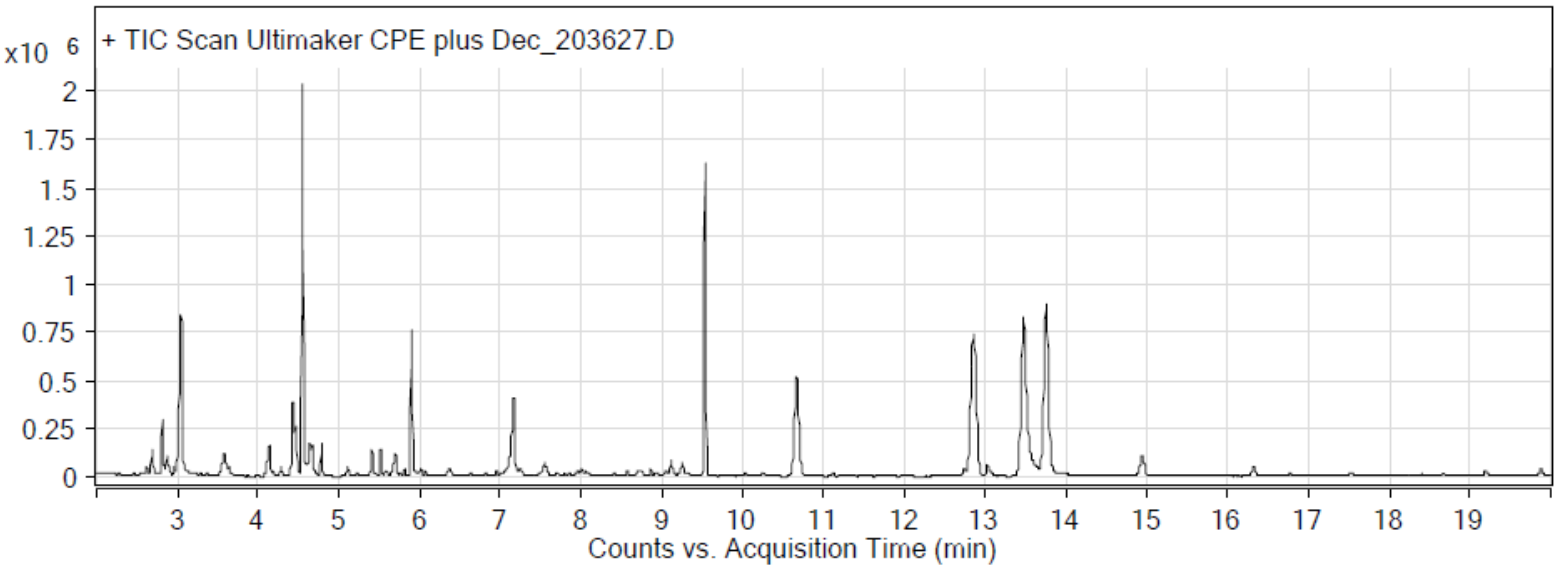
Sample: Ultimaker extruded CPE+ filament

Oddy test result: Temporary

Date collected: 12/15/2017

Technique used: SPME with a PDMS/DVB fiber; Agilent 7890B GC and 5977B MS fitted with a GL Sciences OPTIC-4 multimode inlet and LEAP PAL RTC autosampler; Pre-heated at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample injected into 220°C inlet and crotrapped for 2 min at -15°C; GC ramped from 40°C to 225 °C at 10°C/min. Data analyzed in masshunter Qualitative. Samples > 85% match with a NIST 17.0 or Wiley 9 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 13.0 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 13.5 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid; (3) 13.8 min: 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
2.68	95.1	171745	2-Propanone	C3H6O
2.81	92.48	515042	Ethene, fluoro-	C2H3F
2.87	94.26	102589	Silanol, trimethyl-	C3H10OSi
2.96	87.95	56195	2,3-Butanedione	C4H6O2
3.05	98.25	2075795	Acetic acid	C2H4O2
4.14	92.68	448343	Propanoic acid, 2-methyl-	C4H8O2
4.28	91.03	66059	Benzene, methyl-	C7H8
4.43	93.14	450335	2,4-Hexadiene, 2,5-dimethyl-	C8H14
4.46	87.43	713674	Butanoic acid	C4H8O2
4.55	94.51	2823670	3-Pentanone, 2,4-dimethyl-	C7H14O
4.78	94.01	204489	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.11	93.64	89405	Butanoic acid, 3-methyl-	C5H10O2
5.41	95.2	203475	Cyclopentadiene, 2,5,5-trimethyl-	C8H12
5.52	94.84	225415	2,4-Hexadiene, 2,5-dimethyl-	C8H14
5.58	91.47	49581	unidentified C2-benzene	C8H10
5.7	94.4	305719	Pentanoic acid	C5H10O2
5.81	90.42	45033	1-Dodecene, 2-ethyl-	C14H28
5.9	87.24	1146476	Cyclopropane, 3-chloro-1,1,2,2-tetramethyl-	C7H13Cl
6.07	89.46	39471	Ethanol, 2-butoxy-	C6H14O2
7.17	94.17	401858	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.95	85.82	67654	1-Hexanol, 2-ethyl-	C8H18O
8	88.13	53679	dl-Limonene	C10H16
8.73	87.77	86375	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
8.86	89.3	48900	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O

9.11	91.35	140567	Nonanal	C9H18O
9.25	93.73	168190	2-Ethyl-hexoic acid	C8H16O2
9.53	88.51	2107904	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
10.67	88.96	1787478	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
12.74	86.81	135337	2,2-Dimethyl-1-(2-hydroxy-1-isopropyl)propyl ester of isobutanoic acid	C12H24O3
12.86	88.8	2786780	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
13.02	89.8	117532	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
13.47	92.31	3924696	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
13.75	92.83	3541491	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	C12H24O3
19.2	95.79	66132	1,2-Benzenedicarboxylic acid, butyl 2-methylpropyl ester	C16H22O4
19.88	89.02	77422	Benzene, 1,1'-sulfonylbis-	C12H10O2S