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

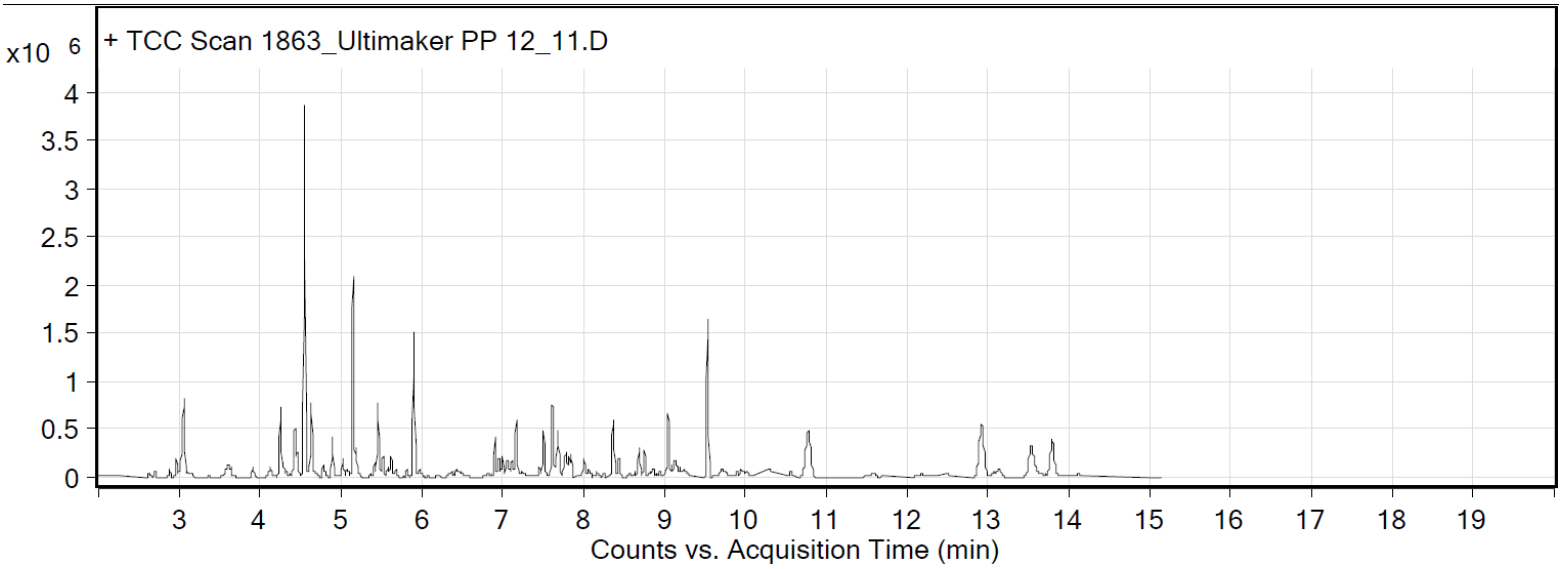
Sample: Ultimaker extruded polypropylene filament

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) 13.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 13.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
2.96	87.71	171832	1-Hexene	C6H12
3.06	98.25	1897101	Acetic acid	C2H4O2
3.17	90.72	51065	1-Hexanol	C6H14O
3.6	95.45	290906	Propanoic acid	C3H6O2
3.64	88.4	94647	1,3-Pentadiene, 2,4-dimethyl-	C7H12
4.13	91.81	276308	Propanoic acid, 2-methyl-	C4H8O2
4.25	95.77	1210998	Heptane, 4-methyl-	C8H18
4.28	94.19	128254	Benzene, methyl-	C7H8
4.32	92.57	115319	Heptane, 3-methyl-	C8H18
4.43	92.3	431769	2,4-Hexadiene, 2,5-dimethyl-	C8H14
4.55	94.42	3253158	3-Pentanone, 2,4-dimethyl-	C7H14O
4.63	96.39	1359987	Octane	C8H18
4.78	94.8	168479	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
4.89	95.09	596928	Heptane, 2,4-dimethyl-	C9H20
5.02	86.95	298610	2,3-Dimethyl-2-heptene	C9H18
5.07	85.19	76472	Heptane, 3,5-dimethyl-	C9H20
5.15	94.44	2363320	2,4-Dimethyl-1-heptene	C9H18
5.36	93.79	54610	Heptane, 2,3-dimethyl-	C9H20
5.41	87.27	180106	Cyclopentadiene, 2,5,5-trimethyl-	C8H12
5.45	92.39	1011413	Octane, 4-methyl-	C9H20
5.52	93.49	257795	2,4-Hexadiene, 2,5-dimethyl-	C8H14
5.62	88.29	346124	1,3-Hexadiene, 3-ethyl-2-methyl-	C9H16
5.9	87.09	2409273	Cyclopropane, 3-chloro-1,1,2,2-tetramethyl-	C7H13Cl

5.98	92.47	129940	Nonane	C9H20
6.07	88.16	55287	Ethanol, 2-butoxy-	C6H14O2
6.9	93.44	362701	Nonane, 4-methyl-	C10H22
7.14	89.29	75756	Phenol	C6H6O
7.17	95.66	819557	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.5	96.17	380013	Decane	C10H22
7.61	92.54	763493	Nonane, 2,6-dimethyl-	C11H24
7.68	92.86	964005	Nonane, 2,6-dimethyl-	C11H24
7.84	91.11	355502	Octane, 3-ethyl-	C10H22
8	93.01	313792	dl-Limonene	C10H16
8.16	93.88	63068	Decane, 4-methylene-	C11H22
8.43	88.89	332351	2-UNDECENE, 5-METHYL-, (Z)-	C12H24
8.56	90.38	44061	Ethanone, 1-phenyl-	C8H8O
8.63	87.72	83399	Decane, 2,6,8-trimethyl-	C13H28
8.69	88.88	487539	1-Octanol, 3,7-dimethyl-	C10H22O
8.75	89.06	423019	1-Octanol, 3,7-dimethyl-	C10H22O
8.84	90.16	178024	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
8.86	86.17	107042	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O
9.05	94.29	1072250	Undecane, 4,7-dimethyl-	C13H28
9.53	88.6	2509307	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
10.02	88.46	252533	2-chloro-1,1,1-trifluoro-2-tridecene	C13H22ClF3
10.29	91.9	375604	Dodecane, 2,6,11-trimethyl-	C15H32
10.56	93.89	113710	Tetradecane	C14H30
10.78	88.28	2192025	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
11.58	96.09	179759	Tridecane	C13H28
12.17	95.04	233852	Hexadecane, 7,9-dimethyl-	C18H38
12.92	89.25	2284316	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
13.14	89.87	395888	Undecane, 3,7-dimethyl-	C13H28
13.53	93.11	1675750	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
13.79	92.6	1407925	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	C12H24O3
14.1	96.37	118680	Hexadecane, 7,9-dimethyl-	C18H38