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

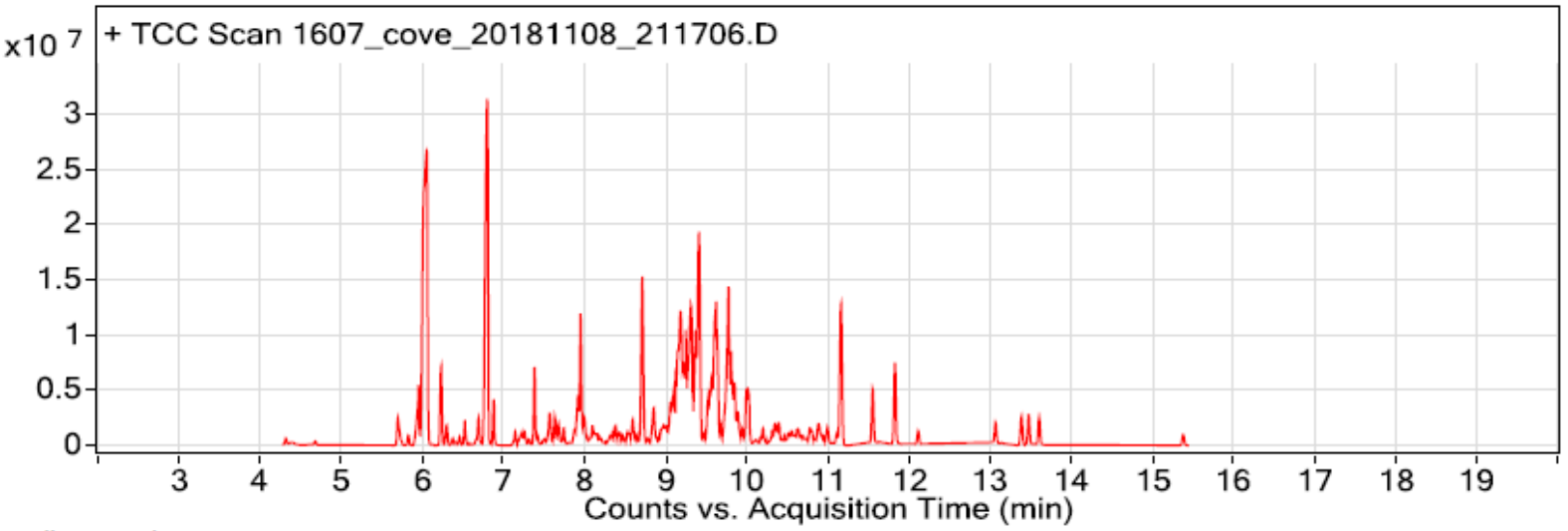
Sample: Johnsonite thermoplastic vinyl wall base in snow white

Oddy test result: Permanent

Date collected: 11/08/2018

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 > 80% match with a NIST library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 11.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 11.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
4.320	91.5	C6H12O3	132.1	1016015	108-65-6	1-Methoxy-2-propyl acetate
4.390	94.6	C8H10	106.1	1341416	106-42-3	Benzene, 1,4-dimethyl-
4.680	90.0	C10H18O2	170.1	930938	2499-58-3	acrylic acid heptyl ester
5.700	96.1	C7H6O	106.0	4597778	100-52-7	Benzaldehyde
5.830	95.5	C9H12	120.1	1307044	0-00-0	unidentified C3-benzene
5.950	87.5	C4H10O3	106.1	9399362	111-46-6	Ethanol, 2,2'-oxybis-
6.230	95.8	C9H12	120.1	10775745	0-00-0	unidentified C3-benzene
6.300	94.8	C8H24O4Si4	296.1	2905204	556-67-2	Cyclotetrasiloxane, octamethyl-
6.380	95.9	C8H16O	128.1	858026	124-13-0	Octanal
6.460	84.4	C10H22	142.2	1199726	17302-01-1	3-Ethyl-3-methylheptane
6.660	82.3	C11H22	154.2	921559	62338-48-1	4-Decene, 7-methyl-, (E)-
6.690	95.2	C9H12	120.1	3483271	0-00-0	unidentified C3-benzene
6.790	91.4	C10H16	136.1	2514610	138-86-3	dl-Limonene
6.800	95.7	C8H18O	130.1	72968017	104-76-7	1-Hexanol, 2-ethyl-
6.880	95.6	C7H8O	108.1	3113981	100-51-6	Benzyl Alcohol
7.150	93.4	C10H14	134.1	2098981	135-98-8	Benzene, (1-methylpropyl)-
7.200	88.7	C10H14	134.1	785885	135-98-8	Benzene, (1-methylpropyl)-
7.260	94.5	C10H14	134.1	937908	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-
7.320	90.3	C15H32	212.3	868552	31295-56-4	Dodecane, 2,6,11-trimethyl-
7.380	98.2	C8H8O	120.1	6795853	98-86-2	Ethanone, 1-phenyl-
7.420	95.4	C8H18O	130.1	1040725	111-87-5	1-Octanol
7.550	84.9	C10H14	134.1	972792	527-53-7	Benzene, 1,2,3,5-tetramethyl-
7.570	88.4	C12H26O	186.2	3171357	3913-02-8	1-Octanol, 2-butyl-
7.630	88.2	C12H24	168.2	2967023	112-41-4	1-Dodecene
7.680	82.3	C10H14	134.1	2374103	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-
7.750	96.0	C8H16O3	160.1	1866428	112-07-2	2-Butoxyethyl acetate
7.880	83.7	C20H42	282.3	1325742	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
7.920	85.1	C10H22	142.2	2146570	17302-01-1	3-Ethyl-3-methylheptane
7.950	97.0	C9H18O	142.1	7892345	124-19-6	Nonanal

7.990	88.4	C8H18O2	146.1	1737500	112-25-4	Ethanol, 2-(hexyloxy)-
8.150	84.0	C10H14	134.1	772268	488-23-3	Benzene, 1,2,3,4-tetramethyl-
8.200	85.5	C13H22ClF3	270.1	1052555	108400-10-8	2-chloro-1,1,1-trifluoro-2-tridecene
8.320	82.1	C9H20O	144.2	2116339	143-08-8	1-Nonanol
8.380	86.2	C9H20O	144.2	3438091	999057-81-8	4-Methyloctan-1-ol
8.470	82.4	C12H19F5O2	290.1	1361368	999429-60-3	Pentafluoropropionic acid, nonyl ester
8.530	81.8	C9H17ClO2	192.1	1449516	999157-67-1	1-(Chloromethyl)heptyl ester of formic acid
8.650	87.0	C10H20O2	172.1	1206611	103-09-3	Acetic acid, 2-ethylhexyl ester
8.710	95.8	C10H30O5Si5	370.1	21171517	541-02-6	Cyclopentasiloxane, decamethyl-
8.780	85.1	C10H22O	158.2	780900	2051-33-4	1-Hexanol, 5-methyl-2-(1-methylethyl)-
8.850	89.8	C10H20	140.2	6111589	21328-57-4	Cyclooctane, 1,5-dimethyl-
9.100	81.6	C9H20O	144.2	11003611	110453-78-6	(S)-(+)-6-Methyl-1-octanol
9.410	90.0	C10H22O	158.2	24958061	106-21-8	1-Octanol, 3,7-dimethyl-
9.780	84.1	C10H20	140.2	13425452	4737-43-3	Cyclopentane, (1-methylbutyl)-
9.890	83.2	C9H18O2	158.1	2415008	1000368-74-8	Formic acid, 2-propylpentyl ester
9.950	82.9	C11H22O2	186.2	2075371	999145-46-3	2-Ethyl-1-hexyl propionate
10.000	84.3	C10H22O	158.2	3646612	112-30-1	1-Decanol
10.520	90.4	C13H28	184.2	1203623	629-50-5	Tridecane
10.550	84.5	C6H10O4	146.1	1889520	652-67-5	Isosorbide
10.660	81.1	C11H24O	172.2	989336	112-42-5	1-Undecanol
10.780	86.9	C13H28	184.2	2580313	629-50-5	Tridecane
10.880	83.3	C11H24O	172.2	2421455	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
11.000	89.2	C12H26O	186.2	2615914	3913-02-8	1-Octanol, 2-butyl-
11.160	96.2	C12H36O6Si6	444.1	22789817	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.550	89.1	C12H24O3	216.2	8728964	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.830	93.8	C12H24O3	216.2	12740175	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.110	94.8	C14H30	198.2	1901284	629-59-4	Tetradecane
13.070	86.4	C15H24O2	236.2	3517112	10396-80-2	2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one
13.390	81.1	C14H42O7Si7	518.1	4803963	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.480	93.3	C16H34O	242.3	4548382	10143-60-9	bis(2-Ethylhexyl) ether
13.610	98.3	C15H24O	220.2	4261485	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-
15.380	88.6	C16H48O8Si8	592.2	1762550	556-68-3	Cyclooctasiloxane, hexadecamethyl-