

**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

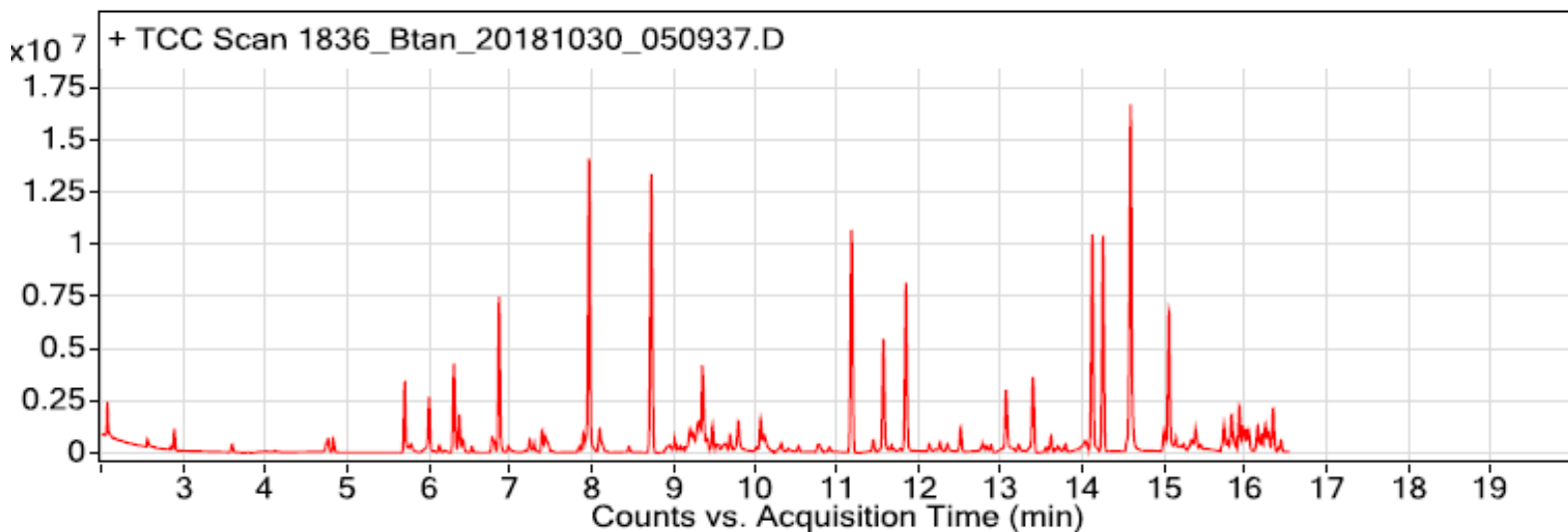
Sample: Benchmark tan polyester felt padding without adhesive backing

Oddy test result: Temporary

Date collected: 10/30/2018

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) 11.6 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
1.260	93.8	CH2O2	46.0	428161	64-18-6	Formic acid
1.470	97.2	C2H4O2	60.0	1121791	64-19-7	Acetic acid
1.850	96.9	C7H8	92.1	35423924	108-88-3	Benzene, methyl-
2.070	89.9	C2H8O2Si	92.0	1954054	1066-42-8	Silanediol, dimethyl-
2.560	94.4	C3H8O2	76.1	502609	57-55-6	1,2-Propanediol
2.890	94.7	C7H8	92.1	1513421	108-88-3	Benzene, methyl-
3.600	93.2	C6H18O3Si3	222.1	621878	541-05-9	Cyclotrisiloxane, hexamethyl-
4.010	80.9	C12H18O	178.1	633192	999126-33-1	2-Methyl-4-phenyl-3-pentanol
4.770	86.6	C7H14O	114.1	1069574	111-71-7	Heptanal
4.840	96.9	C6H14O2	118.1	693535	111-76-2	Ethanol, 2-butoxy-
5.710	97.9	C7H6O	106.0	5102179	100-52-7	Benzaldehyde
6.010	82.3	C6H6O	94.0	4629103	108-95-2	Phenol
6.130	90.7	C8H14O	126.1	476441	110-93-0	6-Methyl-5-hepten-2-one
6.310	96.0	C8H24O4Si4	296.1	7388703	556-67-2	Cyclotetrasiloxane, octamethyl-
6.380	95.1	C8H16O	128.1	2435175	124-13-0	Octanal
6.400	84.5	C6H14O3	134.1	468458	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
6.430	96.6	C6H4Cl2	146.0	602908	541-73-1	Benzene, 1,3-dichloro-
6.530	96.6	C6H4Cl2	146.0	423881	541-73-1	Benzene, 1,3-dichloro-
6.780	96.8	C8H18O	130.1	1083232	104-76-7	1-Hexanol, 2-ethyl-
6.800	93.9	C10H16	136.1	654085	138-86-3	dL-Limonene
6.870	96.0	C7H8O	108.1	5746504	100-51-6	Benzyl Alcohol
6.980	94.9	C5H9NO	99.1	729059	872-50-4	2-Pyrrolidinone, 1-methyl-
7.240	90.6	C12H26	170.2	1008368	112-40-3	Dodecane
7.300	85.1	C8H17Cl	148.1	440508	111-85-3	Octane, 1-chloro-
7.390	91.6	C8H8O	120.1	1368772	98-86-2	Ethanone, 1-phenyl-
7.430	89.5	C8H18O	130.1	933536	111-87-5	1-Octanol
7.840	88.4	C8H8O2	136.1	403682	93-58-3	Benzoic acid, methyl ester
7.900	91.5	C10H18O	154.1	1137489	78-70-6	Linalool
7.970	97.6	C9H18O	142.1	22900857	124-19-6	Nonanal

8.120	85.8	C8H10O	122.1	373130	60-12-8	Benzeneethanol
8.140	91.8	C8H16O2	144.1	527086	149-57-5	Hexanoic acid, 2-ethyl-
8.460	94.5	C7H12O4	160.1	446001	1119-40-0	Pentanedioic acid, dimethyl ester
8.730	95.6	C10H30O5Si5	370.1	24432015	541-02-6	Cyclopentasiloxane, decamethyl-
8.960	84.7	C9H18O	142.1	551252	124-19-6	Nonanal
9.020	93.3	C10H20O	156.2	657566	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./-./-)
9.210	93.4	C10H8	128.1	1121704	275-51-4	Azulene
9.240	86.2	C8H18O3	162.1	1052537	54446-78-5	Ethanol, 1-(2-butoxyethoxy)-
9.320	84.5	C13H22ClF3	270.1	2068248	108400-10-8	2-chloro-1,1,1-trifluoro-2-tridecene
9.360	96.9	C8H8O3	152.0	5447003	119-36-8	Methyl salicylate
9.480	97.5	C10H20O	156.2	1916463	112-31-2	Decanal
9.640	82.1	C12H22O2	198.2	1048929	688-84-6	2-Ethylhexyl methacrylate
9.690	92.9	C8H10O2	138.1	1067863	122-99-6	Ethanol, 2-phenoxy-
10.020	84.2	C8H14O4	174.1	415039	627-93-0	Hexanedioic acid, dimethyl ester
10.070	93.5	C9H12O2	152.1	2640545	770-35-4	1-Phenoxypropan-2-ol
10.110	94.4	C6H11NO	113.1	868073	105-60-2	Caprolactam
10.320	91.4	C9H18O2	158.1	863021	112-05-0	Nonanoic acid
10.530	89.4	C14H30	198.2	505636	61141-72-8	Dodecane, 4,6-dimethyl-
10.910	85.3	C11H22O	170.2	413518	112-44-7	Undecanal
11.180	96.1	C12H36O6Si6	444.1	19974992	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.570	89.8	C12H24O3	216.2	9741450	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.690	81.3	C9H16O2	156.1	365809	104-61-0	2(3H)-Furanone, dihydro-5-pentyl-
11.850	93.9	C12H24O3	216.2	14018979	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.130	91.9	C14H30	198.2	548058	629-59-4	Tetradecane
12.260	95.1	C12H24O	184.2	616806	112-54-9	Dodecanal
12.360	89.7	C14H26O2	226.2	651467	126-86-3	2,4,7,9-Tetramethyl-5-decyn-4,7-diol
12.520	92.2	C13H20O2	208.1	2050732	128-51-8	Nopyl acetate
12.780	83.2	C13H26	182.2	364745	999136-71-7	Heptyl - cyclohexane
12.890	95.4	C10H10O4	194.1	381250	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
13.070	82.7	C14H20O2	220.1	4584020	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
13.400	80.8	C14H42O7Si7	518.1	6302559	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.570	93.0	C14H22O	206.2	480049	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
13.630	94.4	C15H24O	220.2	951782	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-
13.810	95.8	C14H20O	204.2	583432	80-54-6	Lilial
14.260	90.8	C16H26O	234.2	17104525	4130-42-1	Ionol 2
14.600	96.0	C12H14O4	222.1	28121085	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
14.630	94.3	C16H30O4	286.2	2204675	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
15.070	85.4	C16H24O	232.2	9975968	6738-27-8	2,5-Cyclohexadien-1-one, 2,6-bis(1,1-dimethylethyl)-4-ethylidene-
15.340	84.9	C15H24O	220.2	752546	999236-10-5	2-[1',5'-Dimethylhexyl]-3-methylphenol
15.400	89.1	C16H48O8Si8	592.2	2013545	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.790	89.9	C19H40	268.3	455342	1921-70-6	Pentadecane, 2,6,10,14-tetramethyl-
15.840	87.6	C14H22O	206.2	3024429	54932-78-4	Phenol, 4-(2,2,3,3-tetramethylbutyl)-
15.930	91.1	C15H24O	220.2	3775026	25154-52-3	NONYLPHENOL ISOMER
15.980	83.7	C15H24O	220.2	1843259	25154-52-3	Phenol, nonyl-
16.010	91.0	C9H9DO	135.1	922395	999041-45-9	(E)-2-(2H(1)-4-Methoxyphenylethene
16.050	82.4	C15H24O	220.2	1841075	25154-52-3	Phenol, nonyl-
16.160	92.6	C14H22O	206.2	1007900	999197-45-2	Phenol, 4-(2,2,4-trimethylpentyl)-
16.200	83.0	C15H24O	220.2	1054880	25154-52-3	NONYLPHENOL ISOMER
16.250	88.4	C15H24O	220.2	1709295	25154-52-3	Phenol, nonyl-
16.290	83.4	C13H22	178.2	957329	96806-52-9	1,1,2,2,3,3-hexamethyl-4,5-bis(methylene)cyclopentane
16.350	92.5	C14H22O	206.2	1615307	54932-78-4	Phenol, 4-(2,2,3,3-tetramethylbutyl)-
16.440	89.6	C15H24O	220.2	1120802	25154-52-3	NONYLPHENOL ISOMER