

**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

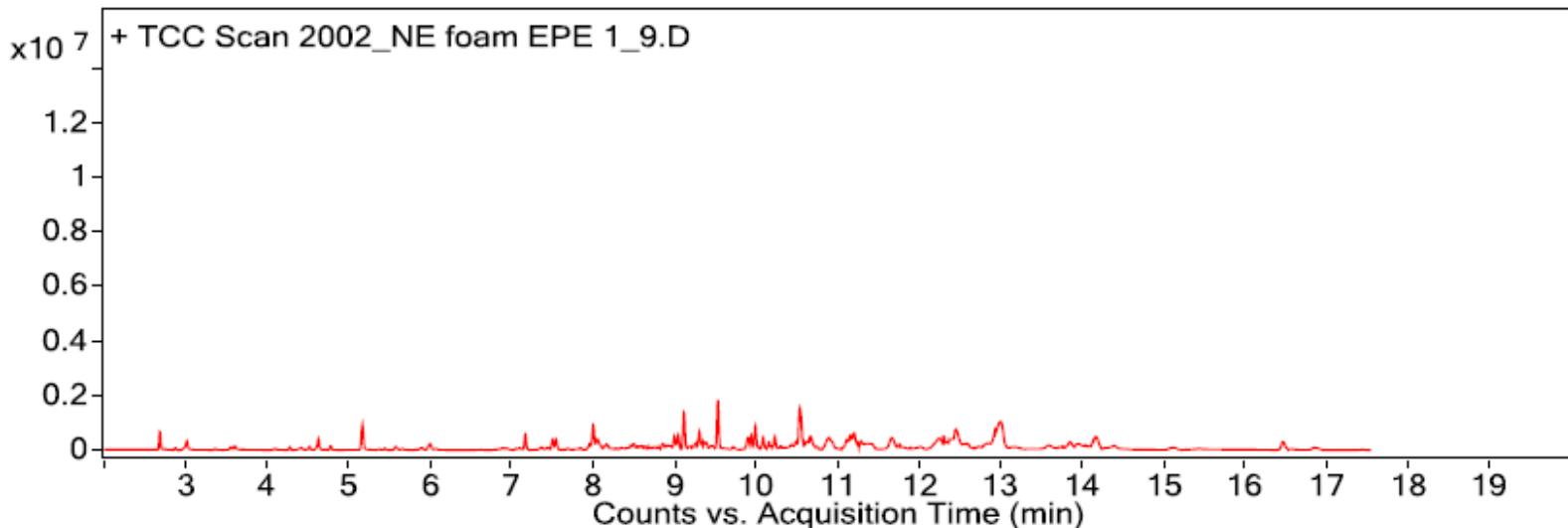
Sample: New England Foam 1.9 lb expanded polyethylene foam

Oddy test result: Permanent

Date collected: 12/23/2017

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 > 80% match with a NIST library are reported.

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



RT	Score	Formula	MW	Area	CAS #	Name
2.683	96.8	C3H6O	58.0	821534	67-64-1	2-Propanone
2.764	87.7	C5H10O2	102.1	42981	62748-09-8	(2R)-2,3-Epoxy-3-methyl-1-butanol
2.875	94.3	C3H10OSi	90.1	102349	1066-40-6	Silanol, trimethyl-
3.015	97.1	C2H4O2	60.0	630645	64-19-7	Acetic acid
3.551	83.0	C2H8O2Si	92.0	281136	1066-42-8	Silanediol, dimethyl-
3.604	88.9	C5H10O	86.1	135290	110-62-3	Pentanal
4.098	93.6	C4H8O2	88.1	106949	79-31-2	Propanoic acid, 2-methyl-
4.280	94.3	C7H8	92.1	159542	108-88-3	Benzene, methyl-
4.422	87.0	C4H8O2	88.1	227745	107-92-6	Butanoic acid
4.523	94.9	C8H16	112.1	113766	2511-91-3	Cyclopropane, pentyl-
4.607	96.3	C6H10O	98.1	111870	999009-44-8	4-Ethyl-2,3-dihydrofuran
4.630	90.2	C6H12O	100.1	630440	66-25-1	Hexanal
4.781	94.3	C6H18O3Si3	222.1	224559	541-05-9	Cyclotrisiloxane, hexamethyl-
5.169	96.6	C6H12O2	116.1	1689529	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.453	96.0	C8H10	106.1	78596	100-41-4	Ethylbenzene
5.577	95.5	C8H10	106.1	282778	106-42-3	Benzene, 1,4-dimethyl-
5.663	93.7	C5H10O2	102.1	70954	109-52-4	Pentanoic acid
5.886	94.6	C8H8	104.1	106327	100-42-5	Styrene
5.906	91.2	C8H10	106.1	93452	95-47-6	Benzene, 1,2-dimethyl-
6.002	89.1	C7H14O	114.1	306986	111-71-7	Heptanal
6.071	85.3	C6H14O2	118.1	44082	111-76-2	Ethanol, 2-butoxy-
6.928	89.7	C9H12	120.1	69386	0-00-0	unidentified C3-benzene
7.108	92.1	C6H12O2	116.1	162363	142-62-1	Hexanoic acid
7.170	95.9	C8H24O4Si4	296.1	831465	556-67-2	Cyclotetrasiloxane, octamethyl-
7.369	84.4	C20H42O	298.3	254374	629-96-9	1-Eicosanol
7.445	93.3	C9H12	120.1	113025	108-67-8	Mesitylene
7.501	96.4	C10H22	142.2	481781	124-18-5	Decane
7.548	97.3	C8H16O	128.1	540597	124-13-0	Octanal
7.846	84.6	C13H28	184.2	104693	62108-25-2	Decane, 2,6,7-trimethyl-
7.958	86.9	C8H18O	130.1	315687	26952-21-6	Isooctanol

8.004	95.1	C10H16	136.1	878956	138-86-3	dl-Limonene
8.166	90.2	C8H18O	130.1	314230	57803-73-3	(S)-(+)-5-Methyl-1-heptanol
8.346	88.7	C10H22	142.2	169324	2051-30-1	Octane, 2,6-dimethyl-
8.560	87.7	C18H22O2	270.2	74835	999377-39-7	DICUMYL PEROXIDE
8.951	81.6	C8H24O4Si4	296.1	166364	556-67-2	Cyclotetrasiloxane, octamethyl-
9.002	97.1	C8H8O2	136.1	534448	93-58-3	Benzoic acid, methyl ester
9.047	92.6	C11H24	156.2	780998	1120-21-4	Undecane
9.117	97.7	C9H18O	142.1	2213051	124-19-6	Nonanal
9.306	89.2	C8H18O	130.1	1451983	1653-40-3	1-Heptanol, 6-methyl-
9.534	88.8	C10H30O5Si5	370.1	2741611	541-02-6	Cyclopentasiloxane, decamethyl-
9.942	81.4	C8H16O2	144.1	826228	35897-13-3	3-Methylpentyl acetate
9.993	86.3	C10H20O2	172.1	1392890	112-14-1	Acetic acid, octyl ester
10.088	85.7	C10H20O2	172.1	664779	112-14-1	Acetic acid, octyl ester
10.159	85.4	C11H22O2	186.2	460832	143-13-5	Acetic acid, nonyl ester
10.232	90.1	C10H20O2	172.1	581822	103-09-3	Acetic acid, 2-ethylhexyl ester
10.537	80.9	C7H10O3	142.1	1189969	999053-09-0	1,6-Dioxaspiro[4.4]nonan-2-one
10.553	84.8	C12H26	170.2	690109	1632-70-8	Undecane, 5-methyl-
10.677	90.4	C10H20O2	172.1	463112	103-09-3	Acetic acid, 2-ethylhexyl ester
10.894	88.6	C10H30O5Si5	370.1	1959561	541-02-6	Cyclopentasiloxane, decamethyl-
10.943	86.8	C8H18O	130.1	295369	999037-42-1	(S)-3-Ethyl-4-methylpentanol
11.206	80.3	C12H21F3O2	254.1	1220333	999330-05-7	3-Ethyl-6-trifluoroacetoxystyrene
11.292	83.3	C8H18O	130.1	595066	1070-32-2	1-Heptanol, 3-methyl-
11.669	87.7	C13H22ClF3	270.1	1769068	108400-10-8	2-chloro-1,1,1-trifluoro-2-tridecene
11.796	86.0	C13H22F4	254.2	319549	108377-18-0	1,1,1,2-tetrafluoro-2-tridecene
12.942	93.8	C13H28	184.2	815647	629-50-5	Tridecane
13.005	88.6	C12H36O6Si6	444.1	3578950	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.151	83.9	C17H36O	256.3	428668	1000406-39-1	Decyl heptyl ether
13.595	89.2	C12H24O3	216.2	621790	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.855	92.2	C12H24O3	216.2	784288	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.962	83.6	C15H24	204.2	204057	1137-12-8	Longicyclene
14.171	94.4	C14H30	198.2	813039	629-59-4	Tetradecane
14.398	93.8	C15H24	204.2	469596	475-20-7	Junipene
15.433	87.1	C15H32	212.3	208008	31295-56-4	Dodecane, 2,6,11-trimethyl-
16.467	95.3	C12H14O4	222.1	639281	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
16.480	89.8	C16H30O4	286.2	313268	74381-40-1	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
16.576	99.5	C26H54	366.4	91547	630-01-3	Hexacosane
16.850	87.1	C18H30O	262.2	247055	17540-75-9	Phenol, 2,6-bis(1,1-dimethylethyl)-4-(1-methylpropyl)-