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

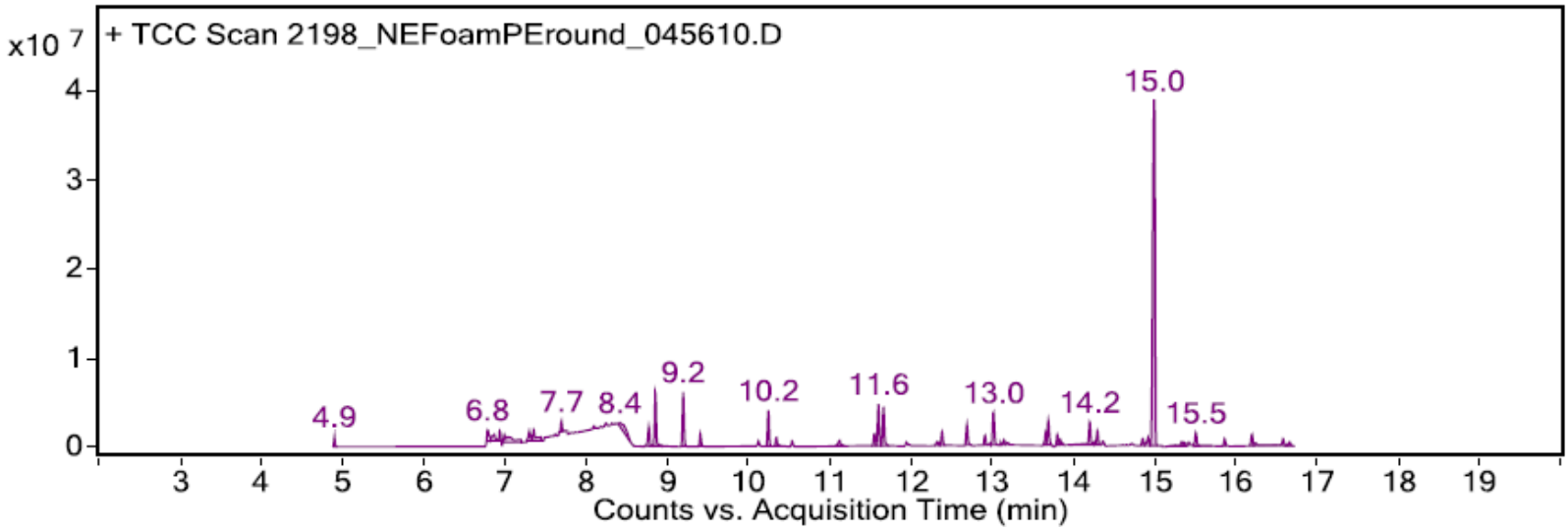
Sample: Uline Foam core, black, S-12861

Oddy test result: Temporary

Date collected: 06/26/2018

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) 5.7 min: methoxyphenyl oxime; (2) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.900	93.7	C2H8O2Si	92.0	1199947	1066-42-8	Silanediol, dimethyl-
4.800	96.5	C6H12O	100.1	667569	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	2853956	541-05-9	Cyclotrisiloxane, hexamethyl-
5.500	96.3	C8H10	106.1	23705012	0-00-0	METHYLLAURATE
5.600	97.9	C8H10	106.1	1250474	0-00-0	unidentified C2-benzene
5.700	85.0	C8H9NO2	151.1	925682	1000222-86-6	Oxime-, methoxy-phenyl-_
5.900	87.8	C6H10O	98.1	1051277	108-94-1	Cyclohexanone
5.900	82.6	C7H14O	114.1	673709	111-71-7	Heptanal
6.000	90.9	C6H14O2	118.1	1274294	111-76-2	Ethanol, 2-butoxy-
6.300	96.8	C9H12	120.1	7765205	98-82-8	Benzene, (1-methylethyl)-
6.600	95.5	C9H10	118.1	1137074	873-49-4	Benzene, cyclopropyl-
6.700	95.4	C9H12	120.1	4621192	0-00-0	unidentified C3-benzene
6.800	97.3	C7H6O	106.0	21597724	100-52-7	Benzaldehyde
6.900	96.2	C9H12	120.1	764827	0-00-0	unidentified C3-benzene

6.900	85.7	C6H6O	94.0	3029974	108-95-2	Phenol
6.900	94.3	C8H24O4Si4	296.1	3820742	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	80.2	C9H12	120.1	1320899	611-14-3	Benzene, 1-ethyl-2-methyl-
7.100	96.4	C9H10	118.1	9348189	98-83-9	Benzene, (1-methylethenyl)-
7.200	90.2	C9H12	120.1	1477661	0-00-0	unidentified C3-benzene
7.300	94.6	C10H22	142.2	1030609	124-18-5	Decane
7.300	97.6	C8H16O	128.1	2530209	124-13-0	Octanal
7.500	94.8	C10H14	134.1	2591939	135-98-8	Benzene, (1-methylpropyl)-
7.700	97.3	C8H18O	130.1	9939992	104-76-7	1-Hexanol, 2-ethyl-
7.800	96.8	C10H16	136.1	2111440	138-86-3	dl-Limonene
7.800	86.1	C7H8O	108.1	1449842	100-51-6	Benzyl alcohol
8.000	91.7	C8H8O	120.1	1671188	122-78-1	PHENYL ACETALDEHYDE
8.000	95.3	C10H14	134.1	1648766	135-01-3	o-Diethyl benzene
8.200	80.2	C10H14	134.1	1648267	135-01-3	o-Diethyl benzene
8.300	94.6	C8H8O	120.1	14076993	98-86-2	Ethanone, 1-phenyl-
8.500	81.3	C12H24	168.2	1513288	55499-02-0	3-Decene, 2,2-dimethyl-, (E)-
8.700	83.5	C12H24	168.2	1118176	74630-68-5	3-UNDECENE, 4-METHYL-
8.800	88.1	C11H24	156.2	4421570	1120-21-4	Undecane
8.800	97.3	C9H18O	142.1	30157931	124-19-6	Nonanal
8.900	84.1	C12H24	168.2	1951150	74630-54-9	3-Undecene, 9-methyl-, (E)-
9.100	87.1	C9H14O	138.1	943836	78-59-1	2-Cyclohexen-1-one, 3,5,5-trimethyl-
9.200	95.4	C10H30O5Si5	370.1	13179700	541-02-6	Cyclopentasiloxane, decamethyl-
9.400	85.7	C10H20O2	172.1	890624	103-09-3	Acetic acid, 2-ethylhexyl ester
9.600	91.8	C9H8O	132.1	1291568	30844-12-3	1,3,5,7-Cyclooctatetraene-1-carboxaldehyde
9.800	86.7	C20H42O	298.3	1361157	2456-28-2	Decane, 1,1'-oxybis-
10.000	97.6	C10H20O	156.2	1581712	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	94.9	C8H18O3	162.1	1043927	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	87.0	C16H32	224.3	836064	629-73-2	1-Hexadecene
10.100	95.2	C10H8	128.1	994606	275-51-4	Azulene
10.200	92.9	C12H26	170.2	2605290	112-40-3	Dodecane
10.300	97.8	C10H20O	156.2	3423615	112-31-2	Decanal
10.600	85.9	C11H20O2	184.1	650125	103-11-7	2-Propenoic acid, 2-ethylhexyl ester
11.200	93.1	C18H38O	270.3	777321	1000406-38-3	Decyl octyl ether
11.500	80.5	C16H30O	238.2	771360	34894-60-5	Cyclopentadecanone, 4-methyl-
11.600	95.9	C12H36O6Si6	444.1	13660867	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	94.5	C13H28	184.2	1919104	629-50-5	Tridecane
11.800	95.8	C11H22O	170.2	690938	112-44-7	Undecanal
12.400	89.8	C12H24O3	216.2	14001455	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	93.9	C12H24O3	216.2	18290926	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.000	94.9	C14H30	198.2	1744238	629-59-4	Tetradecane
13.100	97.9	C12H24O	184.2	1046889	112-54-9	Dodecanal
13.800	80.2	C14H42O7Si7	518.1	5578738	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.000	96.7	C12H26O	186.2	1613215	112-53-8	1-Dodecanol
14.200	95.2	C13H12	168.1	1122775	644-08-6	1,1'-Biphenyl, 4-methyl-
14.300	94.3	C15H32	212.3	927907	629-62-9	pentadecane
14.400	96.6	C13H26O	198.2	624624	10486-19-8	Tridecanal
15.500	91.5	C16H34	226.3	747010	544-76-3	Hexadecane
15.800	90.7	C16H48O8Si8	592.2	1285695	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	86.5	C15H30O2	242.2	601608	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.700	83.4	C13H14N2O	214.1	1847265	66951-11-9	(2',2'-DIMETHYL-3'-PHENYLAZETIDIN-1'-YL)OXOACETONITRILE
17.300	86.9	C16H16	208.1	4708860	20071-09-4	Benzene, 1,1'-(1,2-cyclobutanediyl)bis-, trans-