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

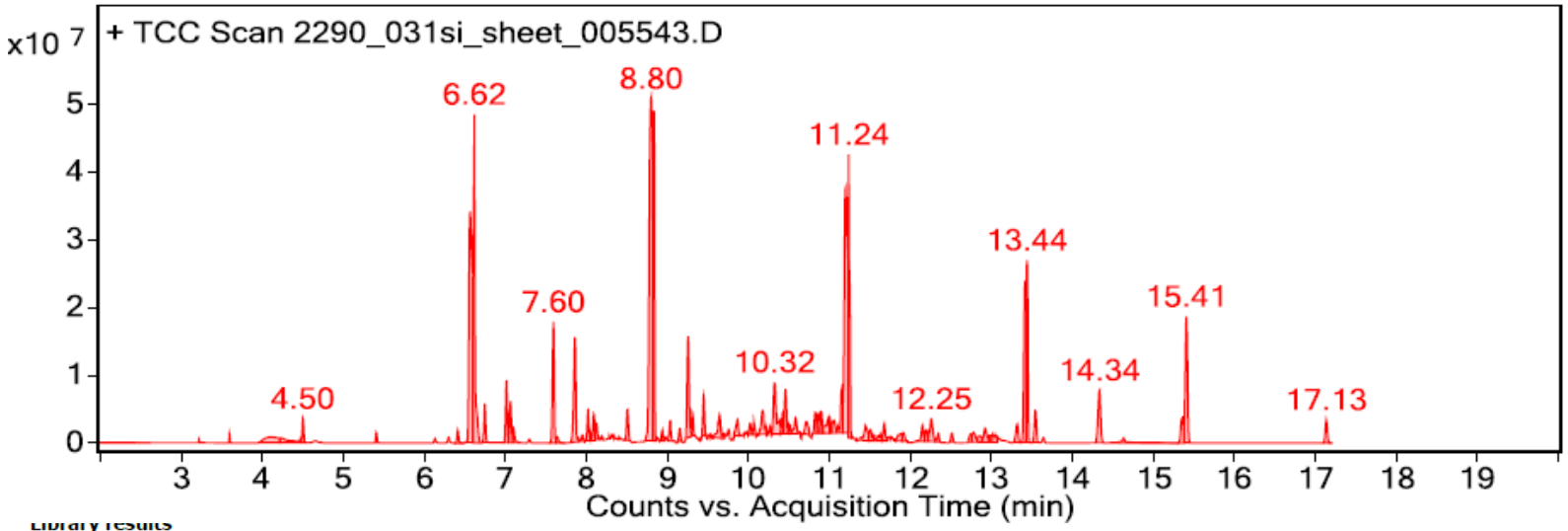
Alkynes – can become reactive when exposed to heat or UV light

Sample: ACME rubber 0.031” silicone rubber sheet; black

Oddy test result: Permanent

Date collected: 08/18/2018

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.



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.220	82.5	C4H11N	73.1	1039185	75-64-9	2-Propanamine, 2-methyl-
3.600	93.7	C2H8O2Si	92.0	949874	1066-42-8	Silanediol, dimethyl-
4.110	93.4	C14H11NO	209.1	13769307	999205-14-4	(3R)-3-Phenyl-2,3-dihydro-1H-isoindol-1-one
4.500	93.0	C6H18O3Si3	222.1	4893019	541-05-9	Cyclotrisiloxane, hexamethyl-
5.410	97.0	C6H14O2	118.1	1755079	111-76-2	Ethanol, 2-butoxy-
6.130	94.3	C7H6O	106.0	954168	100-52-7	Benzaldehyde
6.420	95.9	C9H10	118.1	2514724	98-83-9	.alpha.-Methylstyrene
6.610	86.3	C2H5NO	59.0	1540075	999000-82-0	N-Methylformide
6.750	96.8	C6H4Cl2	146.0	8096596	541-73-1	Benzene, 1,3-dichloro-
7.020	97.3	C8H18O	130.1	12929354	104-76-7	1-Hexanol, 2-ethyl-
7.070	98.2	C10H16	136.1	7378094	138-86-3	dl-Limonene
7.100	92.1	C7H8O	108.1	1409151	100-51-6	Benzyl Alcohol
7.300	91.7	C10H30O3Si4	310.1	934259	141-62-8	Tetrasiloxane, decamethyl-
7.600	98.0	C8H8O	120.1	28016814	98-86-2	Ethanone, 1-phenyl-
7.640	88.1	C6H18O3Si3	222.1	918800	541-05-9	Cyclotrisiloxane, hexamethyl-
7.830	91.5	C10H28O4Si3	296.1	1557100	3555-45-1	Silicic acid, diethyl bis(trimethylsilyl) ester
7.860	92.9	C9H12O	136.1	26238132	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-

7.950	88.7	C10H14O	150.1	1014647	935-67-1	Benzene, (1-methoxy-1-methylethyl)-
8.020	97.5	C11H24	156.2	5931513	1120-21-4	Undecane
8.100	96.3	C9H18O	142.1	4943809	124-19-6	Nonanal
8.130	89.7	C8H18O2	146.1	2085518	112-25-4	Ethanol, 2-(hexyloxy)-
8.420	91.9	C13H28	184.2	1532215	17301-32-5	Undecane, 4,7-dimethyl-
8.510	91.3	C11H32O4Si4	340.1	8748218	18030-67-6	3-Ethoxy-1,1,1,5,5,5-hexamethyl-3-(trimethylsiloxy)trisiloxane
8.750	88.7	C11H20O2	184.1	1636220	103-11-7	2-Ethylhexyl acrylate
8.780	86.6	C8H24O4Si4	296.1	39636239	556-67-2	Cyclotetrasiloxane, octamethyl-
8.810	87.8	C10H30O5Si5	370.1	53005228	541-02-6	Cyclopentasiloxane, decamethyl-
8.840	84.5	C10H30O5Si5	370.1	49473950	541-02-6	Cyclopentasiloxane, decamethyl-
8.880	82.2	C12H26	170.2	942787	2980-69-0	Undecane, 4-methyl-
8.940	83.1	C12H26	170.2	1534960	7045-71-8	Undecane, 2-methyl-
9.160	94.7	C10H30O5Si5	370.1	3676574	541-02-6	Cyclopentasiloxane, decamethyl-
9.260	94.9	C12H36O4Si5	384.1	27834026	141-63-9	Pentasiloxane, dodecamethyl-
9.310	93.8	C8H18O3	162.1	4779903	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
9.450	95.4	C12H26	170.2	11303355	112-40-3	Dodecane
9.540	93.4	C10H20O	156.2	1363081	112-31-2	Decanal
9.650	94.5	C13H28	184.2	7044327	17312-82-2	Undecane, 4,6-dimethyl-
9.850	89.2	C8H24O4Si4	296.1	2269703	556-67-2	Cyclotetrasiloxane, octamethyl-
9.870	82.3	C7H5NS	135.0	3896068	95-16-9	Benzothiazole
10.020	81.6	C12H24	168.2	4204316	61142-20-9	Cyclohexane, (4-methylpentyl)-
10.070	96.2	C12H36O4Si5	384.1	1785150	141-63-9	Pentasiloxane, dodecamethyl-
10.180	81.9	C13H28	184.2	3414616	6044-71-9	Dodecane, 6-methyl-
10.270	82.1	C13H28	184.2	4236155	17312-77-5	Undecane, 2,3-dimethyl-
10.320	82.9	C10H30O5Si5	370.1	11119166	541-02-6	Cyclopentasiloxane, decamethyl-
10.330	89.6	C13H28	184.2	6880056	17301-27-8	Undecane, 2,10-dimethyl-
10.460	92.3	C13H28	184.2	10196686	17312-76-4	Undecane, 6,6-dimethyl-
10.550	82.0	C25H52	352.4	2032145	1560-78-7	2-Methyltetracosane
10.710	84.4	C10H20	140.2	3021489	489-20-3	Cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-
10.830	90.4	C13H28	184.2	4541173	629-50-5	Tridecane
10.870	96.2	C12H36O6Si6	444.1	5175136	540-97-6	Cyclohexasiloxane, dodecamethyl-
10.900	87.7	C9H19NO	157.1	2770544	761-65-9	Formamide, N,N-dibutyl-
10.960	85.2	C12H22	166.2	1441927	92-51-3	1,1'-Bicyclohexyl
11.200	96.6	C12H36O6Si6	444.1	88747508	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.250	92.1	C12H36O6Si6	444.1	23927449	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.770	88.7	C14H30	198.2	1169761	6418-41-3	Tridecane, 3-methyl-
11.920	84.1	C10H30O5Si5	370.1	2535379	541-02-6	Cyclopentasiloxane, decamethyl-
12.150	94.6	C14H30	198.2	3790516	629-59-4	Tetradecane
12.340	92.2	C14H42O5Si6	458.2	1954588	107-52-8	Hexasiloxane, tetradecamethyl-
12.920	94.6	C15H42O7Si5	474.2	3519894	1000074-06-9	3,3,5-Triethoxy-1,1,1,7,7,7-hexamethyl-5-(trimethylsilyloxy)tetrasiloxane
13.420	82.6	C14H42O7Si7	518.1	67878791	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.630	90.8	C16H30O4	286.2	1338687	74381-40-1	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
15.410	87.9	C16H48O8Si8	592.2	36554828	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.130	84.7	C18H54O9Si9	666.2	6177280	556-71-8	Cyclononasiloxane, octadecamethyl-