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

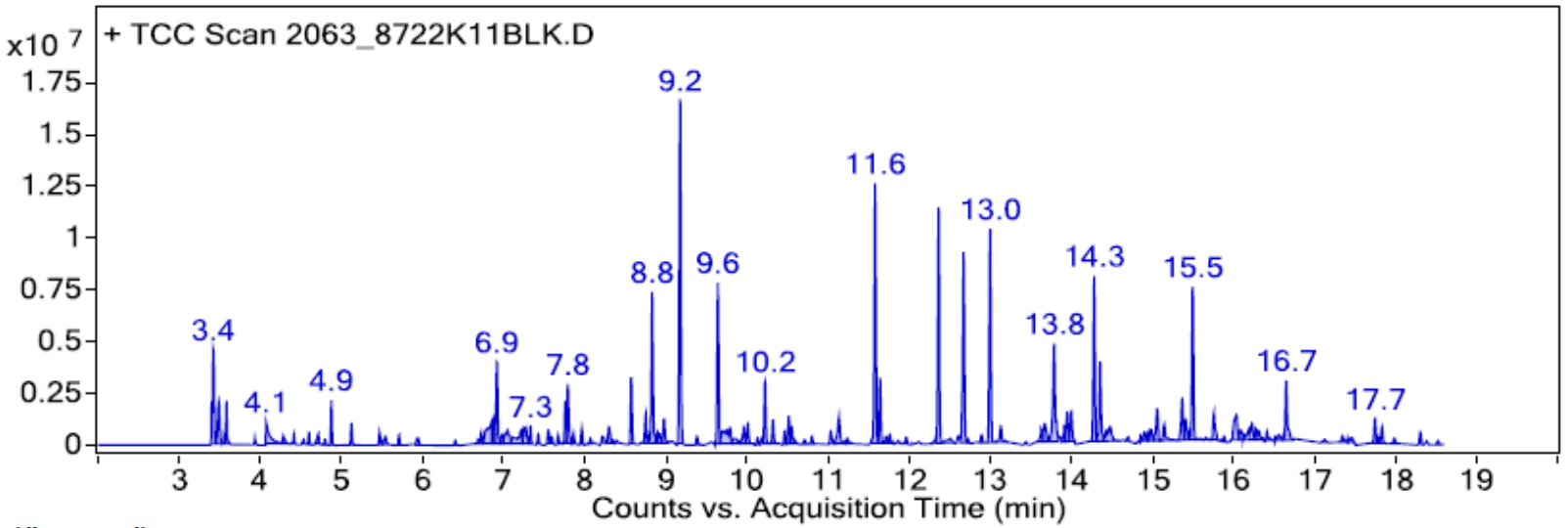
Alkynes – can become reactive when exposed to heat or UV light

Sample: McMaster Carr super-cushioning food-grade polyethylene foam sheet, 3/8”, black, 8722K11

Oddy test result: Unsuitable

Date GC-MS collected: 3/19/2018

Technique used: SPME Arrow 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 sample at 60°C for 20 minutes; fiber exposure to sample at 60°C for 20 minutes; fiber injected into 220°C inlet and cryotrapped 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: methoxy-phenyl 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
1.600	85.4	CHNO	43.0	248261	75-13-8	ISOCYANIC ACID
1.600	85.4	CHNO	43.0	275778	75-13-8	ISOCYANIC ACID
1.700	85.4	CHNO	43.0	353985	75-13-8	ISOCYANIC ACID
1.700	85.4	CHNO	43.0	272172	75-13-8	ISOCYANIC ACID
3.400	92.5	CHNO	43.0	7674397	75-13-8	ISOCYANIC ACID
3.500	92.9	CH2O2	46.0	3316317	64-18-6	Formic acid
3.600	97.8	C2H4O2	60.0	968875	64-19-7	Acetic acid
3.900	93.3	C2H8O2Si	92.0	372031	1066-42-8	Silanediol, dimethyl-
4.100	89.5	C2H4O	44.0	3733785	75-07-0	Acetaldehyde
4.300	93.5	C3H8O2	76.1	862704	57-55-6	1,2-Propanediol
4.500	82.9	C4H8O2	88.1	464353	107-92-6	Butanoic acid
4.700	90.0	C5H10O2	102.1	1045239	75-98-9	Propanoic acid, 2,2-dimethyl-
4.800	94.5	C6H12O	100.1	298927	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	1942802	541-05-9	Cyclotrisiloxane, hexamethyl-
5.100	88.3	C6H14O2Si	146.1	1177607	999059-38-4	2,2,4-trimethyl-2-sila-1,3-dioxacyclohexane
5.500	96.4	C4H10O2	90.1	826180	24621-61-2	1,3-Butanediol, (S)-
5.500	95.4	C5H10O2	102.1	535025	109-52-4	Pentanoic acid
5.700	85.1	C8H9NO2	151.1	554228	1000222-86-6	Oxime-, methoxy-phenyl-_
6.000	90.8	C6H14O2	118.1	308298	111-76-2	Ethanol, 2-butoxy-
6.700	95.0	C4H10O3	106.1	475099	111-46-6	Ethanol, 2,2'-oxybis-
6.800	91.3	C7H6O	106.0	239313	100-52-7	Benzaldehyde
6.900	82.5	C6H12O2	116.1	4006016	142-62-1	Hexanoic acid
6.900	85.5	C6H6O	94.0	276999	108-95-2	Phenol
6.900	94.3	C8H24O4Si4	296.1	3964462	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	88.0	C8H14O	126.1	299755	110-93-0	6-Methyl-5-hepten-2-one
7.300	86.4	C6H14O3	134.1	551180	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
7.300	88.1	C10H22	142.2	720808	124-18-5	Decane
7.300	97.4	C8H16O	128.1	1029772	124-13-0	Octanal
7.400	97.9	C7H16O3	148.1	664934	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.600	94.3	C6H14O3	134.1	838425	110-98-5	2-Propanol, 1,1'-oxybis-
7.600	82.8	C13H28	184.2	244597	17301-28-9	Undecane, 3,6-dimethyl-

7.700	97.3	C8H18O	130.1	585682	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.0	C10H16	136.1	1985972	138-86-3	dl-Limonene
7.800	91.7	C7H8O	108.1	2172282	100-51-6	Benzyl Alcohol
7.800	92.6	C6H14O3	134.1	561256	25265-71-8	2-Propanol, 1,1'-oxybis-
7.900	90.9	C6H14O3	134.1	674103	25265-71-8	2-Propanol, 1,1'-oxybis-
8.000	94.2	C10H30O3Si4	310.1	998095	141-62-8	Tetrasiloxane, decamethyl-
8.200	88.0	C10H22	142.2	492544	2051-30-1	Octane, 2,6-dimethyl-
8.300	84.7	C11H26O3Si	234.2	506041	2761-24-2	Silane, triethoxypentyl-
8.400	84.8	C13H28	184.2	269812	6117-97-1	Dodecane, 4-methyl-
8.800	96.3	C11H24	156.2	1904003	1120-21-4	Undecane
8.800	97.8	C9H18O	142.1	8880015	124-19-6	Nonanal
8.900	93.4	C8H16O2	144.1	1240839	149-57-5	Hexanoic acid, 2-ethyl-
9.000	95.3	C8H10O	122.1	1381338	60-12-8	Benzeneethanol
9.200	94.9	C10H30O5Si5	370.1	22083957	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	96.8	C16H11NO2S	281.1	646990	70453-75-7	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one
9.600	97.9	C12H36O4Si5	384.1	9932330	141-63-9	Pentasiloxane, dodecamethyl-
9.700	80.5	C8H16O2	144.1	3629634	124-07-2	Octanoic acid
10.000	97.4	C10H20O	156.2	608288	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	93.2	C8H18O3	162.1	715449	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	96.1	C10H8	128.1	505419	275-51-4	Azulene
10.200	96.9	C8H8O3	152.0	276496	119-36-8	Methyl salicylate
10.200	96.1	C12H26	170.2	3878735	112-40-3	Dodecane
10.300	89.4	C10H20O	156.2	1501913	112-31-2	Decanal
10.500	97.2	C12H36O4Si5	384.1	931049	141-63-9	Pentasiloxane, dodecamethyl-
10.500	93.0	C8H10O2	138.1	1642284	122-99-6	Ethanol, 2-phenoxy-
10.800	87.5	C8H18O2	146.1	554535	1117-86-8	1,2-Octanediol
11.000	92.1	C6H11NO	113.1	1197036	105-60-2	Caprolactam
11.100	91.4	C9H18O2	158.1	2288827	112-05-0	Nonanoic acid
11.200	90.5	C18H38O	270.3	469014	1000406-38-3	Decyl octyl ether
11.600	96.0	C12H36O6Si6	444.1	17470008	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	95.0	C13H28	184.2	4346744	629-50-5	Tridecane
11.700	95.6	C11H10	142.1	258456	91-57-6	Naphthalene, 2-methyl-
11.800	92.8	C11H22O	170.2	563058	112-44-7	Undecanal
12.000	90.9	C16H34	226.3	557482	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	90.0	C12H24O3	216.2	9280080	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.500	86.3	C21H44	296.3	510097	54833-23-7	Eicosane, 10-methyl-
12.700	93.4	C12H24O3	216.2	12330465	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.700	93.0	C14H42O5Si6	458.2	263512	107-52-8	Hexasiloxane, tetradecamethyl-
12.900	93.6	C14H28	196.2	598119	295-17-0	Cyclotetradecane
13.000	94.9	C14H30	198.2	14764265	629-59-4	Tetradecane
13.100	96.7	C12H24O	184.2	1215110	112-54-9	Dodecanal
13.700	86.3	C14H28	196.2	666357	2882-98-6	Cyclopentane, nonyl-
13.800	87.5	C15H32	212.3	646336	1560-95-8	Tetradecane, 2-methyl-
13.900	82.0	C14H20O2	220.1	252807	2460-77-7	2,5-di-tert-Butyl-1,4-benzoquinone
14.000	96.4	C12H26O	186.2	1421788	112-53-8	1-Dodecanol
14.000	83.6	C11H14O2	178.1	1510168	54549-72-3	Ethanone, 1-[4-(1-hydroxy-1-methylethyl)phenyl]-
14.300	94.7	C15H32	212.3	11259067	629-62-9	pentadecane
14.400	93.6	C15H24O	220.2	5572607	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-
14.400	80.7	C13H26O	198.2	439791	10486-19-8	Tridecanal
14.900	81.9	C18H38O3S	334.3	738327	999541-20-9	Sulfurous acid, dodecyl hexyl ester
15.000	81.9	C19H38	266.3	913664	13151-89-8	Tridecane, 4-cyclohexyl-
15.100	90.8	C16H34	226.3	1006948	1560-93-6	Pentadecane, 2-methyl-
15.100	87.0	C16H34	226.3	1165096	2882-96-4	Pentadecane, 3-methyl-
15.400	89.9	C12H26O	186.2	758715	112-53-8	1-Dodecanol
15.500	93.7	C16H34	226.3	10507128	544-76-3	Hexadecane
15.800	90.1	C16H48O8Si8	592.2	1680998	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	84.6	C17H26O2	262.2	627545	14035-34-8	2,6-Bis(1,1-dimethylethyl)-4-(1-oxopropyl)phenol
16.000	85.8	C14H30	198.2	1362798	107770-99-0	3,5-Dimethyldodecane
16.200	89.6	C18H38O	270.3	1366255	1000406-38-3	Decyl octyl ether
16.300	84.7	C17H28	232.2	244127	4536-87-2	Benzene, (1-ethylnonyl)-
16.600	94.7	C17H36	240.3	5084865	629-78-7	Heptadecane
17.100	86.1	C18H38	254.3	323462	593-45-3	Octadecane
17.400	87.2	C18H38	254.3	289701	6418-44-6	Heptadecane, 3-methyl-
17.500	84.3	C18H54O9Si9	666.2	358382	556-71-8	Cyclononasiloxane, octadecamethyl-
17.700	87.0	C18H38	254.3	1706510	593-45-3	Octadecane
17.800	97.2	C15H22O3	250.2	1280910	118-60-5	2-Ethylhexyl salicylate
18.000	90.3	C17H34O2	270.3	401051	110-27-0	Isopropyl myristate