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

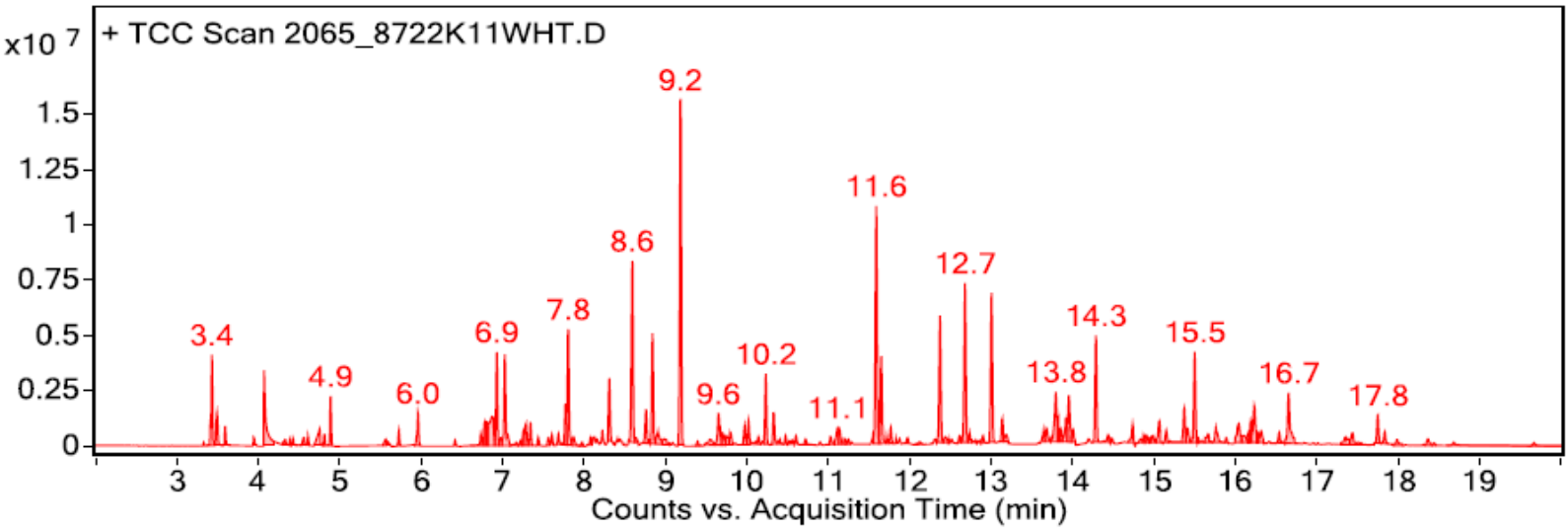
Alkynes – can become reactive when exposed to heat or UV light

Sample: McMaster Carr super-cushioning food-grade foamed polyethylene sheeting, 8722K11, white

Oddy test result: Unsuitable

Date GC-MS collected: 3/20/2018

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; (2) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.400	85.4	CHNO	43.0	5067378	75-13-8	ISOCYANIC ACID
3.500	92.9	CH2O2	46.0	2135266	64-18-6	Formic acid
3.600	98.0	C2H4O2	60.0	765561	64-19-7	Acetic acid
3.900	95.4	C2H8O2Si	92.0	484689	1066-42-8	Silanediol, dimethyl-
4.100	89.4	C2H4O	44.0	5734428	75-07-0	Acetaldehyde
4.300	86.1	C4H8O2	88.1	253730	79-31-2	Propanoic acid, 2-methyl-
4.400	90.6	C6H11N	97.1	213449	124-02-7	2-Propen-1-amine, N-2-propenyl-
4.800	90.7	C5H10O2	102.1	1790167	75-98-9	Propanoic acid, 2,2-dimethyl-
4.800	96.2	C6H12O	100.1	494837	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	2225886	541-05-9	Cyclotrisiloxane, hexamethyl-
5.600	93.5	C6H12O2	116.1	634279	142-62-1	Hexanoic acid
5.600	95.8	C8H10	106.1	237173	106-42-3	Benzene, 1,4-dimethyl-
5.700	83.0	C8H9NO2	151.1	766091	1000222-86-6	Oxime-, methoxy-phenyl-_
6.000	93.4	C6H14O2	118.1	1596811	111-76-2	Ethanol, 2-butoxy-
6.800	82.8	C9H12	120.1	659672	622-96-8	Benzene, 1-ethyl-4-methyl-
6.800	84.7	C10H10O3	178.1	215619	67519-26-0	1,4-[13C]-4-Oxo-4-phenylbutanoic acid
6.900	87.4	C6H12O2	116.1	2042094	142-62-1	Hexanoic acid
6.900	94.2	C8H24O4Si4	296.1	4501848	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	91.8	C7H14O3	146.1	2550054	763-69-9	Propanoic acid, 3-ethoxy-, ethyl ester
7.200	82.7	C7H16O3	148.1	256630	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	93.9	C9H12	120.1	612242	0-00-0	unidentified C3-benzene
7.300	84.4	C6H14O3	134.1	455135	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
7.300	92.6	C10H22	142.2	1115522	124-18-5	Decane
7.300	97.5	C8H16O	128.1	1225505	124-13-0	Octanal
7.400	99.6	C7H16O3	148.1	504781	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.600	92.6	C6H14O3	134.1	580945	110-98-5	2-Propanol, 1,1'-oxybis-
7.600	82.6	C10H22	142.2	329028	2051-30-1	Octane, 2,6-dimethyl-
7.700	96.4	C8H18O	130.1	865973	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.2	C10H16	136.1	2326002	138-86-3	dl-Limonene
7.800	95.4	C7H8O	108.1	3829671	100-51-6	Benzyl Alcohol
7.900	86.5	C9H20O4	192.1	461043	999157-72-0	TRIPROPYLENE GLYCOL 4

8.000	91.5	C10H30O3Si4	310.1	231070	141-62-8	Tetrasiloxane, decamethyl-
8.100	82.6	C15H32	212.3	522848	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.100	87.7	C6H18O3Si3	222.1	256503	541-05-9	Cyclotrisiloxane, hexamethyl-
8.200	90.9	C15H32	212.3	622173	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.300	95.5	C8H8O	120.1	3730537	98-86-2	Ethanone, 1-phenyl-
8.400	88.8	C13H28	184.2	305870	6117-97-1	Dodecane, 4-methyl-
8.600	90.6	C9H12O	136.1	10082177	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.800	95.8	C11H24	156.2	2096225	1120-21-4	Undecane
8.800	97.7	C9H18O	142.1	6312971	124-19-6	Nonanal
8.900	85.5	C8H16O2	144.1	520084	149-57-5	Hexanoic acid, 2-ethyl-
9.200	95.4	C10H30O5Si5	370.1	20827298	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	95.4	C16H11NO2S	281.1	254638	70453-75-7	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one
9.700	97.5	C12H36O4Si5	384.1	1749061	141-63-9	Pentasiloxane, dodecamethyl-
9.700	87.4	C10H18O	154.1	670325	89-80-5	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, trans-
10.000	97.7	C10H20O	156.2	1090884	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	93.5	C8H18O3	162.1	830729	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	83.4	C16H32	224.3	225494	629-73-2	1-Hexadecene
10.100	96.0	C10H8	128.1	483700	275-51-4	Azulene
10.200	96.3	C8H8O3	152.0	271638	119-36-8	Methyl salicylate
10.200	96.0	C12H26	170.2	4047336	112-40-3	Dodecane
10.300	88.0	C10H20O	156.2	1994707	112-31-2	Decanal
10.500	97.5	C12H36O4Si5	384.1	537593	141-63-9	Pentasiloxane, dodecamethyl-
10.500	91.3	C8H10O2	138.1	302520	122-99-6	Ethanol, 2-phenoxy-
10.600	85.9	C11H20O2	184.1	406890	42928-87-0	4-(Prop-2-enoyloxy)octane
11.000	91.7	C6H11NO	113.1	693107	105-60-2	Caprolactam
11.100	85.1	C9H18O2	158.1	709653	112-05-0	Nonanoic acid
11.200	90.8	C18H38O	270.3	411506	1000406-38-3	Decyl octyl ether
11.500	80.7	C10H18O	154.1	477948	54244-81-4	Cyclohexanol, 2-methyl-3-(1-methylethenyl)-, (1.alpha.,2.alpha.,3.alpha.)-
11.600	96.0	C12H36O6Si6	444.1	15017955	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	95.0	C13H28	184.2	4328715	629-50-5	Tridecane
11.700	92.3	C11H10	142.1	266928	91-57-6	Naphthalene, 2-methyl-
11.800	94.8	C11H22O	170.2	841672	112-44-7	Undecanal
11.900	83.7	C12H26O	186.2	396429	10522-26-6	2-Methyl-1-undecanol
12.000	91.6	C16H34	226.3	539361	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	89.8	C12H24O3	216.2	8095694	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.500	83.0	C21H44	296.3	370888	54833-23-7	Eicosane, 10-methyl-
12.700	94.6	C12H24O3	216.2	10412792	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.700	93.2	C14H42O5Si6	458.2	385597	107-52-8	Hexasiloxane, tetradecamethyl-
12.900	94.3	C14H28	196.2	474135	295-17-0	Cyclotetradecane
13.000	95.6	C14H30	198.2	9744881	629-59-4	Tetradecane
13.100	96.7	C12H24O	184.2	1572136	112-54-9	Dodecanal
13.600	85.9	C17H36	240.3	779932	6008-17-9	5,5-Dibutylnonane
13.700	80.4	C14H28	196.2	623903	2882-98-6	Cyclopentane, nonyl-
13.800	81.8	C15H32	212.3	635770	1560-95-8	Tetradecane, 2-methyl-
13.900	83.5	C14H20O2	220.1	599514	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
14.000	95.2	C12H26O	186.2	1214798	112-53-8	1-Dodecanol
14.300	94.5	C15H32	212.3	6846481	629-62-9	pentadecane
14.400	94.1	C13H26O	198.2	497863	10486-19-8	Tridecanal
14.700	88.6	C16H48O6Si7	532.2	1170583	541-01-5	Heptasiloxane, hexadecamethyl-
14.900	81.0	C20H42O3S	362.3	576513	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
15.100	90.1	C16H34	226.3	634252	1560-93-6	Pentadecane, 2-methyl-
15.200	87.9	C16H34	226.3	785275	2882-96-4	Pentadecane, 3-methyl-
15.400	88.6	C12H26O	186.2	493101	112-53-8	1-Dodecanol
15.500	93.7	C16H34	226.3	5737515	544-76-3	Hexadecane
15.800	90.4	C16H48O8Si8	592.2	734943	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	86.3	C15H30O2	242.2	437492	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.000	86.5	C16H34	226.3	737238	55045-11-9	Tridecane, 5-propyl-
16.200	85.6	C16H32	224.3	532990	6785-23-5	Cyclopentane, undecyl-
16.200	89.8	C18H38O	270.3	1005019	1000406-38-3	Decyl octyl ether
16.700	94.1	C17H36	240.3	3215270	629-78-7	Heptadecane
17.400	83.4	C18H38	254.3	248978	6418-44-6	Heptadecane, 3-methyl-
17.700	85.2	C18H38	254.3	1421617	593-45-3	Octadecane
17.800	96.7	C15H22O3	250.2	653659	118-60-5	2-Ethylhexyl salicylate
18.000	90.1	C17H34O2	270.3	240210	110-27-0	Isopropyl myristate
18.400	82.2	C13H16O2	204.1	338054	54932-88-6	Benzenepropanoic acid, .alpha.,.alpha.-dimethyl-, ethenyl ester