

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

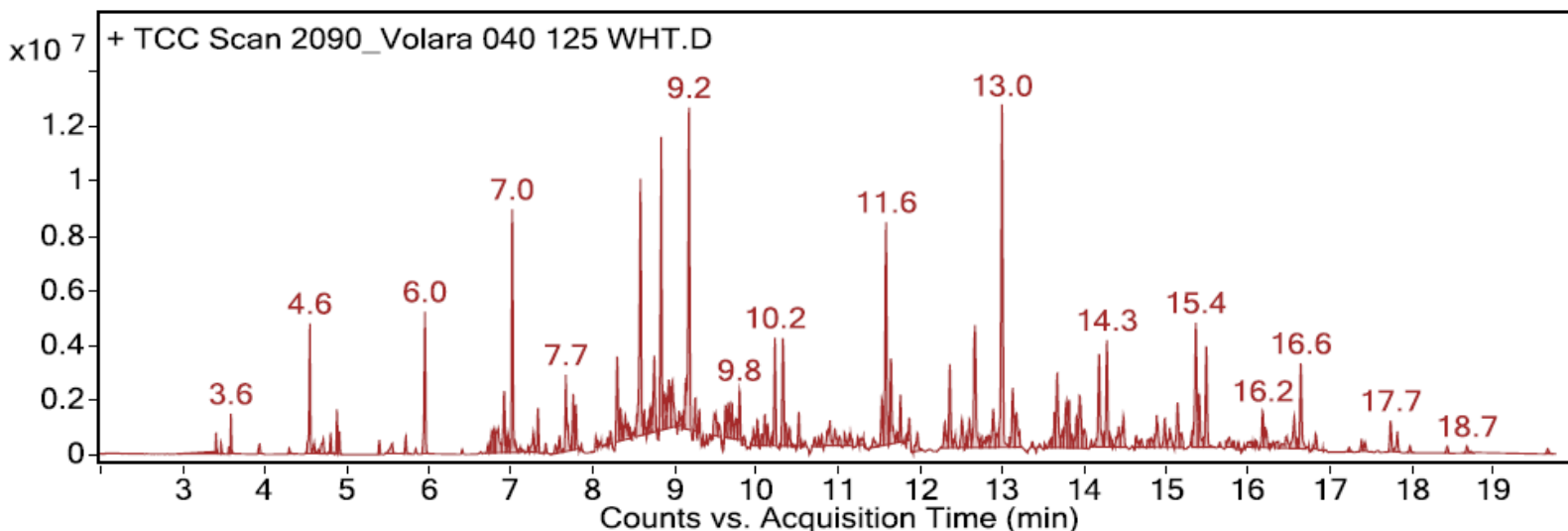
Alkynes – can become reactive when exposed to heat or UV light

Sample: Sekisui Voltek Volara 040A 125 white closed cell polyethylene foam

Oddy test result: Temporary

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) 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	92.4	CHNO	43.0	683943	75-13-8	ISOCYANIC ACID
3.500	92.9	CH2O2	46.0	317489	64-18-6	Formic acid
3.600	94.2	C3H10OSi	90.1	175423	1066-40-6	Silanol, trimethyl-
3.600	98.0	C2H4O2	60.0	872156	64-19-7	Acetic acid
3.900	94.7	C3H6O2	74.0	341104	79-09-4	Propanoic acid
3.900	92.9	C2H8O2Si	92.0	224777	1066-42-8	Silanediol, dimethyl-
4.300	84.2	C4H8O2	88.1	342201	79-31-2	Propanoic acid, 2-methyl-
4.500	88.2	C4H8O2	88.1	812839	107-92-6	Butanoic acid
4.500	94.3	C7H8	92.1	4424796	108-88-3	Benzene, methyl-
4.700	87.8	C5H10O2	102.1	1006693	75-98-9	Propanoic acid, 2,2-dimethyl-
4.800	96.4	C6H12O	100.1	683404	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	1487774	541-05-9	Cyclotrisiloxane, hexamethyl-
4.900	92.8	C6H12O2	116.1	694133	123-86-4	Acetic acid, butyl ester
5.400	94.5	C7H4ClF3	180.0	495862	98-56-6	Benzene, 1-chloro-4-(trifluoromethyl)-
5.600	92.8	C6H12O2	116.1	940563	142-62-1	Hexanoic acid
6.000	96.9	C6H14O2	118.1	5767844	111-76-2	Ethanol, 2-butoxy-
6.800	98.3	C7H6O	106.0	475908	100-52-7	Benzaldehyde
6.900	87.7	C6H6O	94.0	284808	108-95-2	Phenol
6.900	94.6	C8H24O4Si4	296.1	2672503	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	91.8	C8H14O2	142.1	900573	97-88-1	2-Propenoic acid, 2-methyl-, butyl ester
7.000	95.8	C7H14O3	146.1	8550408	763-69-9	Propanoic acid, 3-ethoxy-, ethyl ester
7.200	94.7	C7H16O3	148.1	249126	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.200	92.5	C9H12	120.1	265896	0-00-0	unidentified C3-benzene
7.300	83.8	C7H16O3	148.1	300141	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	91.4	C10H22	142.2	866649	124-18-5	Decane
7.300	97.6	C8H16O	128.1	1908976	124-13-0	Octanal
7.400	99.4	C7H16O3	148.1	526508	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.500	88.1	C6H14O3	134.1	508418	110-98-5	2-Propanol, 1,1'-oxybis-
7.600	86.3	C13H28	184.2	420305	62108-26-3	Decane, 2,6,8-trimethyl-
7.700	97.5	C8H18O	130.1	2026145	104-76-7	1-Hexanol, 2-ethyl-
7.800	96.8	C10H16	136.1	2592990	138-86-3	dl-Limonene

7.800	85.9	C7H8O	108.1	1462999	100-51-6	Benzyl Alcohol
7.900	80.1	C6H14O3	134.1	395331	25265-71-8	2-Propanol, 1,1'-oxybis-
8.000	89.3	C12H26	170.2	484997	1002-43-3	Undecane, 3-methyl-
8.200	89.2	C15H32	212.3	1262844	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.300	90.1	C8H8O	120.1	3631077	98-86-2	Ethanone, 1-phenyl-
8.300	81.3	C18H40O3Si	332.3	435979	18536-91-9	Silane, dodecyltriethoxy-
8.300	87.0	C20H42	282.3	2152088	112-95-8	Eicosane
8.400	87.0	C9H20	128.2	1025808	4032-86-4	Heptane, 3,3-dimethyl-
8.400	93.9	C12H26	170.2	1569851	62185-21-1	Octane, 3,4,5,6-tetramethyl-
8.500	82.6	C10H22	142.2	1122921	17302-01-1	3-Ethyl-3-methylheptane
8.500	91.3	C12H26	170.2	2669184	2801-84-5	Decane, 2,4-dimethyl-
8.600	91.1	C9H12O	136.1	9175709	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.700	84.8	C10H22	142.2	2337402	17301-94-9	Nonane, 4-methyl-
8.800	93.4	C11H24	156.2	6058133	1120-21-4	Undecane
8.800	96.9	C9H18O	142.1	11301817	124-19-6	Nonanal
8.900	88.8	C13H28	184.2	2591192	17312-79-7	Undecane, 4,5-dimethyl-
9.000	90.5	C14H30	198.2	4635726	13287-21-3	Tridecane, 6-methyl-
9.000	80.1	C8H10O	122.1	878627	60-12-8	Benzeneethanol
9.100	83.9	C11H24	156.2	1714028	62016-30-2	Octane, 2,3,3-trimethyl-
9.100	87.2	C11H24	156.2	3797511	17302-32-8	Nonane, 3,7-dimethyl-
9.200	95.4	C10H30O5Si5	370.1	15398536	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	83.7	C14H19NO3S	281.1	374572	999405-76-8	2-Ethylthio-2-ethoxy-3-oxo-N-phenylbutanamide
9.300	89.6	C13H28	184.2	2833026	62238-11-3	Decane, 2,3,5-trimethyl-
9.300	88.7	C10H22	142.2	542761	52896-87-4	Heptane, 4-(1-methylethyl)-
9.500	87.0	C10H22	142.2	778672	5911-04-6	Nonane, 3-methyl-
9.500	91.4	C13H28	184.2	2013457	17312-63-9	Nonane, 5-butyl-
9.600	90.1	C13H28	184.2	1212590	62185-54-0	Nonane, 5-(1-methylpropyl)-
9.700	89.3	C13H28	184.2	1249565	17312-78-6	Undecane, 3,4-dimethyl-
9.800	92.9	C18H38	254.3	1945561	26741-18-4	9-methylheptadecane
10.000	94.6	C10H20O	156.2	1210258	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	90.2	C8H18O3	162.1	1028710	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	85.3	C9H18	126.1	726982	1678-97-3	Cyclohexane, 1,2,3-trimethyl-
10.100	90.4	C10H8	128.1	772953	91-20-3	Naphthalene
10.200	94.8	C8H8O3	152.0	411748	119-36-8	Methyl salicylate
10.200	96.0	C12H26	170.2	5381622	112-40-3	Dodecane
10.300	96.5	C10H20O	156.2	5853325	112-31-2	Decanal
10.500	85.9	C12H36O4Si5	384.1	192824	141-63-9	Pentasiloxane, dodecamethyl-
10.500	92.5	C8H10O2	138.1	2099683	122-99-6	Ethanol, 2-phenoxy-
10.600	82.2	C11H20O2	184.1	447848	103-11-7	2-Ethylhexyl acrylate
10.900	80.3	C10H20	140.2	721704	3741-00-2	Cyclopentane, pentyl-
11.100	80.0	C17H36O	256.3	431155	1000406-39-1	Decyl heptyl ether
11.200	88.8	C18H38O	270.3	710842	1000406-38-3	Decyl octyl ether
11.400	83.3	C12H24	168.2	637042	64723-36-0	Cyclopropane, 1-(2-methylbutyl)-1-(1-methylpropyl)-
11.500	86.1	C8H24O4Si4	296.1	234966	556-67-2	Cyclotetrasiloxane, octamethyl-
11.500	88.6	C13H26	182.2	2697685	2437-56-1	1-Tridecene
11.600	96.0	C12H36O6Si6	444.1	11318045	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	93.7	C13H28	184.2	5351343	629-50-5	Tridecane
11.700	86.0	C11H10	142.1	402421	90-12-0	Naphthalene, 1-methyl-
11.800	94.1	C11H22O	170.2	1903652	112-44-7	Undecanal
11.900	86.7	C12H24	168.2	1172944	64723-36-0	Cyclopropane, 1-(2-methylbutyl)-1-(1-methylpropyl)-
11.900	92.8	C11H10	142.1	160855	999054-80-4	methylnaphthalene
12.000	82.5	C16H34	226.3	1114383	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.300	85.6	C13H26	182.2	1525773	5617-41-4	Heptylcyclohexane
12.400	89.9	C12H24O3	216.2	4389134	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	93.6	C12H24O3	216.2	6721205	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.900	96.0	C14H28	196.2	1849259	295-17-0	Cyclotetradecane
13.000	95.5	C14H30	198.2	11715368	629-59-4	Tetradecane
13.100	95.5	C12H24O	184.2	2961720	112-54-9	Dodecanal
13.700	93.8	C14H28	196.2	2964070	2882-98-6	Cyclopentane, nonyl-

13.800	80.4	C14H42O7Si7	518.1	2008682	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.900	94.1	C12H26O	186.2	1864955	112-53-8	1-Dodecanol
14.100	84.5	C14H28	196.2	353826	19780-34-8	1-Dodecene, 2-ethyl-
14.200	95.4	C15H30	210.2	5301518	13360-61-7	1-Pentadecene
14.200	85.9	C12H10	154.1	183059	83-32-9	Acenaphthylene, 1,2-dihydro-
14.300	94.3	C15H32	212.3	5803480	629-62-9	pentadecane
14.400	92.8	C13H26O	198.2	725534	10486-19-8	Tridecanal
14.500	87.8	C16H34	226.3	1888436	59222-86-5	Tetradecane, 2,2-dimethyl-
14.900	85.9	C20H42O3S	362.3	1311498	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
15.000	94.2	C15H30	210.2	1723026	2883-02-5	n-Nonylcyclohexane
15.100	86.9	C16H34	226.3	792665	2801-87-8	Pentadecane, 4-methyl-
15.100	93.5	C16H34	226.3	1215720	2882-96-4	Pentadecane, 3-methyl-
15.300	83.2	C12H21F3O2	254.1	845382	28745-07-5	Acetic acid, trifluoro-, 3,7-dimethyloctyl ester
15.400	87.7	C12H14O4	222.1	4907824	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
15.400	94.6	C16H32	224.3	2003690	629-73-2	Cetene
15.500	90.9	C16H34	226.3	5445515	544-76-3	Hexadecane
15.700	81.1	C14H28O	212.2	488646	124-25-4	Tetradecanal
15.800	87.3	C16H48O8Si8	592.2	364492	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	85.3	C15H30O2	242.2	624803	10233-13-3	Dodecanoic acid, 1-methylethyl ester
15.900	88.4	C13H10O	182.1	265773	119-61-9	Benzophenone
16.100	88.0	C17H36	240.3	493354	1000360-41-2	3,3-Diethyltridecane
16.200	92.6	C16H32	224.3	2036391	295-65-8	Cyclohexadecane
16.200	86.8	C22H46O3S	390.3	1025313	999646-00-5	Sulfurous acid, 2-ethylhexyl tetradecyl ester
16.600	86.2	C17H36O	256.3	2059354	1454-85-9	n-Heptadecanol-1
16.600	93.8	C17H36	240.3	5008974	629-78-7	Heptadecane
16.800	80.9	C12H26	170.2	818634	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
17.400	88.4	C17H34	238.3	405868	54105-66-7	Cyclohexane, undecyl-
17.400	84.9	C18H38	254.3	320067	6418-44-6	Heptadecane, 3-methyl-
17.700	89.7	C18H38	254.3	1695179	593-45-3	Octadecane
17.800	97.1	C15H22O3	250.2	747170	118-60-5	2-Ethylhexyl salicylate
18.000	89.6	C17H34O2	270.3	338261	110-27-0	Isopropyl myristate
18.400	84.5	C18H38O	270.3	372158	112-92-5	1-Octadecanol