

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

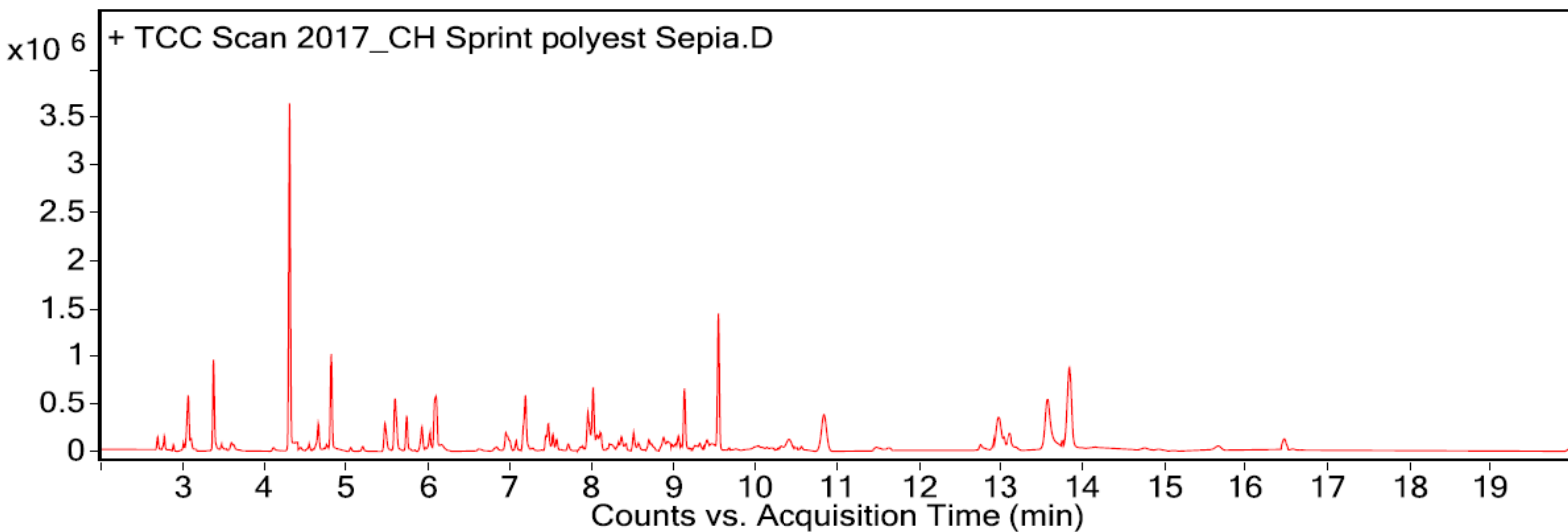
Sample: Clarence House Decortex Sprint polyester fabric; Sepia

Oddy test result: Temporary

Date collected: 12/14/2017

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) 12.7, 13.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 13.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.695	89.9	C3H6O	58.0	207211	67-64-1	2-Propanone
2.777	94.9	C3H6O2	74.0	186965	79-20-9	Acetic acid, methyl ester
2.888	94.4	C3H10OSi	90.1	87996	1066-40-6	Silanol, trimethyl-
3.008	94.3	C4H8O	72.1	65991	78-93-3	2-Butanone
3.068	98.3	C2H4O2	60.0	1205916	64-19-7	Acetic acid
3.376	93.6	C4H10O	74.1	1153450	71-36-3	1-Butanol
3.477	84.3	C4H10O2	90.1	63050	107-98-2	2-Propanol, 1-methoxy-
3.535	82.3	C3H4O	56.0	77510	107-02-8	2-Propenal
3.623	87.5	C5H10O	86.1	70314	110-62-3	Pentanal
4.108	80.9	C4H8O2	88.1	115201	79-31-2	Propanoic acid, 2-methyl-
4.302	95.0	C7H8	92.1	5479305	108-88-3	Benzene, methyl-
4.438	89.8	C6H12O2	116.1	101800	142-62-1	Hexanoic acid
4.544	92.4	C8H16	112.1	82634	2511-91-3	Cyclopropane, pentyl-
4.628	89.8	C11H20O	168.2	70676	56745-59-6	1-Heptanoyl-2-methylcyclopropane
4.652	91.8	C6H12O	100.1	488157	66-25-1	Hexanal
4.760	90.2	C2Cl4	163.9	96088	127-18-4	Tetrachloroethylene
4.802	94.3	C6H18O3Si3	222.1	247761	541-05-9	Cyclotrisiloxane, hexamethyl-
4.810	94.1	C6H12O2	116.1	1212085	123-86-4	Acetic acid, butyl ester
5.060	91.5	C5H4O2	96.0	73256	98-01-1	2-Furancarboxaldehyde
5.205	94.9	C6H12O2	116.1	94712	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.475	96.8	C8H10	106.1	412547	100-41-4	Ethylbenzene
5.493	90.8	C6H12O3	132.1	221955	108-65-6	1-Methoxy-2-propyl ester of acetic acid
5.599	97.8	C8H10	106.1	1288463	106-42-3	Benzene, 1,4-dimethyl-
5.741	91.6	C8H18O	130.1	596777	142-96-1	n-Butyl ether
5.908	81.0	C8H8	104.1	128442	100-42-5	Styrene
5.927	84.5	C8H10	106.1	379741	106-42-3	Benzene, 1,4-dimethyl-

6.023	95.6	C7H14O	114.1	219043	111-71-7	Heptanal
6.100	91.7	C7H14O2	130.1	472780	590-01-2	Propanoic acid, butyl ester
6.837	86.9	C9H12	120.1	65590	0-00-0	unidentified C3-benzene
6.947	90.5	C9H12	120.1	297123	0-00-0	unidentified C3-benzene
6.971	82.0	C10H10O3	178.1	232239	67519-26-0	1,4-[13C]-4-Oxo-4-phenylbutanoic acid
7.075	88.5	C9H12	120.1	146511	108-67-8	Benzene, 1,3,5-trimethyl-
7.163	95.0	C6H6O	94.0	423547	108-95-2	Phenol
7.188	95.3	C8H24O4Si4	296.1	849172	556-67-2	Cyclotetrasiloxane, octamethyl-
7.219	95.3	C9H12	120.1	76236	98-82-8	Benzene, (1-methylethyl)-
7.436	96.0	C8H16O2	144.1	217011	109-21-7	Butanoic acid, butyl ester
7.465	94.1	C9H12	120.1	489065	526-73-8	Benzene, 1,2,3-trimethyl-
7.520	89.9	C13H28	184.2	92569	629-50-5	Tridecane
7.567	94.0	C8H16O	128.1	208743	124-13-0	Octanal
7.721	90.2	C7H16O3	148.1	156450	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.867	90.0	C13H28	184.2	54940	62108-22-9	Decane, 2,5,9-trimethyl-
7.895	96.9	C9H12	120.1	75928	526-73-8	Benzene, 1,2,3-trimethyl-
7.961	96.9	C8H18O	130.1	967342	104-76-7	1-Hexanol, 2-ethyl-
8.024	96.5	C10H16	136.1	927255	138-86-3	dl-Limonene
8.119	94.0	C9H10	118.1	214620	873-49-4	Benzene, cyclopropyl-
8.228	91.5	C5H9NO	99.1	201779	872-50-4	2-Pyrrolidinone, 1-methyl-
8.369	92.9	C15H32	212.3	214982	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.428	84.2	C10H14	134.1	68794	999041-75-5	(2-Methylprop-1-enyl)-cyclohexa-1,5-diene
8.517	89.5	C12H26	170.2	174242	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
8.579	92.6	C8H8O	120.1	194194	98-86-2	Ethanone, 1-phenyl-
8.702	93.3	C13H28	184.2	155301	62238-15-7	Decane, 2,3,4-trimethyl-
8.883	85.3	C9H12O	136.1	198091	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.935	83.8	C8H24O4Si4	296.1	228370	556-67-2	Cyclotetrasiloxane, octamethyl-
9.062	83.9	C13H28	184.2	314147	17301-32-5	Undecane, 4,7-dimethyl-
9.136	97.6	C9H18O	142.1	1046315	124-19-6	Nonanal
9.322	83.1	C36H74	506.6	105241	630-06-8	Hexatriacontane
9.449	83.8	C10H16	136.1	184155	138-86-3	dl-Limonene
9.494	83.4	C8H18O	130.1	220045	104-76-7	1-Hexanol, 2-ethyl-
9.551	88.5	C10H30O5Si5	370.1	2142018	541-02-6	Cyclopentasiloxane, decamethyl-
10.420	88.7	C9H18O	142.1	416186	124-19-6	Nonanal
10.572	90.3	C13H28	184.2	95503	629-50-5	Tridecane
10.848	88.6	C10H30O5Si5	370.1	1731414	541-02-6	Cyclopentasiloxane, decamethyl-
11.638	85.4	C12H26	170.2	67387	1002-43-3	Undecane, 3-methyl-
12.754	87.4	C12H24O3	216.2	190299	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.975	88.0	C12H36O6Si6	444.1	1589258	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.042	88.2	C12H24O3	216.2	106872	999223-22-5	2-Ethyl-3-hydroxyhexyl ester of butanoic acid
13.118	89.0	C9H20	128.2	556316	16747-25-4	Hexane, 2,2,3-trimethyl-
13.582	93.3	C12H24O3	216.2	2702178	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.847	92.8	C12H24O3	216.2	3287217	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
14.167	86.2	C21H44	296.3	85457	54833-48-6	Heptadecane, 2,6,10,15-tetramethyl-
15.660	86.9	C16H34	226.3	224841	59222-86-5	Tetradecane, 2,2-dimethyl-
16.483	81.4	C16H30O4	286.2	196302	74381-40-1	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
16.577	80.4	C18H38	254.3	59199	593-45-3	Octadecane
19.952	92.1	C12H10O2S	218.0	76663	127-63-9	Benzene, 1,1'-sulfonylbis-