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

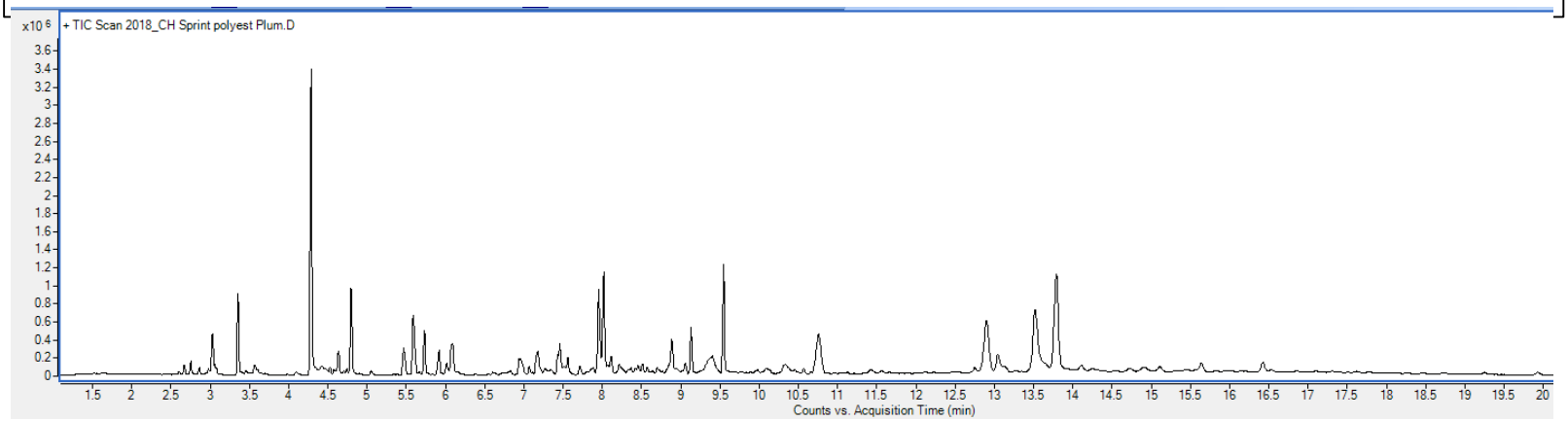
Sample: Clarence House Decortex Sprint polyester fabric; Plum

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
2.601	93.0	CH3NO	45.0	51537	865-40-7	Methane, nitroso-
2.668	90.9	C3H6O	58.0	124380	67-64-1	2-Propanone
2.750	96.8	C3H6O2	74.0	161784	79-20-9	Acetic acid, methyl ester
2.862	94.0	C3H10OSi	90.1	85431	1066-40-6	Silanol, trimethyl-
3.029	98.2	C2H4O2	60.0	892827	64-19-7	Acetic acid
3.353	93.7	C4H10O	74.1	1198720	71-36-3	1-Butanol
3.451	82.5	C4H10O2	90.1	71608	107-98-2	2-Propanol, 1-methoxy-
3.564	87.6	C2H8O2Si	92.0	201104	1066-42-8	Silanediol, dimethyl-
3.601	85.6	C5H10O	86.1	84244	590-86-3	Butanal, 3-methyl-
4.099	81.4	C4H8O2	88.1	117410	79-31-2	Propanoic acid, 2-methyl-
4.285	95.0	C7H8	92.1	4474324	108-88-3	Benzene, methyl-
4.427	90.4	C4H8O2	88.1	112360	107-92-6	Butanoic acid
4.457	82.7	C17H20O4	288.1	214388	74269-73-1	8A.ALPHA.-BENZYLOXYMETHYL-7.ALPHA.-HYDROXY-4A.ALPHA.,7,8,8A-TETRAHYDROISOCHR...
4.529	95.6	C8H16	112.1	121448	2511-91-3	Cyclopropane, pentyl-
4.578	86.6	C3H7NO	73.1	141742	68-12-2	Formamide, N,N-dimethyl-
4.637	92.5	C6H12O	100.1	457238	66-25-1	Hexanal
4.708	92.5	C8H16	112.1	67313	111-67-1	2-Octene
4.745	90.6	C2Cl4	163.9	84374	127-18-4	Tetrachloroethylene
4.790	95.3	C6H18O3Si3	222.1	209526	541-05-9	Cyclotrisiloxane, hexamethyl-
4.797	95.0	C6H12O2	116.1	1228931	123-86-4	Acetic acid, butyl ester
5.047	91.2	C5H4O2	96.0	76042	98-01-1	2-Furancarboxaldehyde
5.464	98.7	C8H10	106.1	409924	100-41-4	Ethylbenzene
5.483	91.1	C6H12O3	132.1	228573	108-65-6	1-Methoxy-2-propyl ester of acetic acid
5.589	97.8	C8H10	106.1	1399999	106-42-3	Benzene, 1,4-dimethyl-
5.732	91.6	C8H18O	130.1	729295	142-96-1	n-Butyl ether
5.918	82.0	C8H10	106.1	425443	95-47-6	Benzene, 1,2-dimethyl-
6.015	93.2	C7H14O	114.1	189051	111-71-7	Heptanal
6.093	90.3	C7H14O2	130.1	569964	590-01-2	Propanoic acid, butyl ester
6.941	90.5	C9H12	120.1	263370	0-00-0	unidentified C3-benzene
6.965	82.0	C10H10O3	178.1	264565	67519-26-0	1,4-[13C]-4-Oxo-4-phenylbutanoic acid
6.990	83.9	C9H12	120.1	142745	0-00-0	unidentified C3-benzene
7.069	89.4	C9H12	120.1	150011	108-67-8	Benzene, 1,3,5-trimethyl-

7.108	86.2	C6H12O2	116.1	45833	142-62-1	Hexanoic acid
7.158	95.0	C6H6O	94.0	322407	108-95-2	Phenol
7.183	96.0	C8H24O4Si4	296.1	289993	556-67-2	Cyclotetrasiloxane, octamethyl-
7.212	94.1	C9H12	120.1	146974	0-00-0	C3 - benzene
7.271	92.6	C8H14O	126.1	69612	110-93-0	6-Methyl-5-hepten-2-one
7.430	95.9	C8H16O2	144.1	346399	109-21-7	Butanoic acid, butyl ester
7.459	94.5	C9H12	120.1	508864	0-00-0	unidentified C3-benzene
7.515	87.4	C9H20O	144.2	172174	62238-03-3	Butane, 1-butoxy-2-methyl-
7.561	95.2	C8H16O	128.1	264811	124-13-0	Octanal
7.715	91.9	C7H16O3	148.1	186382	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.861	88.6	C12H26	170.2	156376	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.889	93.6	C9H12	120.1	86263	999025-90-5	pseudo - cumene
7.939	89.2	C10H14	134.1	235550	21195-59-5	p-Mentha-1,5,8-triene
7.955	97.0	C8H18O	130.1	1800457	104-76-7	1-Hexanol, 2-ethyl-
8.018	97.2	C10H16	136.1	1714295	138-86-3	dl-Limonene
8.114	93.9	C9H10	118.1	256864	873-49-4	Benzene, cyclopropyl-
8.215	94.9	C5H9NO	99.1	292795	872-50-4	2-Pyrrolidinone, 1-methyl-
8.363	87.5	C15H32	212.3	138328	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.424	81.0	C12H18O2	194.1	86646	89398-41-4	Bicyclo[5.2.1]dec-7-en-1-ol acetate
8.513	89.1	C12H26	170.2	120874	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
8.574	90.8	C8H8O	120.1	124944	98-86-2	Ethanone, 1-phenyl-

8.698	89.2	C13H28	184.2	99815	6117-97-1	Dodecane, 4-methyl-
8.829	89.9	C8H24O4Si4	296.1	102900	556-67-2	Cyclotetrasiloxane, octamethyl-
8.888	92.6	C10H16	136.1	685424	99-86-5	1,3-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-
9.059	83.9	C13H28	184.2	221725	17301-32-5	Undecane, 4,7-dimethyl-
9.132	97.7	C9H18O	142.1	782888	124-19-6	Nonanal
9.354	94.6	C10H16	136.1	479017	138-86-3	dl-Limonene
9.547	89.1	C10H30O5Si5	370.1	1553736	541-02-6	Cyclopentasiloxane, decamethyl-
10.090	89.0	C10H16	136.1	160139	99-86-5	.alpha.-Terpinene
10.334	83.3	C9H18O	142.1	351614	124-19-6	NONANAL
10.569	92.6	C14H30	198.2	68512	629-59-4	Tetradecane
10.758	87.2	C10H30O5Si5	370.1	1548089	541-02-6	Cyclopentasiloxane, decamethyl-
11.560	97.7	C20H42	282.3	102138	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
12.747	81.5	C12H24O3	216.2	139657	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.853	84.1	C10H21Br	220.1	169683	30571-71-2	Decane, 3-bromo-
12.900	85.3	C12H36O6Si6	444.1	1997141	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.045	83.1	C9H20	128.2	699908	16747-25-4	Hexane, 2,2,3-trimethyl-
13.125	85.1	C16H34	226.3	165505	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
13.519	93.0	C12H24O3	216.2	3305317	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.790	92.8	C12H24O3	216.2	3890153	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
14.112	92.7	C21H44	296.3	209997	18344-37-1	Heptadecane, 2,6,10,14-tetramethyl-
14.728	82.4	C30H58O4	482.4	141339	2432-89-5	Decanedioic acid, didecyl ester
15.639	88.1	C16H34	226.3	299231	59222-86-5	Tetradecane, 2,2-dimethyl-
16.531	86.7	C19H40	268.3	67458	629-92-5	Nonadecane
19.249	93.4	C16H22O4	278.2	57458	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
19.927	88.1	C12H10O2S	218.0	72717	127-63-9	Benzene, 1,1'-sulfonylbis-