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

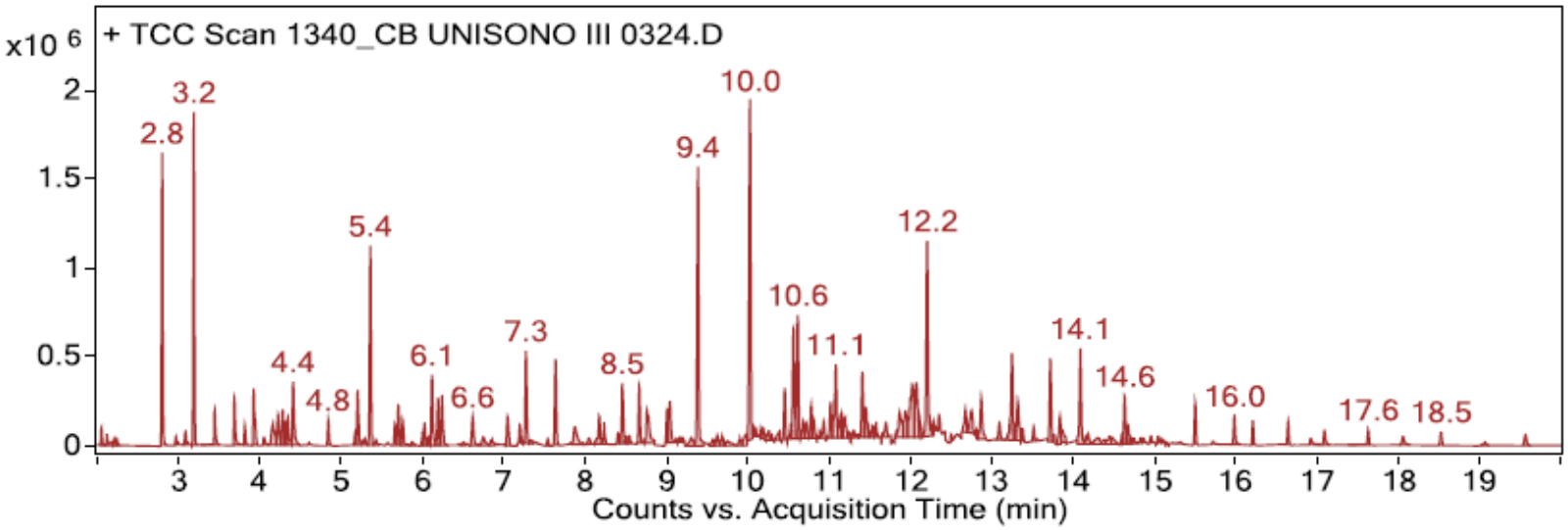
Sample: Creation Baumann Unisono III 0324 (blue) cotton fabric

Oddy test result: Permanent

Date GC-MS collected: 6/13/2016

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) 4.2 min: methoxy-phenyl-oxime (2) ~10.8 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid (3) ~11.1 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.500	98.0	C2H6O	46.0	31685	64-17-5	Ethanol
1.500	83.0	C3H4O2	72.0	212422	78-98-8	Propanal, 2-oxo-
1.600	94.2	C2H3F	46.0	51209	75-02-5	Ethene, fluoro-
1.700	96.7	C4H6O	70.0	28578	1191-99-7	Furan, 2,3-dihydro-
1.800	98.3	C2H4O2	60.0	334468	64-19-7	Acetic acid
1.900	98.5	C4H8O	72.1	131782	109-99-9	Furan, tetrahydro-
2.100	85.1	C6H6	78.0	97251	71-43-2	Benzene
2.100	95.7	C3H6O2	74.0	69134	116-09-6	2-Propanone, 1-hydroxy-
2.200	83.5	C2H8O2Si	92.0	61357	1066-42-8	Silanediol, dimethyl-
2.200	88.8	C7H16	100.1	30043	142-82-5	Heptane
2.800	97.4	C7H8	92.1	1608960	108-88-3	Benzene, methyl-
3.000	87.9	C8H16	112.1	59906	1632-16-2	Heptane, 3-methylene-
3.100	84.5	C6H12O	100.1	109396	66-25-1	Hexanal
3.200	91.5	C6H18O3Si3	222.1	1887184	541-05-9	Cyclotrisiloxane, hexamethyl-
3.400	95.4	C5H4O2	96.0	234085	98-01-1	2-Furancarboxaldehyde
3.700	98.4	C5H6O2	98.0	311539	98-00-0	2-Furanmethanol
3.800	89.8	C8H10	106.1	129035	100-41-4	Benzene, ethyl-
3.900	97.7	C8H10	106.1	482535	1330-20-7	XYLENE
4.100	91.4	C5H4O2	96.0	70865	1000411-44-6	Cyclopent-4-ene-1,3-dione
4.200	85.0	C8H9NO2	151.1	356962	1000222-86-6	Oxime-, methoxy-phenyl-_
4.200	93.1	C8H10	106.1	156531	1330-20-7	XYLENE
4.300	96.4	C9H20	128.2	90378	111-84-2	Nonane
4.300	85.2	C7H14O	114.1	34991	111-71-7	Heptanal
4.300	91.3	C6H14O2	118.1	110530	111-76-2	Ethanol, 2-butoxy-
4.400	98.4	C4H4O2	84.0	221261	497-23-4	2(5H)-Furanone
5.200	81.4	C9H12	120.1	92674	0-00-0	unidentified C3-benzene
5.200	98.4	C7H6O	106.0	252713	100-52-7	Benzaldehyde
5.400	94.1	C8H24O4Si4	296.1	1309618	556-67-2	Cyclotetrasiloxane, octamethyl-

5.700	92.6	C9H12	120.1	158440	0-00-0	unidentified C3-benzene
5.700	80.7	C10H22	142.2	216734	124-18-5	Decane
5.800	95.5	C8H16O	128.1	84584	124-13-0	Octanal
6.000	88.1	C7H9N	107.1	144612	100-45-8	4-Cyanocyclohexene
6.100	96.6	C9H12	120.1	38706	25551-13-7	x - ethyl - x - methyl - benzene
6.100	92.0	C8H18O	130.1	511972	104-76-7	1-Hexanol, 2-ethyl-
6.200	98.2	C10H16	136.1	222356	138-86-3	dl-Limonene
6.200	97.1	C7H8O	108.1	201030	100-51-6	Benzenemethanol
6.600	86.1	C6H18O3Si3	222.1	289881	541-05-9	Cyclotrisiloxane, hexamethyl-
7.200	90.9	C11H24	156.2	138991	1120-21-4	Undecane
7.300	98.0	C9H18O	142.1	669380	124-19-6	Nonanal
7.900	82.4	C6H8O4	144.0	261291	28564-83-2	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-
8.200	83.2	C10H18O	154.1	175279	3913-81-3	2-Decenal, (E)-
8.200	82.5	C13H28	184.2	81504	17312-77-5	Undecane, 2,3-dimethyl-
8.400	93.4	C10H20O	156.2	81513	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
8.500	96.2	C8H18O3	162.1	413215	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
8.700	96.7	C12H26	170.2	413999	112-40-3	Dodecane
8.800	96.8	C10H20O	156.2	220240	112-31-2	Decanal
8.800	93.4	C8H24O4Si4	296.1	221265	556-67-2	Cyclotetrasiloxane, octamethyl-
9.000	95.3	C6H6O3	126.0	535426	67-47-0	5-Hydroxymethylfurfural
9.300	80.3	C17H36O	256.3	64320	1454-85-9	1-Heptadecanol
9.400	96.9	C12H24O2	200.2	2076598	7434-89-1	Hexanoic acid, 2-ethyl-, 2-methylpropyl ester
10.500	84.8	C12H16	160.1	398459	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
10.600	85.1	C12H16	160.1	846225	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
10.600	86.6	C12H16	160.1	1013103	1076-69-3	5,6,7,8,9,10-Hexahydrobenzocyclooctene
10.800	88.1	C12H24O3	216.2	249239	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
10.900	83.0	C21H44	296.3	82081	54833-23-7	Eicosane, 10-methyl-
11.000	91.2	C14H30	198.2	273064	6418-41-3	Tridecane, 3-methyl-
11.100	85.1	C12H24O3	216.2	570491	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
11.300	92.0	C16H32	224.3	34429	295-65-8	Cyclohexadecane
11.400	95.1	C14H30	198.2	611789	629-59-4	Tetradecane
11.500	93.3	C14H22	190.2	208009	0-00-0	C8 - alkyl - benzene (structure not known)
11.700	85.3	C15H24	204.2	106201	4630-07-3	4.beta.H,5.alpha.-Eremophila-1(10),11-diene
12.100	83.6	C14H28	196.2	193761	2882-98-6	Cyclopentane, nonyl-
12.400	89.1	C13H28O	200.2	100253	112-70-9	1-Tridecanol
13.300	88.4	C14H20	188.2	449241	30628-31-0	1,3,5-Trimethyl-2-cyclopentylbenzene
13.300	88.5	C14H20	188.2	281083	30628-31-0	1,3,5-Trimethyl-2-cyclopentylbenzene
13.500	85.8	C16H34	226.3	103318	2882-96-4	Pentadecane, 3-methyl-
13.700	82.7	C16H30O4	286.2	617891	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
13.800	89.0	C17H36	240.3	169494	1000360-41-3	5,5-Diethyltridecane
16.200	97.2	C16H22O4	278.2	167307	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester