

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

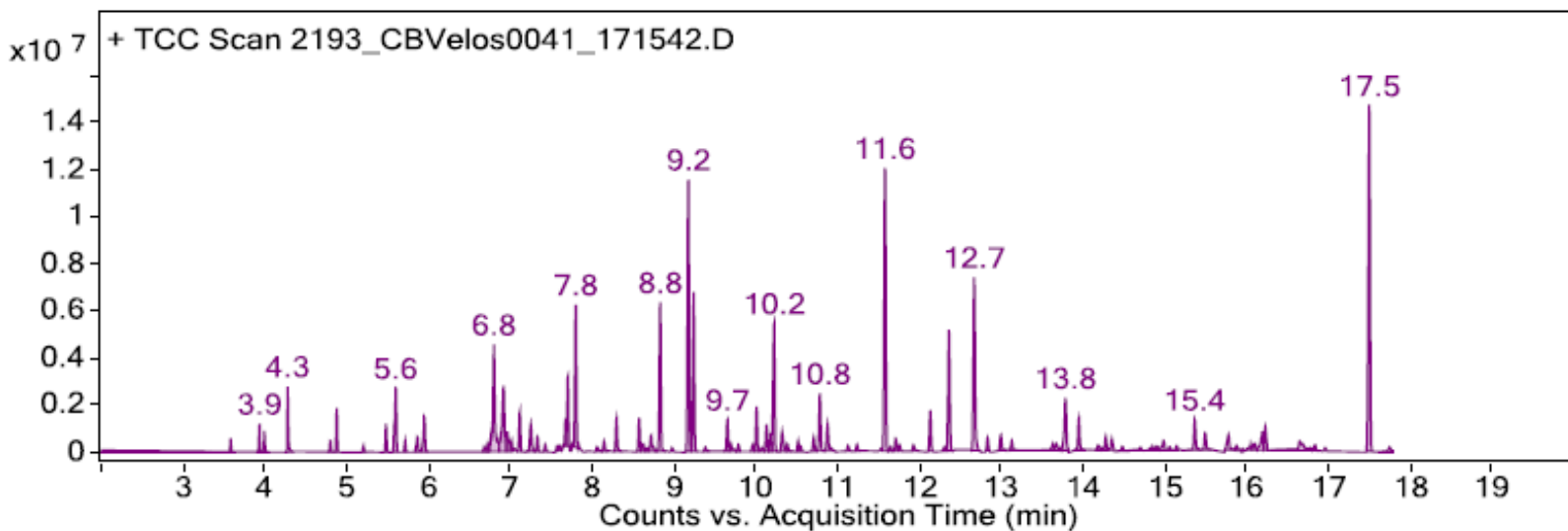
Sample: Creation Baumann Velos II 0041 gray velvet polyester fabric with flame retardant

Oddy test result: Temporary

Date collected: 06/26/2018

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) 5.7 min: methoxyphenyl oxime; (2) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxyl-, 2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.600	97.9	C2H4O2	60.0	468288	64-19-7	Acetic acid
3.900	95.0	C2H8O2Si	92.0	958493	1066-42-8	Silanediol, dimethyl-
4.000	96.2	C6H15N	101.1	623568	121-44-8	Triethylamine
4.300	94.5	C3H8O2	76.1	2344840	57-55-6	1,2-Propanediol
4.800	97.1	C6H12O	100.1	455033	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	1675130	541-05-9	Cyclotrisiloxane, hexamethyl-
5.200	93.8	C6H12O2	116.1	261580	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.500	96.7	C8H10	106.1	1171487	0-00-0	METHYLLAURATE
5.600	97.4	C8H10	106.1	3922116	106-42-3	Benzene, 1,4-dimethyl-
5.700	85.1	C8H9NO2	151.1	502365	1000222-86-6	Oxime-, methoxy-phenyl-
5.900	84.1	C8H8	104.1	322637	100-42-5	Styrene
5.900	89.8	C8H10	106.1	607578	95-47-6	Benzene, 1,2-dimethyl-
6.000	94.3	C6H14O2	118.1	1671973	111-76-2	Ethanol, 2-butoxy-
6.800	94.9	C7H6O	106.0	4504273	100-52-7	Benzaldehyde
6.900	81.9	C11H20O	168.2	414685	999104-64-4	3,4,7-Trimethyl-1,5-octadien-4-ol
6.900	81.2	C6H6O	94.0	4845273	108-95-2	Phenol
6.900	92.7	C8H24O4Si4	296.1	2708636	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	93.5	C7H5N	103.0	273188	100-47-0	Benzonitrile
7.100	97.3	C5H8O3	116.0	1826363	592-20-1	2-Propanone, 1-(acetyloxy)-
7.200	91.8	C9H12	120.1	963634	108-67-8	Mesitylene
7.300	93.2	C6H14O3	134.1	822010	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
7.300	96.5	C8H16O	128.1	739852	124-13-0	Octanal
7.400	97.9	C7H16O3	148.1	390464	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.600	96.1	C6H4Cl2	146.0	308835	541-73-1	Benzene, 1,3-dichloro-
7.600	95.5	C9H12	120.1	248714	526-73-8	Benzene, 1,2,3-trimethyl-

7.700	92.0	C8H18O	130.1	1585062	104-76-7	1-Hexanol, 2-ethyl-
7.700	96.7	C6H10O4	146.1	2714171	106-65-0	Butanedioic acid, dimethyl ester
7.800	86.0	C10H16	136.1	375506	138-86-3	dl-Limonene
7.800	95.6	C7H8O	108.1	7495863	100-51-6	Benzyl Alcohol
7.800	83.7	C5H9NO	99.1	370224	872-50-4	2-Pyrrolidinone, 1-methyl-
8.600	83.6	C6H5NO2	123.0	274228	98-95-3	Benzene, nitro-
8.700	96.5	C8H8O2	136.1	731692	93-58-3	Benzoic acid, methyl ester
8.800	84.5	C11H24	156.2	302223	1120-21-4	Undecane
8.800	97.2	C9H18O	142.1	8129340	124-19-6	Nonanal
9.000	91.3	C8H10O	122.1	248134	60-12-8	Benzeneethanol
9.200	95.6	C10H30O5Si5	370.1	15564165	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	97.0	C7H12O4	160.1	8456829	1119-40-0	Pentanedioic acid, dimethyl ester
9.700	96.0	C9H16O	140.1	1742091	18829-56-6	2-Nonenal, (E)-
9.700	83.9	C9H10O2	150.1	230101	140-11-4	Acetic acid, phenylmethyl ester
9.800	83.4	C9H20O	144.2	402208	143-08-8	1-Nonanol
10.000	95.9	C10H20O	156.2	389160	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	96.3	C8H18O3	162.1	1676137	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	96.1	C10H8	128.1	1422803	275-51-4	Azulene
10.200	96.9	C8H8O3	152.0	964585	119-36-8	Methyl salicylate
10.200	85.9	C5H8N2O2	128.1	7975505	696-11-7	Hydrouracil, 1-methyl-
10.300	94.8	C10H20O	156.2	1025059	112-31-2	Decanal
10.300	94.6	C5H6N2O3	142.0	354448	5176-82-9	1,3-Dimethyl-2,4,5-trioximidazolidine
10.500	92.9	C8H10O2	138.1	617645	122-99-6	Ethanol, 2-phenoxy-
10.700	91.8	C7H5NS	135.0	865881	95-16-9	Benzothiazole
10.800	97.8	C8H14O4	174.1	2554448	627-93-0	Hexanedioic acid, dimethyl ester
10.900	94.4	C9H7N	129.1	1588257	119-65-3	Isoquinoline
11.100	85.1	C10H18O	154.1	332343	2497-25-8	2-Decenal, (Z)-
11.200	96.2	C10H22O	158.2	396229	112-30-1	1-Decanol
11.600	96.0	C12H36O6Si6	444.1	17397548	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	86.5	C9H19NO	157.1	329401	761-65-9	Formamide, N,N-dibutyl-
11.700	97.0	C11H10	142.1	593858	91-57-6	Naphthalene, 2-methyl-
11.800	94.7	C11H22O	170.2	289352	112-44-7	Undecanal
12.100	93.3	C7H12O5	176.1	2371812	25395-31-7	1,2,3-Propanetriol, diacetate
12.400	90.1	C12H24O3	216.2	7184755	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	94.3	C12H24O3	216.2	10451973	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.800	96.8	C12H10	154.1	879622	92-52-4	1,1'-Biphenyl
13.000	95.2	C14H30	198.2	1043323	629-59-4	Tetradecane
13.100	97.5	C12H24O	184.2	582032	112-54-9	Dodecanal
13.700	80.3	C14H28	196.2	243398	2882-98-6	Cyclopentane, nonyl-
13.800	80.2	C14H42O7Si7	518.1	3128515	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.900	96.9	C12H26O	186.2	1882689	112-53-8	1-Dodecanol
14.200	84.7	C12H24	168.2	405953	294-62-2	Cyclododecane
14.300	92.7	C15H32	212.3	832707	629-62-9	pentadecane
14.400	89.9	C14H22O	206.2	508550	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
14.900	87.0	C20H42O3S	362.3	309896	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
15.000	86.3	C15H30	210.2	289575	2883-02-5	n-Nonylcyclohexane
15.100	85.5	C15H32	212.3	237241	18435-22-8	Tetradecane, 3-methyl-
15.100	86.6	C16H34	226.3	285737	2882-96-4	Pentadecane, 3-methyl-
15.500	91.1	C16H34	226.3	1095616	544-76-3	Hexadecane
15.800	89.5	C16H48O8Si8	592.2	358032	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	92.0	C15H30O2	242.2	824259	10233-13-3	Dodecanoic acid, 1-methylethyl ester
15.900	93.8	C13H10O	182.1	213815	119-61-9	Methanone, diphenyl-
16.000	89.9	C16H34	226.3	386500	55045-11-9	Tridecane, 5-propyl-
16.200	89.2	C16H32	224.3	449932	6785-23-5	Cyclopentane, undecyl-
16.200	93.1	C16H34O	242.3	758766	629-82-3	Octane, 1,1'-oxybis-
16.800	84.3	C12H26	170.2	358219	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
17.500	98.0	C14H12O2	212.1	21137672	120-51-4	Benzyl benzoate