

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

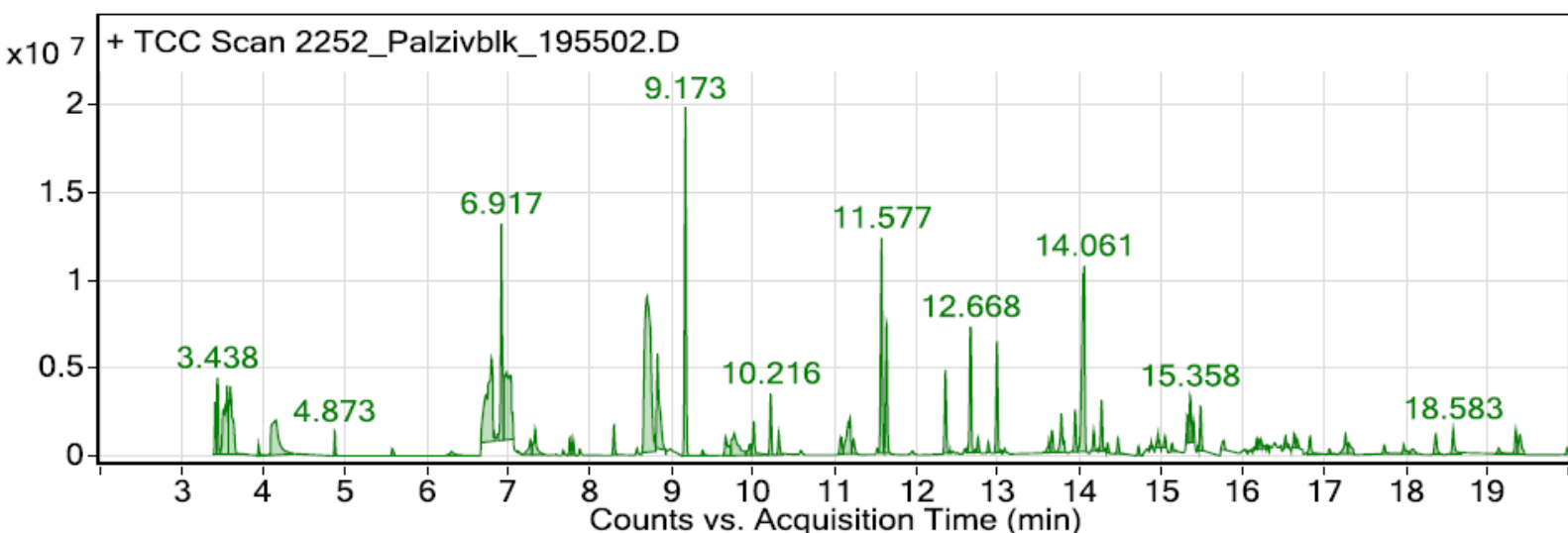
Sample: Palziv 2 lb. vision standard black foam

Oddy test result: Temporary

Date collected: 07/23/2018

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) 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
3.407	92.8	CHNO	43.0	2126107	75-13-8	Hydrogen isocyanate
3.437	92.8	CHNO	43.0	6377304	75-13-8	Hydrogen isocyanate
3.556	93.8	C3H8O2	76.1	3220178	109-87-5	Methane, dimethoxy-
3.596	87.9	C3H4O4	104.0	5164320	141-82-2	Propanedioic acid
3.942	93.4	C2H8O2Si	92.0	815984	1066-42-8	Silanediol, dimethyl-
4.152	90.5	C2H4O	44.0	12976915	75-07-0	Acetaldehyde
4.876	93.3	C6H18O3Si3	222.1	1338738	541-05-9	Cyclotrisiloxane, hexamethyl-
5.580	97.4	C8H10	106.1	631079	106-42-3	Benzene, 1,4-dimethyl-
6.727	89.2	C2H3N3	69.0	14530018	288-88-0	1H-1,2,4-Triazole
6.797	97.1	C7H6O	106.0	1722241	100-52-7	Benzaldehyde
6.916	96.0	C8H24O4Si4	296.1	9269441	556-67-2	Cyclotetrasiloxane, octamethyl-
6.926	90.5	C6H6O	94.0	542462	108-95-2	Phenol
7.055	95.6	C9H10	118.1	2190612	98-83-9	.alpha.-Methylstyrene
7.332	93.1	C8H16O	128.1	1050306	124-13-0	Octanal

7.757	97.0	C10H16	136.1	1290795	138-86-3	dl-Limonene
7.797	95.3	C7H8O	108.1	621165	100-51-6	Benzyl Alcohol
7.878	95.9	C5H9NO	99.1	492636	872-50-4	2-Pyrrolidinone, 1-methyl-
8.297	93.8	C8H8O	120.1	2327875	98-86-2	Ethanone, 1-phenyl-
8.701	87.0	C9H11NO2	165.1	45287305	565-07-1	2-Aminohydratropic acid
8.747	92.7	C11H24	156.2	2299925	1120-21-4	Undecane
8.829	95.7	C9H18O	142.1	6488153	124-19-6	Nonanal
8.849	81.3	C16H23NO	245.2	8219782	999306-00-6	4,4-Dimethyl-3-[(N-methyl-N-phenylamino)methyl]cyclohexanone
9.173	95.4	C10H30O5Si5	370.1	26322445	541-02-6	Cyclopentasiloxane, decamethyl-
9.666	92.4	C18H22	238.2	1694573	1889-67-4	Benzene, 1,1'-(1,1,2,2-tetramethyl-1,2-ethanediyl)bis-
9.960	94.3	C10H20O	156.2	510349	89-78-1	Menthol
10.218	96.1	C12H26	170.2	4621232	112-40-3	Dodecane
10.318	96.3	C10H20O	156.2	1652248	112-31-2	Decanal
10.589	81.8	C11H20O2	184.1	541776	103-11-7	2-Ethylhexyl acrylate
11.074	91.6	C6H11NO	113.1	1660132	105-60-2	Caprolactam
11.191	95.3	C9H18O2	158.1	5999204	112-05-0	Nonanoic acid
11.235	92.3	C10H22O	158.2	740379	106-21-8	1-Octanol, 3,7-dimethyl-
11.527	82.0	C12H22O	182.2	581880	4826-62-4	2-Dodecenal
11.576	96.0	C12H36O6Si6	444.1	17381684	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.638	95.1	C13H28	184.2	10755552	629-50-5	Tridecane
11.955	85.5	C13H28	184.2	524146	17301-28-9	Undecane, 3,6-dimethyl-
12.360	90.3	C12H24O3	216.2	6916855	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.668	94.2	C12H24O3	216.2	10496125	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.759	95.9	C13H20O2	208.1	1335297	5888-33-5	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-
12.886	96.4	C14H28	196.2	851636	1120-36-1	1-Tetradecene
12.991	95.1	C14H30	198.2	8914007	629-59-4	Tetradecane
13.086	86.5	C14H26O2	226.2	572395	126-86-3	2,4,7,9-Tetramethyl-5-decyn-4,7-diol
13.668	86.3	C14H28	196.2	962446	2882-98-6	Cyclopentane, nonyl-
13.814	87.7	C15H32	212.3	472107	25117-24-2	Tetradecane, 4-methyl-
13.950	96.6	C12H26O	186.2	3504358	112-53-8	1-Dodecanol
14.178	95.4	C15H30	210.2	1783771	13360-61-7	1-Pentadecene
14.274	94.4	C15H32	212.3	4205486	629-62-9	pentadecane
14.475	86.6	C16H34	226.3	1213711	59222-86-5	Tetradecane, 2,2-dimethyl-
14.726	87.8	C16H48O6Si7	532.2	781135	541-01-5	Heptasiloxane, hexadecamethyl-
14.895	83.9	C20H42O3S	362.3	661453	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
14.980	89.0	C15H30	210.2	868906	2883-02-5	n-Nonylcyclohexane
15.051	90.6	C16H34	226.3	719053	1560-93-6	Pentadecane, 2-methyl-
15.138	90.6	C16H34	226.3	799311	2882-96-4	Pentadecane, 3-methyl-
15.324	83.1	C14H30O	214.2	2710085	0-00-0	a tetradecanol ?
15.401	91.3	C16H32	224.3	911353	629-73-2	Cetene
15.488	91.7	C16H34	226.3	3867950	544-76-3	Hexadecane
15.752	90.1	C16H48O8Si8	592.2	587034	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.772	84.6	C15H30O2	242.2	847353	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.029	85.6	C16H34	226.3	597803	55045-11-9	Tridecane, 5-propyl-
16.104	81.1	C17H36	240.3	491675	1000360-41-2	3,3-Diethyltridecane
16.177	90.9	C16H32	224.3	1229317	6785-23-5	Cyclopentane, undecyl-
16.221	89.9	C18H38O	270.3	1209792	1000406-38-3	Decyl octyl ether
16.302	86.7	C15H22O2	234.2	624918	999275-15-3	1-(4-ISOPROPYLPHENYL)-2-METHYLPROPYL ACETATE
16.642	89.4	C13H28	184.2	1788724	31081-18-2	Nonane, 3-methyl-5-propyl-
16.828	87.2	C12H26	170.2	1431205	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
17.263	95.2	C14H28O2	228.2	1800988	544-63-8	Tetradecanoic acid
17.739	85.5	C20H42	282.3	791359	1560-86-7	Nonadecane, 2-methyl-
17.976	89.1	C17H34O2	270.3	487240	110-27-0	Isopropyl myristate
18.370	81.9	C13H16O2	204.1	2535199	54932-88-6	Benzenepropanoic acid, .alpha.,.alpha.-dimethyl-, ethenyl ester
18.583	97.2	C16H34O	242.3	2390620	36653-82-4	1-Hexadecanol
19.141	87.5	C16H30O2	254.2	663428	2416-19-5	cis-7-Hexadecenoic acid
19.351	89.7	C16H32O2	256.2	2195987	57-10-3	n-Hexadecanoic acid
19.402	82.2	C13H16O2	204.1	1904658	54932-88-6	Benzenepropanoic acid, .alpha.,.alpha.-dimethyl-, ethenyl ester
19.984	90.7	C19H38O2	298.3	593308	142-91-6	Isopropyl palmitate
21.342	81.0	C13H16O2	204.1	697337	54932-88-6	Benzenepropanoic acid, .alpha.,.alpha.-dimethyl-, ethenyl ester