

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

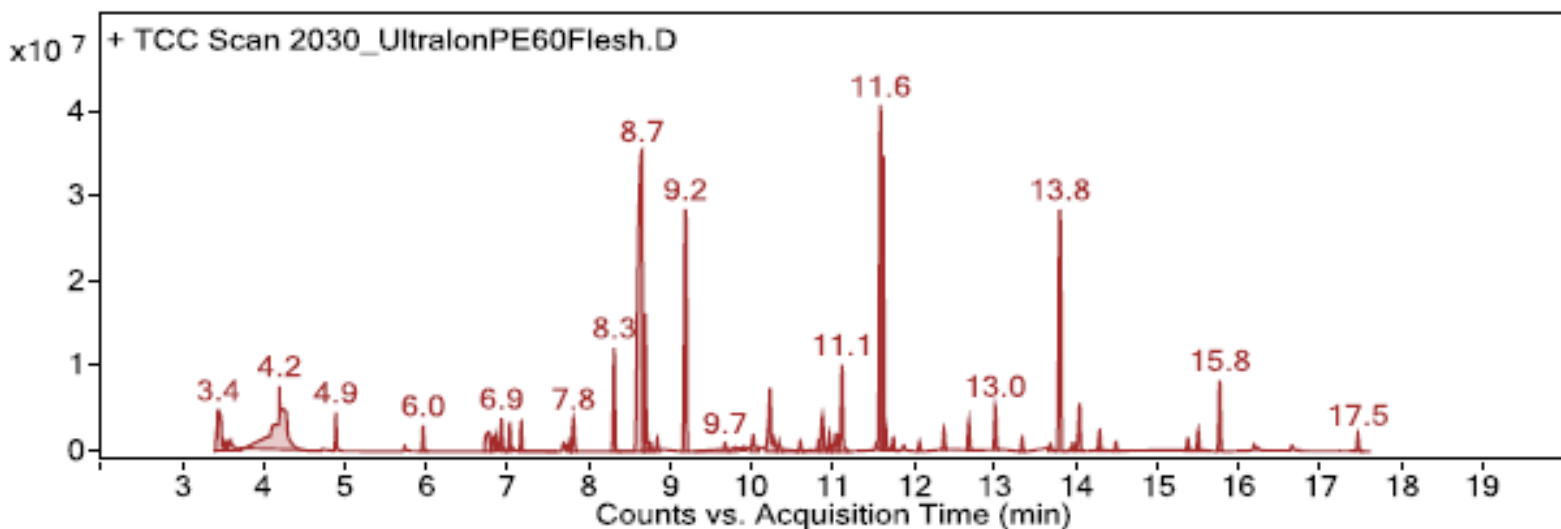
Sample: Ultralon PE60 foamed polyethylene, flesh

Oddy test result: Unsuitable

Date GC-MS collected: 03/20/2018

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) methoxy-phenyl 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
3.400	85.4	CHNO	43.0	16625603	75-13-8	ISOCYANIC ACID
3.500	92.9	CH2O2	46.0	4753612	64-18-6	Formic acid
3.600	93.3	C2H4O2	60.0	1433858	64-19-7	Acetic acid
4.200	89.0	C2H4O	44.0	37934978	75-07-0	Acetaldehyde
4.900	92.5	C6H18O3Si3	222.1	4318628	541-05-9	Cyclotrisiloxane, hexamethyl-
5.700	81.5	C8H9NO2	151.1	1114490	1000222-86-6	Oxime-, methoxy-phenyl-
6.000	96.0	C6H14O2	118.1	3397314	111-76-2	Ethanol, 2-butoxy-
6.800	97.4	C2H3N3	69.0	9775750	288-88-0	1H-1,2,4-Triazole
6.800	97.4	C4H10O3	106.1	2592710	111-46-6	Ethanol, 2,2'-oxybis-
6.900	81.2	C8H16O	128.1	1381446	15045-43-9	Furan, tetrahydro-2,2,5,5-tetramethyl-
6.900	90.6	C8H24O4Si4	296.1	5243696	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	95.3	C7H14O3	146.1	4058238	763-69-9	Propanoic acid, 3-ethoxy-, ethyl ester
7.200	94.5	C12H26	170.2	4245562	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.700	94.5	C8H18O	130.1	957621	104-76-7	1-Hexanol, 2-ethyl-
7.700	92.5	C12H26	170.2	1089952	62183-79-3	2,2,4,4-Tetramethyloctane
7.800	95.6	C10H16	136.1	1634608	138-86-3	dl-Limonene
7.800	95.9	C7H8O	108.1	3946284	100-51-6	Benzyl Alcohol
8.300	99.5	C8H8O	120.1	15918020	98-86-2	Ethanone, 1-phenyl-
8.700	88.2	C9H11NO2	165.1	14551834	565-07-1	2-Aminohydratropic acid

8.800	92.8	C11H24	156.2	994417	1120-21-4	Undecane
8.800	92.1	C9H18O	142.1	1647353	124-19-6	Nonanal
9.700	81.9	C12H24O2	200.2	1400061	20780-49-8	3,7-Dimethyloctyl acetate
10.200	91.5	C12H26	170.2	12036860	112-40-3	Dodecane
10.400	89.6	C10H20O2	172.1	928441	112-14-1	Acetic acid, octyl ester
10.600	86.3	C11H20O2	184.1	1519580	42928-87-0	4-(Prop-2-enoyloxy)octane
11.000	84.3	C11H20O2	184.1	2725813	2499-59-4	2-Propenoic acid, octyl ester
11.000	83.9	C6H11NO	113.1	3185495	105-60-2	2H-Azepin-2-one, hexahydro-
11.100	84.3	C8H18O	130.1	2192435	57803-73-3	(5)-(+)-5-Methyl-1-heptanol
11.500	88.1	C13H24O2	212.2	1256689	1330-61-6	2-PROPENOIC ACID, ISODECYL ESTER
11.600	95.8	C12H36O6Si6	444.1	88107210	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	94.8	C13H28	184.2	4613262	629-50-5	Tridecane
11.800	82.8	C9H12O	136.1	1720203	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
11.900	83.9	C12H26	170.2	941222	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
12.100	98.4	C7H7NO	121.1	1563075	55-21-0	Benzamide
12.400	90.0	C12H24O3	216.2	3511005	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	93.1	C12H24O3	216.2	5194372	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.000	95.5	C14H30	198.2	7833003	629-59-4	Tetradecane
13.700	94.0	C14H28	196.2	1169175	2882-98-6	Cyclopentane, nonyl-
13.800	82.6	C14H42O7Si7	518.1	54933295	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.000	89.9	C12H26O	186.2	1121684	112-53-8	1-Dodecanol
14.300	94.4	C15H32	212.3	3401584	629-62-9	pentadecane
14.500	88.6	C16H34	226.3	1365115	59222-86-5	Tetradecane, 2,2-dimethyl-
15.500	91.1	C16H34	226.3	3424228	544-76-3	Hexadecane
15.800	88.6	C16H48O8Si8	592.2	12437228	556-68-3	Cyclooctasiloxane, hexadecamethyl-
16.200	92.4	C16H32	224.3	993549	295-65-8	Cyclohexadecane
16.700	89.5	C17H36	240.3	1103972	629-78-7	Heptadecane
17.500	85.0	C18H54O9Si9	666.2	2825342	556-71-8	Cyclononasiloxane, octadecamethyl-