

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

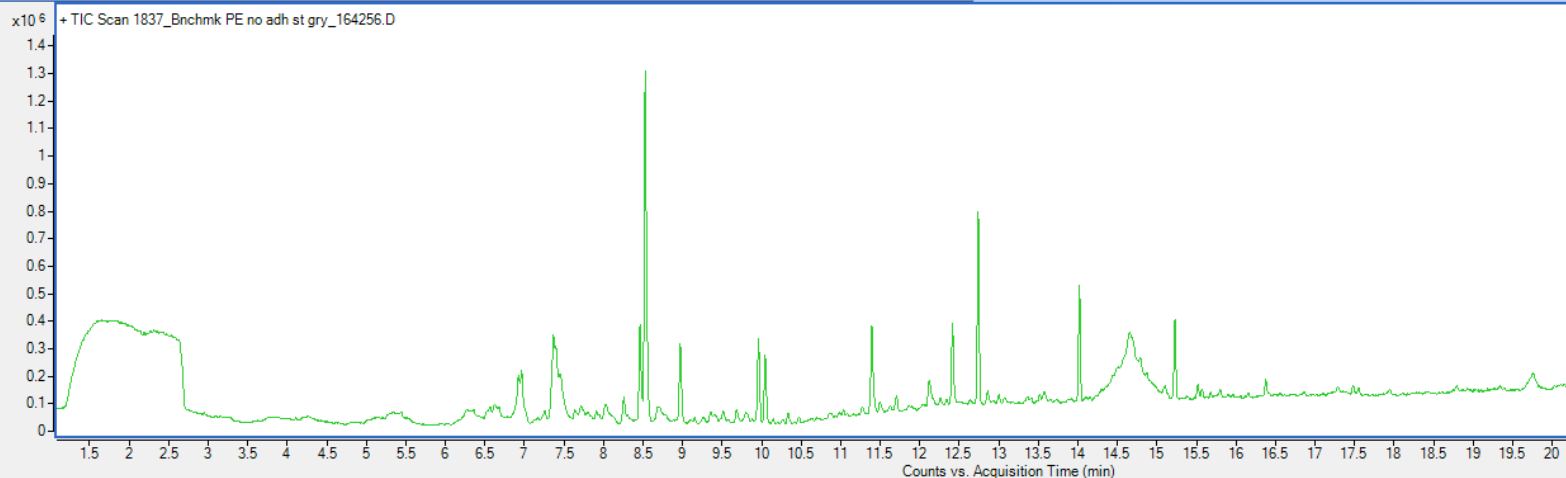
Sample: Benchmark 35-111 sueded polyethylene fabric; steel gray; no adhesive backing

Oddy test result: temporary

Date collected: 12/04/2017

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) 12.1 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 12.2, 12.4 min: 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.945	84.0	C4H10O	74.1	60933	71-36-3	1-Butanol
4.499	80.2	C5H4O2	96.0	107538	98-01-1	2-Furancarboxaldehyde
5.208	89.8	C7H14O	114.1	39846	106-35-4	3-Heptanone
5.550	82.6	C6H8N2	108.1	43353	123-32-0	Pyrazine, 2,5-dimethyl-
6.357	98.5	C7H6O	106.0	323518	100-52-7	Benzaldehyde
6.618	90.3	C8H24O4Si4	296.1	88430	556-67-2	Cyclotetrasiloxane, octamethyl-
6.679	82.8	C8H14O	126.1	223591	110-93-0	5-Hepten-2-one, 6-methyl-
6.845	93.4	C9H12	120.1	107284	25551-13-7	x - ethyl - x - methyl - benzene
6.922	86.6	C10H22	142.2	313463	124-18-5	Decane
6.963	96.2	C8H16O	128.1	645937	124-13-0	Octanal
7.363	97.1	C8H18O	130.1	1265913	104-76-7	1-Hexanol, 2-ethyl-
7.400	90.6	C10H16	136.1	389360	138-86-3	dl-Limonene
7.459	93.0	C7H8O	108.1	430761	100-51-6	Benzyl Alcohol
7.640	95.6	C5H9NO	99.1	155404	872-50-4	2-Pyrrolidinone, 1-methyl-
7.908	89.9	C15H32	212.3	66774	31295-56-4	Dodecane, 2,6,11-trimethyl-
7.949	90.2	C18H22O2	270.2	62790	999377-39-7	DICUMYL PEROXIDE
8.120	82.7	C10H19ClO	190.1	28895	999153-61-7	2-t-Butyl-2-chloro-3,3-dimethylbutanal
8.260	88.4	C9H12O	136.1	179644	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.459	97.1	C11H24	156.2	652455	1120-21-4	Undecane
8.526	98.5	C9H18O	142.1	2496927	124-19-6	Nonanal
8.689	88.1	C8H10O	122.1	170394	60-12-8	Benzeneethanol
8.969	91.9	C10H30O5Si5	370.1	472749	541-02-6	Cyclopentasiloxane, decamethyl-
9.514	80.1	C10H23NO	173.2	102558	29812-71-1	Hydroxylamine, O-decyl-
9.683	93.9	C10H20O	156.2	116030	999080-23-2	isoneomenthol
9.803	86.1	C10H8	128.1	64799	91-20-3	Naphthalene
9.958	96.1	C12H26	170.2	550186	112-40-3	Dodecane
10.045	97.6	C10H20O	156.2	461552	112-31-2	Decanal
10.337	96.0	C11H20O2	184.1	54716	103-11-7	2-Propenoic acid, 2-ethylhexyl ester
10.870	87.4	C12H26S	202.2	38755	999185-34-2	dihexylsulfide
10.986	86.9	C13H28O	200.2	32109	999181-22-9	2-Propyldecan-1-ol

11.036	96.8	C12H26S	202.2	35157	999185-34-2	dihexylsulfide
11.391	87.8	C13H28	184.2	525025	629-50-5	Tridecane
11.400	86.5	C12H36O6Si6	444.1	103720	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.495	89.5	C11H22O	170.2	65392	112-44-7	Undecanal
11.707	94.6	C16H34	226.3	100979	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.121	90.6	C12H24O3	216.2	312721	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.259	90.3	C21H44	296.3	51259	54833-48-6	Heptadecane, 2,6,10,15-tetramethyl-
12.411	93.9	C12H24O3	216.2	566570	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.635	94.9	C16H32	224.3	32044	35507-09-6	7-Hexadecene, (Z)-
12.740	95.6	C14H30	198.2	1086094	629-59-4	Tetradecane
12.862	90.0	C14H28O	212.2	77579	124-25-4	Tetradecanal
13.000	88.5	C15H24	204.2	40848	475-20-7	Junipene
14.017	95.7	C15H32	212.3	645848	629-62-9	pentadecane
14.420	84.6	C14H14N2O	226.1	30072	999253-23-2	2-[3'-(Benzyloxy)-1'-propen-1'-yl]-1,3-pyrimidine
14.661	85.9	C20H27N	281.2	2830448	1000370-31-3	Tert-octyldiphenylamine
14.793	83.3	C16H33Cl	260.2	78359	4860-03-1	Hexadecane, 1-chloro-
14.878	97.7	C22H46	310.4	41791	629-97-0	Docosane
15.083	91.6	C12H14O4	222.1	61095	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
15.106	88.9	C16H30O4	286.2	60980	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
15.228	94.9	C16H34	226.3	451642	544-76-3	Hexadecane
15.516	90.2	C17H26O2	262.2	50930	14035-34-8	2,6-Bis(1,1-dimethylethyl)-4-(1-oxopropyl)phenol
15.568	81.9	C16H48O8Si8	592.2	52215	556-68-3	Cyclooctasiloxane, hexadecamethyl-
16.379	96.2	C35H72	492.6	112667	630-07-9	Pentatriacontane
17.480	91.4	C16H34	226.3	42686	544-76-3	Hexadecane
17.551	87.7	C14H14O2	214.1	38836	104-66-5	Benzene, 1,1'-[1,2-ethanediylbis(oxy)]bis-
17.941	84.3	C8H10N4O2	194.1	39065	58-08-2	Caffeine
18.789	86.3	C12H10O2S	218.0	41310	127-63-9	Benzene, 1,1'-sulfonylbis-
19.751	90.9	C22H42O4	370.3	285623	103-23-1	Di(2-ethylhexyl)adipate