

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

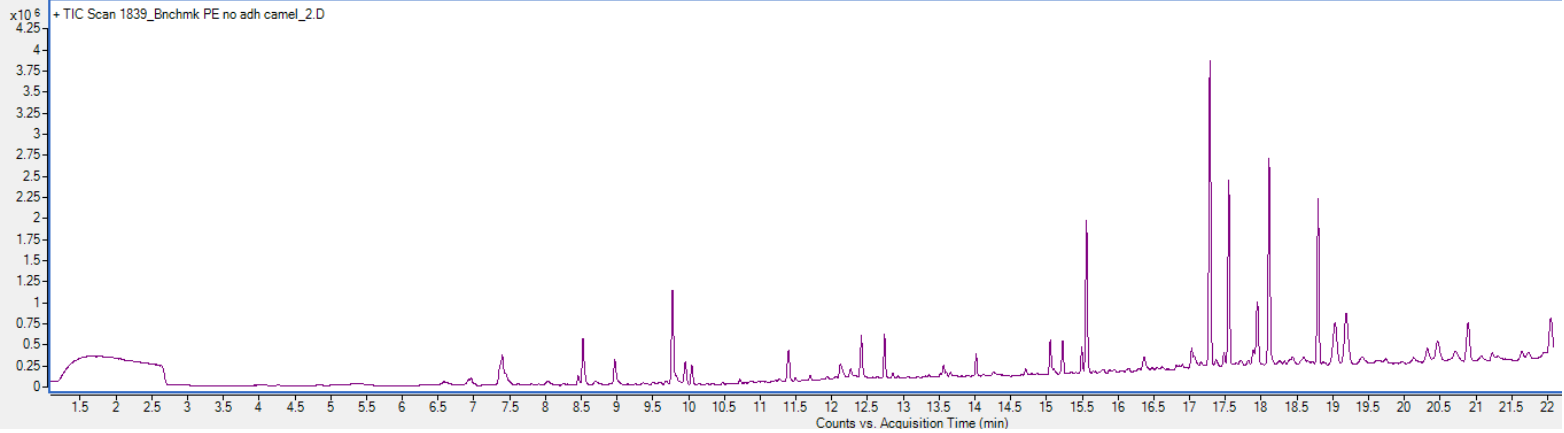
Sample: Benchmark 35-111 sueded polyethylene fabric; camel hair; no adhesive backing

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
6.352	82.1	C9H8O2	148.1	101675	999062-75-1	1-Phenyl-1,2-propandione
6.920	93.4	C12H26	170.2	108165	7045-71-8	Undecane, 2-methyl-
6.960	95.2	C8H16O	128.1	311118	124-13-0	Octanal
7.365	85.4	C8H18O	130.1	369865	104-76-7	1-HEXANOL, 2-ETHYL-
7.396	97.9	C10H16	136.1	1128704	138-86-3	dl-Limonene
7.455	90.0	C7H8O	108.1	195211	100-51-6	Benzenemethanol
8.456	93.9	C11H24	156.2	198585	1120-21-4	Undecane
8.523	98.1	C9H18O	142.1	1123416	124-19-6	Nonanal
8.687	83.4	C8H10O	122.1	146404	60-12-8	Benzeneethanol
8.967	91.1	C10H30O5Si5	370.1	510838	541-02-6	Cyclopentasiloxane, decamethyl-
9.683	85.6	C10H20O	156.2	93778	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
9.777	95.1	C7H11NS	141.1	2359025	1122-82-3	Cyclohexane, isothiocyanato-
9.944	83.8	C7H11NS	141.1	204797	1122-82-3	Cyclohexane, isothiocyanato-
9.956	93.9	C12H26	170.2	399484	112-40-3	Dodecane
10.043	97.9	C10H20O	156.2	437589	112-31-2	Decanal
11.388	93.9	C13H28	184.2	325959	629-50-5	Tridecane
11.401	89.8	C12H36O6Si6	444.1	336655	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.934	87.4	C16H30O4	286.2	85106	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
12.121	91.1	C12H24O3	216.2	557847	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.263	91.6	C12H24O3	216.2	372775	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.411	93.2	C12H24O3	216.2	969553	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.738	95.7	C14H30	198.2	824434	629-59-4	Tetradecane
14.016	94.9	C15H32	212.3	402738	629-62-9	pentadecane
14.712	91.3	C15H29NO3	271.2	118060	97-78-9	Glycine, N-methyl-N-(1-oxododecyl)-
15.052	96.0	C12H14O4	222.1	637596	84-61-2	1,2-Benzenedicarboxylic acid, diethyl ester
15.105	87.7	C16H30O4	286.2	149119	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
15.227	96.2	C20H42	282.3	676291	112-95-8	Eicosane
15.490	94.6	C18H13N5O6	395.1	444368	1707-75-1	Hydrazine, 1,1-diphenyl-2-(2,4,6-trinitrophenyl)-
15.557	90.8	C16H48O8Si8	592.2	2844723	556-68-3	Cyclooctasiloxane, hexadecamethyl-

17.284	82.8	C18H54O9Si9	666.2	5845071	556-71-8	OCTADECAMETHYLCYCLONONASILOXANE
17.371	83.5	C14H10	178.1	90479	4425-82-5	9H-Fluorene, 9-methylene-
17.477	93.0	C20H42	282.3	335722	112-95-8	Eicosane
17.546	97.7	C14H14O2	214.1	3494519	104-66-5	Benzene, 1,1'-[1,2-ethanediylbis(oxy)]bis-
17.719	82.7	C17H34O2	270.3	97347	110-27-0	Isopropyl myristate
17.889	80.1	C14H20O2	220.1	299905	7155-12-6	Benzoic acid, heptyl ester
17.946	97.0	C8H10N4O2	194.1	1353326	58-08-2	Caffeine
18.109	93.2	C16H22O4	278.2	3910004	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
18.796	90.3	C12H10O2S	218.0	3195351	127-63-9	Diphenyl sulfone
19.027	80.1	C20H60O10Si10	740.2	1656172	18772-36-6	EICOSAMETHYLCYCLODECASILOXANE
19.183	88.4	C18H24O4	304.2	1335674	84-64-0	1,2-Benzenedicarboxylic acid, butyl cyclohexyl ester
19.191	84.0	C16H19N	225.2	859143	999250-44-3	butyl-diphenylamine
19.416	84.8	C16H32O2	256.2	348132	57-10-3	Hexadecanoic acid
19.742	92.0	C35H72	492.6	168786	630-07-9	Pentatriacontane
20.324	95.8	C16H10	202.1	485855	129-00-0	Pyrene
20.464	83.5	C24H72O12Si12	888.2	609888	18919-94-3	TETRACOSAMETHYLCYCLODODECASILOXANE
20.720	85.6	C18H38O	270.3	405043	1000406-38-3	Decyl octyl ether
20.893	96.5	C16H10	202.1	1292326	129-00-0	Pyrene
21.072	80.5	C18H38O	270.3	178920	1000406-38-3	Decyl octyl ether
21.224	80.7	C11H14O	162.1	219665	938-16-9	1-Propanone, 2,2-dimethyl-1-phenyl-
21.640	90.5	C23H48	324.4	302287	638-67-5	Tricosane