

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

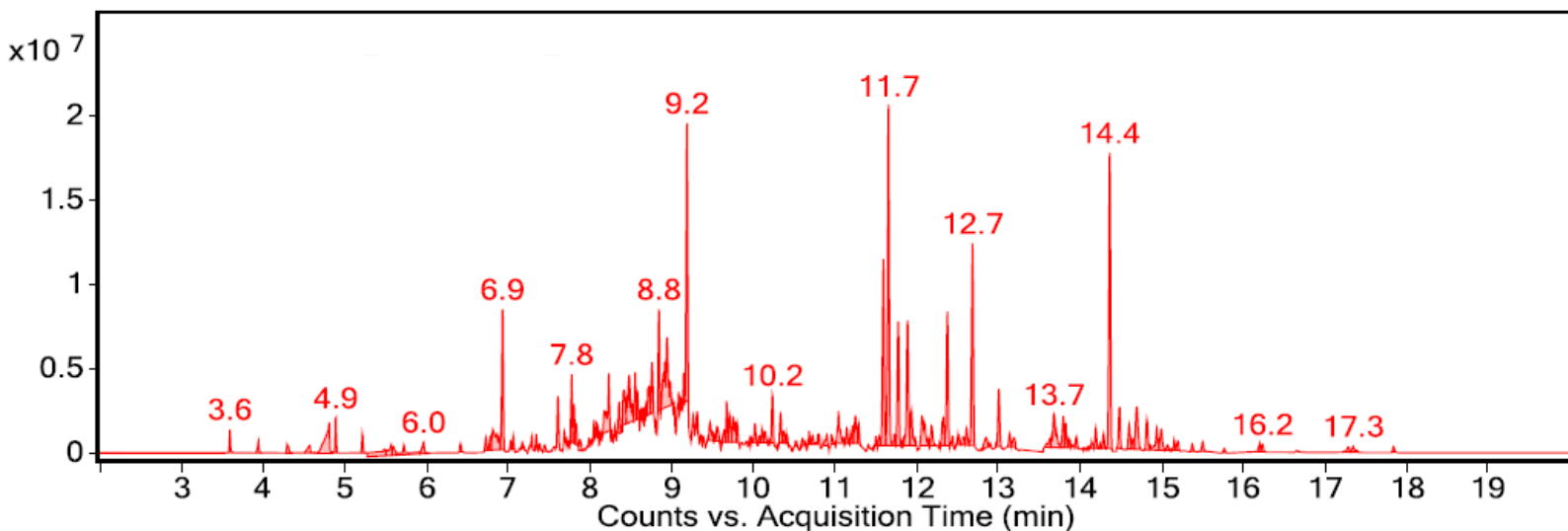
Sample: Pregis polypropylene 0.5" multilayer sheet foam

Oddy test result: Temporary

Date collected: 06/29/2018

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	98.0	C2H4O2	60.0	1194643	64-19-7	Acetic acid
4.300	84.8	C2H7N	45.1	413162	124-40-3	Methanamine, N-methyl-
4.300	89.1	C4H8O2	88.1	410299	999006-02-9	2-Methylpropanoic acid
4.600	92.1	C4H8O2	88.1	1083580	107-92-6	Butanoic acid
4.800	88.5	C5H10O2	102.1	6367299	75-98-9	Propanoic acid, 2,2-dimethyl-
4.900	92.5	C6H18O3Si3	222.1	1976638	541-05-9	Cyclotrisiloxane, hexamethyl-
5.200	94.1	C6H12O2	116.1	1107675	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.600	91.6	C6H12O2	116.1	952696	142-62-1	Hexanoic acid
5.600	83.8	C8H10	106.1	409979	106-42-3	Benzene, 1,4-dimethyl-
5.700	82.0	C8H9NO2	151.1	530151	1000222-86-6	Oxime-, methoxy-phenyl-
5.900	81.9	C7H14O	114.1	353565	111-71-7	Heptanal
6.000	90.8	C6H14O2	118.1	684670	111-76-2	Ethanol, 2-butoxy-
6.700	92.1	C11H24	156.2	922953	62016-28-8	Octane, 2,2,6-trimethyl-
6.800	90.3	C7H6O	106.0	381700	100-52-7	Benzaldehyde
6.900	80.6	C6H12O2	116.1	1840448	142-62-1	Hexanoic acid
6.900	96.0	C8H24O4Si4	296.1	9575582	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	92.6	C8H14O	126.1	715487	110-93-0	6-Methyl-5-hepten-2-one
7.300	93.7	C9H12	120.1	304464	0-00-0	unidentified C3-benzene
7.300	93.3	C10H22	142.2	924578	124-18-5	Decane
7.300	96.5	C8H16O	128.1	978232	124-13-0	Octanal
7.400	90.3	C10H22	142.2	442995	17302-01-1	3-Ethyl-3-methylheptane
7.600	92.0	C12H26	170.2	1991531	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.700	91.1	C8H18O	130.1	1792486	104-76-7	1-Hexanol, 2-ethyl-
7.700	90.7	C12H26	170.2	994923	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.800	97.6	C10H16	136.1	4154429	138-86-3	dl-Limonene
7.800	80.5	C12H26O3S	250.2	991132	999318-58-8	Sulfurous acid, butyl octyl ester
8.000	91.6	C15H32	212.3	2141999	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.100	92.2	C15H32	212.3	2991973	31295-56-4	Dodecane, 2,6,11-trimethyl-

8.200	89.7	C15H32	212.3	2474435	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.200	91.9	C15H32	212.3	4390752	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.400	91.2	C20H42	282.3	4814635	112-95-8	Eicosane
8.400	88.9	C11H24O	172.2	5670897	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
8.500	89.0	C12H26	170.2	4901014	1632-70-8	Undecane, 5-methyl-
8.500	88.7	C12H26	170.2	3152254	1632-70-8	Undecane, 5-methyl-
8.500	83.2	C11H24	156.2	1575847	2847-72-5	Decane, 4-methyl-
8.600	92.1	C11H24	156.2	7715931	62016-18-6	Octane, 5-ethyl-2-methyl-
8.600	87.2	C13H28	184.2	3075893	62108-21-8	Decane, 6-ethyl-2-methyl-
8.700	86.4	C13H28	184.2	2235585	6117-97-1	Dodecane, 4-methyl-
8.700	88.1	C12H26	170.2	6256643	2980-69-0	Undecane, 4-methyl-
8.800	92.7	C15H32	212.3	14185922	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.800	90.4	C9H18O	142.1	12195275	124-19-6	Nonanal
8.900	91.3	C18H38O3S	334.3	6400267	999541-21-3	Sulfurous acid, decyl 2-ethylhexyl ester
9.000	87.4	C14H30	198.2	9602006	13287-21-3	Tridecane, 6-methyl-
9.100	81.2	C9H18O2	158.1	1971960	999083-32-6	tert-butyl (alpha) trimethylacetate
9.200	88.8	C12H26	170.2	6685571	17312-54-8	Decane, 3,7-dimethyl-
9.200	95.3	C10H30O5Si5	370.1	24450018	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	83.2	C7H12O2	128.1	352916	3301-90-4	2H-Pyran-2-one, 6-ethyltetrahydro-
9.300	91.3	C13H28	184.2	4770628	17301-25-6	Undecane, 2,8-dimethyl-
9.300	87.4	C10H22	142.2	833135	52896-87-4	Heptane, 4-(1-methylethyl)-
9.400	88.5	C13H28	184.2	1570909	17312-68-4	Undecane, 4,4-dimethyl-
9.500	85.4	C11H24	156.2	1270282	2847-72-5	Decane, 4-methyl-
9.600	84.1	C13H28	184.2	2539494	17312-63-9	Nonane, 5-butyl-
9.600	86.0	C13H28	184.2	1509507	62185-54-0	Nonane, 5-(1-methylpropyl)-
9.700	86.2	C17H36O3S	320.2	2000698	1000309-19-2	Sulfurous acid, 2-ethylhexyl nonyl ester
9.700	84.4	C13H28	184.2	1363032	17312-78-6	Undecane, 3,4-dimethyl-
9.800	82.8	C13H28	184.2	1626792	62108-31-0	Heptane, 4-ethyl-2,2,6,6-tetramethyl-
9.800	92.1	C18H38	254.3	1996944	26741-18-4	9-methylheptadecane
10.000	89.7	C10H20O	156.2	1332794	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	91.6	C8H18O3	162.1	1428315	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	86.7	C16H32	224.3	943408	629-73-2	1-Hexadecene
10.100	95.1	C10H8	128.1	767577	91-20-3	Naphthalene
10.200	94.2	C8H8O3	152.0	487263	119-36-8	Methyl salicylate
10.200	95.9	C12H26	170.2	4615280	112-40-3	Dodecane
10.300	95.9	C10H20O	156.2	3137588	112-31-2	Decanal
10.400	83.9	C13H28	184.2	955005	17312-57-1	Dodecane, 3-methyl-
10.400	87.4	C13H28	184.2	749753	17301-23-4	Undecane, 2,6-dimethyl-
10.700	87.4	C14H30	198.2	769964	61141-72-8	Dodecane, 4,6-dimethyl-
10.800	93.7	C14H30	198.2	1320031	61141-72-8	Dodecane, 4,6-dimethyl-
11.000	91.7	C6H11NO	113.1	2861035	105-60-2	Caprolactam
11.100	91.3	C20H42	282.3	998975	112-95-8	Eicosane
11.200	91.9	C19H40O3S	348.3	2022072	1000309-19-4	Sulfurous acid, 2-ethylhexyl undecyl ester
11.300	90.1	C14H30	198.2	2329447	61141-72-8	Dodecane, 4,6-dimethyl-
11.500	86.6	C24H50	338.4	532153	646-31-1	Tetracosane
11.500	87.2	C13H28O	200.2	1496103	112-70-9	1-Tridecanol
11.600	95.7	C12H36O6Si6	444.1	15449385	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	89.5	C12H26O	186.2	22608024	3913-02-8	1-Octanol, 2-butyl-
11.700	87.4	C11H10	142.1	397300	91-57-6	Naphthalene, 2-methyl-
11.800	88.4	C19H38	266.3	10380957	18435-45-5	1-Nonadecene
11.900	87.9	C11H24O	172.2	11667511	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
11.900	87.1	C15H32	212.3	4008204	629-62-9	pentadecane
12.100	86.5	C13H28	184.2	1088666	17301-29-0	Undecane, 3,7-dimethyl-
12.100	84.7	C12H25Br	248.1	1677758	13187-99-0	2-Bromo dodecane
12.200	90.2	C23H48	324.4	3300262	638-67-5	Tricosane

12.300	87.4	C18H38O	270.3	2770930	1000406-38-3	Decyl octyl ether
12.400	89.1	C12H24O3	216.2	11850402	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.400	89.2	C14H30	198.2	546469	26730-12-1	Tridecane, 4-methyl-
12.500	87.8	C21H44	296.3	920384	54833-23-7	Eicosane, 10-methyl-
12.600	80.5	C16H34O3S	306.2	1266419	999472-82-3	Sulfurous acid, butyl dodecyl ester
12.700	93.8	C12H24O3	216.2	17848330	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.900	92.9	C14H28	196.2	522532	295-17-0	Cyclotetradecane
13.000	95.2	C14H30	198.2	5508335	629-59-4	Tetradecane
13.100	94.0	C12H24O	184.2	1558199	112-54-9	Dodecanal
13.700	91.9	C14H28	196.2	1755774	2882-98-6	Cyclopentane, nonyl-
13.700	83.6	C13H28	184.2	686956	62338-13-0	Decane, 3,3,5-trimethyl-
13.800	80.4	C14H42O7Si7	518.1	2432625	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.800	89.9	C16H34	226.3	1195928	544-76-3	Hexadecane
13.900	86.3	C14H20O2	220.1	677024	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
14.000	92.5	C22H44O3	356.3	1420650	1000383-16-0	Carbonic acid, decyl undecyl ester
14.100	88.4	C22H46	310.4	642560	629-97-0	Docosane
14.200	95.2	C15H30	210.2	1904309	13360-61-7	1-Pentadecene
14.300	93.8	C15H32	212.3	1748379	629-62-9	pentadecane
14.400	80.9	C14H22O	206.2	24946623	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
14.500	88.8	C20H42O	298.3	3708605	645-72-7	1-Hexadecanol, 3,7,11,15-tetramethyl-
14.600	87.6	C20H42O	298.3	2257831	645-72-7	1-Hexadecanol, 3,7,11,15-tetramethyl-
14.700	85.9	C19H40	268.3	3174086	629-92-5	Nonadecane
14.800	88.1	C20H42O	298.3	2979959	645-72-7	1-Hexadecanol, 3,7,11,15-tetramethyl-
14.900	88.0	C24H50O	354.4	2402627	1000406-38-6	Hexadecyl octyl ether
15.000	91.9	C15H30	210.2	937481	2883-02-5	n-Nonylcyclohexane
15.100	88.7	C18H38	254.3	721194	593-45-3	Octadecane
15.200	86.3	C16H34	226.3	449799	2882-96-4	Pentadecane, 3-methyl-
15.200	82.6	C18H38	254.3	416157	593-45-3	Octadecane
15.500	89.6	C16H34	226.3	796640	544-76-3	Hexadecane
15.800	89.9	C16H48O8Si8	592.2	406400	556-68-3	Cyclooctasiloxane, hexadecamethyl-
16.200	89.8	C16H32	224.3	505273	6785-23-5	Cyclopentane, undecyl-
16.200	84.9	C16H34O	242.3	331120	629-82-3	Octane, 1,1'-oxybis-
16.700	83.4	C21H44	296.3	296049	54833-48-6	Heptadecane, 2,6,10,15-tetramethyl-
17.300	81.6	C19H38	266.3	773843	18435-45-5	1-Nonadecene
17.300	93.8	C15H22O2	234.2	479398	101100-38-3	BHT-aldehyde
17.800	96.8	C15H22O3	250.2	577732	118-60-5	2-Ethylhexyl salicylate