

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

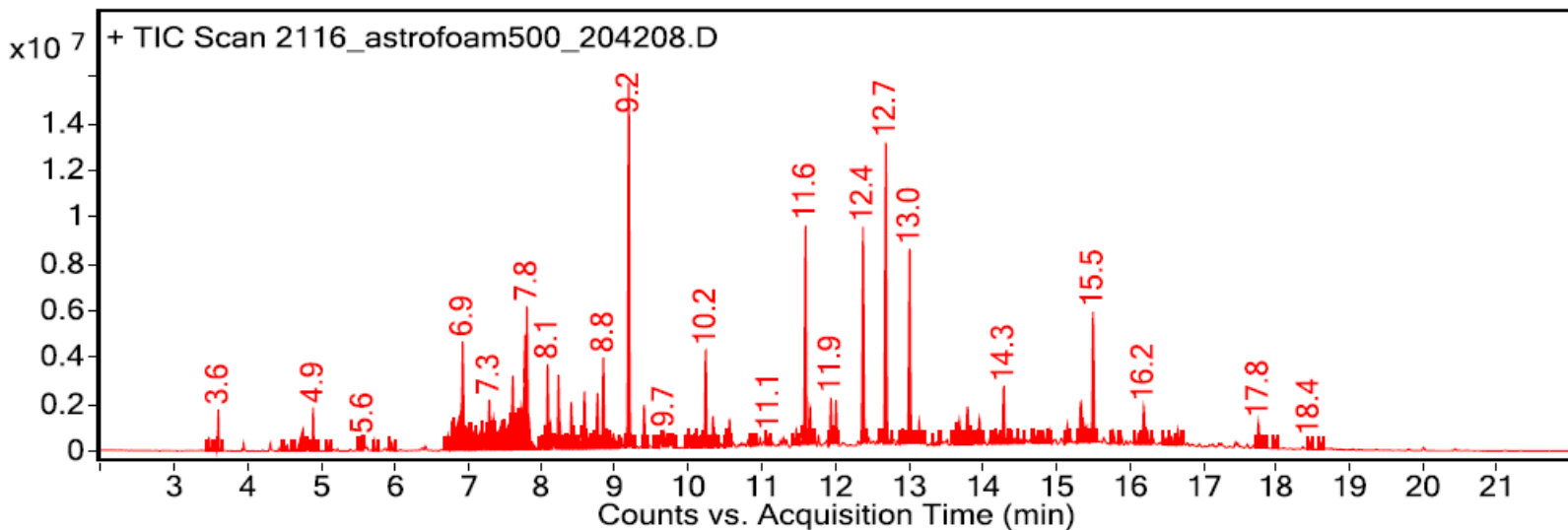
Sample: Pregis polyethylene 0.5" Astrofoam AF500 foam sheet

Oddy test result: Temporary

Date collected: 04/06/2018

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
3.500	94.0	C2H3F	46.0	502086	75-02-5	Ethene, fluoro-
3.600	98.5	C2H4O2	60.0	1686173	64-19-7	Acetic acid
4.800	93.0	C5H10O2	102.1	2694723	75-98-9	Propanoic acid, 2,2-dimethyl-
4.900	97.2	C6H18O3Si3	222.1	1657454	541-05-9	Cyclotrisiloxane, hexamethyl-
5.100	92.3	C5H10O2	102.1	507367	503-74-2	Butanoic acid, 3-methyl-
5.600	93.2	C5H10O2	102.1	1146863	109-52-4	Pentanoic acid
5.700	89.2	C8H9NO2	151.1	504635	1000222-86-6	Oxime-, methoxy-phenyl-
7.500	86.1	C3H8O3	92.0	6682328	56-81-5	1,2,3-Propanetriol
7.600	88.0	C3H8O3	92.0	5175446	56-81-5	Glycerin
7.700	85.8	C3H8O3	92.0	2022762	56-81-5	Glycerin
7.800	83.9	C12H20O2	196.1	6484891	10198-23-9	.beta.-Terpinyl acetate
8.100	92.0	C15H32	212.3	900861	74645-98-0	Dodecane, 2,7,10-trimethyl-
8.100	92.8	C10H22	142.2	4756278	2051-30-1	Octane, 2,6-dimethyl-
8.100	86.1	C12H26	170.2	1878904	62199-06-8	Heptane, 5-ethyl-2,2,3-trimethyl-
8.200	83.9	C12H26	170.2	5307285	62199-06-8	Heptane, 5-ethyl-2,2,3-trimethyl-
8.400	81.2	C19H36O3	312.3	591445	1000382-91-0	Carbonic acid, pentadecyl prop-1-en-2-yl ester
8.400	94.0	C13H28	184.2	2735657	6117-97-1	Dodecane, 4-methyl-
8.400	86.5	C12H26	170.2	1712883	62199-06-8	Heptane, 5-ethyl-2,2,3-trimethyl-
8.500	84.2	C12H26O	186.2	972805	21078-65-9	1-Decanol, 2-ethyl-
8.700	80.8	C23H48O	340.4	665682	1000406-37-6	Nonyl tetradecyl ether
8.800	91.8	C11H24	156.2	3712827	1120-21-4	Undecane
8.800	95.9	C9H18O	142.1	5328140	124-19-6	Nonanal
8.900	82.9	C8H16O2	144.1	1625532	149-57-5	Hexanoic acid, 2-ethyl-
9.200	96.9	C10H30O5Si5	370.1	22013299	541-02-6	Cyclopentasiloxane, decamethyl-
9.700	80.4	C2H7NO3S2	157.0	1524259	2937-53-3	Thiosulfuric acid (H2S2O3), S-(2-aminoethyl) ester
9.800	83.0	C20H42O	298.3	524421	2456-28-2	Decane, 1,1'-oxybis-
10.000	86.0	C10H20O	156.2	708883	23283-97-8	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, [1S-(1.alpha.,2.beta.,5.beta.)]-
10.000	80.8	C19H38O2	298.3	568202	15965-99-8	Oxirane, [(hexadecyloxy)methyl]-

10.100	86.4	C12H24	168.2	630076	112-41-4	1-Dodecene
10.200	96.7	C12H26	170.2	5670264	112-40-3	Dodecane
10.300	91.3	C10H20O	156.2	1747179	112-31-2	Decanal
10.400	85.9	C17H36	240.3	858275	14905-56-7	Tetradecane, 2,6,10-trimethyl-
10.900	82.6	C17H36O	256.3	484068	2490-48-4	1-Hexadecanol, 2-methyl-
11.100	82.2	C2H7NO3S2	157.0	878663	2937-53-3	Thiosulfuric acid (H2S2O3), S-(2-aminoethyl) ester
11.600	95.1	C12H36O6Si6	444.1	13792673	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	90.8	C13H28	184.2	2722091	629-50-5	Tridecane
11.900	88.0	C16H34	226.3	2610718	127204-12-0	Dodecane, 2,2,11,11-tetramethyl-
12.000	86.9	C16H34	226.3	3007532	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	90.6	C12H24O3	216.2	12760008	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	97.5	C12H24O3	216.2	19610427	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.900	94.0	C17H34	238.3	487883	6765-39-5	1-Heptadecene
13.000	97.3	C14H30	198.2	12256841	629-59-4	Tetradecane
13.100	89.0	C16H34O	242.3	1189111	2425-77-6	1-Decanol, 2-hexyl-
13.200	85.7	C16H34O	242.3	462929	2425-77-6	1-Decanol, 2-hexyl-
13.400	81.4	C16H34S	258.2	501830	25360-09-2	tert-Hexadecanethiol
13.600	81.8	C17H36	240.3	1439282	14905-56-7	Tetradecane, 2,6,10-trimethyl-
13.700	88.6	C16H34O	242.3	1909944	36653-82-4	1-Hexadecanol
13.800	82.3	C15H32O	228.2	957257	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
14.000	89.6	C17H34	238.3	1749972	6765-39-5	1-Heptadecene
14.200	84.1	C20H42O	298.3	1031073	5333-42-6	1-Dodecanol, 2-octyl-
14.300	94.2	C15H32	212.3	3991629	629-62-9	Pentadecane
14.400	80.0	C16H34S	258.2	502668	25360-09-2	tert-Hexadecanethiol
14.400	86.6	C15H32O	228.2	671518	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
14.500	85.9	C15H32O	228.2	465195	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
14.700	84.0	C16H34S	258.2	926277	25360-09-2	tert-Hexadecanethiol
14.800	87.9	C17H36	240.3	786166	14905-56-7	Tetradecane, 2,6,10-trimethyl-
14.900	86.0	C18H38O	270.3	835089	110225-00-8	1-Dodecanol, 2-hexyl-
15.200	86.6	C21H44	296.3	971276	13475-75-7	Pentadecane, 8-hexyl-
15.400	92.0	C19H40O	284.3	869656	1454-84-8	n-Nonadecanol-1
15.500	95.0	C16H34	226.3	7617185	544-76-3	Hexadecane
16.100	84.4	C15H30	210.2	761404	999209-00-0	2-Methyl-Z-4-tetradecene
16.200	94.9	C16H32	224.3	2460024	6785-23-5	Cyclopentane, undecyl-
16.200	89.7	C16H34O	242.3	1307424	2425-77-6	1-Decanol, 2-hexyl-
16.500	86.3	C19H38	266.3	636295	18435-45-5	1-Nonadecene
16.600	82.3	C17H34D2O3S	322.3	964210	56555-04-5	1,1-DIDEUTERIO-HEXADECANYL METHANE SULFONATE
16.700	89.4	C17H36	240.3	1261585	14905-56-7	Tetradecane, 2,6,10-trimethyl-
17.800	87.0	C21H44	296.3	1591569	629-94-7	Heneicosane
17.800	82.2	C15H22O3	250.2	484022	118-60-5	2-Ethylhexyl salicylate
18.000	92.8	C17H34O2	270.3	555484	110-27-0	Isopropyl Myristate
18.400	90.8	C19H40O	284.3	522442	1454-84-8	n-Nonadecanol-1
18.600	90.4	C19H40O	284.3	501433	1454-84-8	n-Nonadecanol-1