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

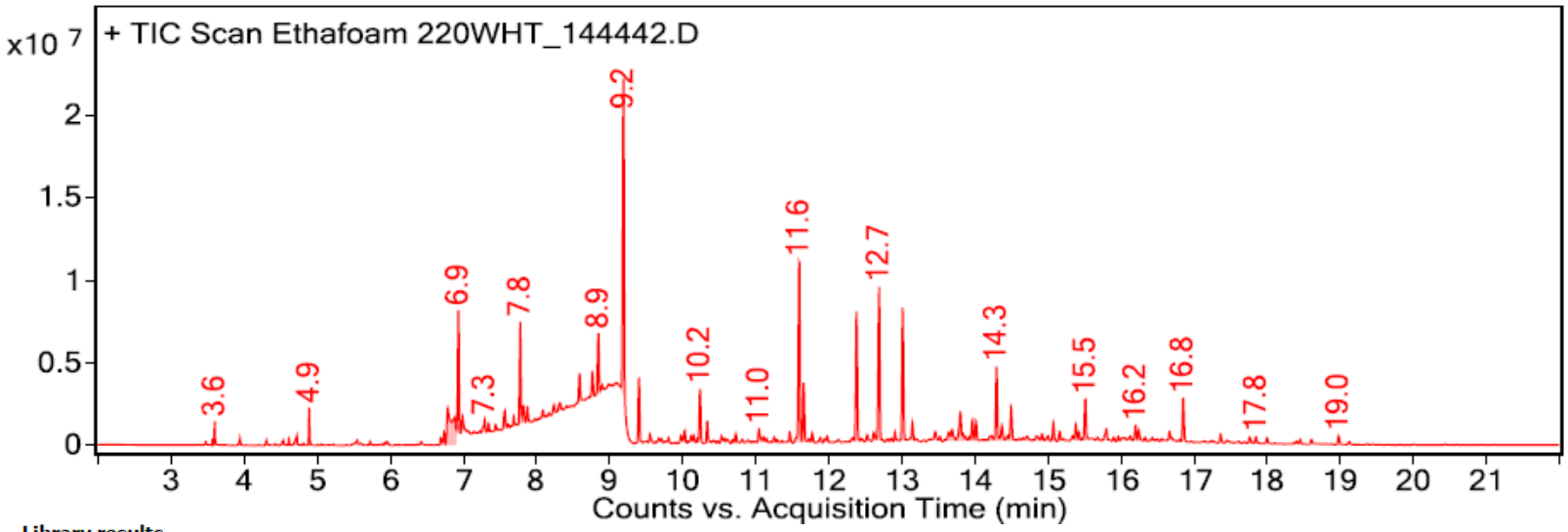
Sample: Ethafoam 220

Oddy test result: Temporary

Date GC-MS collected: 3/20/2018

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) ~12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) ~12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.400	93.0	Co2	117.9	2005904	124-38-9	Carbon dioxide
3.600	98.0	C2H4O2	60.0	1231910	64-19-7	Acetic acid
4.700	91.8	C5H10O2	102.1	1090716	75-98-9	Propanoic acid, 2,2-dimethyl-
4.900	97.7	C6H18O3Si3	222.1	2002304	541-05-9	Cyclotrisiloxane, hexamethyl-
6.700	85.5	C4H10O3	106.1	549093	111-46-6	Ethanol, 2,2'-oxybis-
6.900	94.9	C8H24O4Si4	296.1	8928201	556-67-2	Cyclotetrasiloxane, octamethyl-
7.600	80.3	C5H12O3	120.1	1756456	1874-62-0	3-Ethoxy-1,2-propanediol
7.800	86.9	C12H20O2	196.1	7360734	10198-23-9	Cyclohexanol, 1-methyl-4-(1-methylethenyl)-, acetate
8.100	81.8	C3H8O3	92.0	517902	56-81-5	Glycerin
8.200	84.9	C3H8O3	92.0	622933	56-81-5	Glycerin
9.200	93.0	C10H30O5Si5	370.1	25687936	541-02-6	Cyclopentasiloxane, decamethyl-
10.200	95.3	C12H26	170.2	4150513	112-40-3	Dodecane
10.300	92.1	C10H20O	156.2	1749167	112-31-2	Decanal
11.000	81.4	C12H22O2	198.2	1423806	16429-21-3	2-Oxepanone, 7-hexyl-
11.100	83.0	C2H7NO3S2	157.0	538804	2937-53-3	Thiosulfuric acid (H2S2O3), S-(2-aminoethyl) ester
11.500	83.3	C8H24O4Si4	296.1	826102	556-67-2	Cyclotetrasiloxane, octamethyl-
11.600	95.3	C12H36O6Si6	444.1	15941699	540-97-6	Cyclohexasiloxane, dodecamethyl-

11.700	96.9	C13H28	184.2	4958046	629-50-5	Tridecane
11.800	86.6	C11H22O	170.2	704787	112-44-7	Undecanal
12.000	80.2	C16H34	226.3	531805	544-76-3	Hexadecane
12.400	90.7	C12H24O3	216.2	11049759	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	97.3	C12H24O3	216.2	13588258	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.900	89.5	C17H36O	256.3	556202	2490-48-4	1-Hexadecanol, 2-methyl-
13.000	97.9	C14H30	198.2	11104061	629-59-4	Tetradecane
13.100	87.2	C14H28O	212.2	1503662	124-25-4	Tetradecanal
13.600	80.3	C16H34S	258.2	1217218	25360-09-2	tert-Hexadecanethiol
13.700	80.9	C16H34S	258.2	1423175	25360-09-2	tert-Hexadecanethiol
14.000	87.2	C17H36O	256.3	1868245	2490-48-4	1-Hexadecanol, 2-methyl-
14.200	82.8	C16H34S	258.2	989398	25360-09-2	tert-Hexadecanethiol
14.300	96.5	C15H32	212.3	6433590	629-62-9	Pentadecane
14.400	86.6	C16H34S	258.2	589594	25360-09-2	tert-Hexadecanethiol
14.500	81.0	C16H34	226.3	3329019	59222-86-5	Tetradecane, 2,2-dimethyl-
14.700	81.8	C16H34S	258.2	785396	25360-09-2	tert-Hexadecanethiol
14.800	86.5	C16H34S	258.2	850669	25360-09-2	tert-Hexadecanethiol
14.900	85.4	C16H34S	258.2	668038	25360-09-2	tert-Hexadecanethiol
15.000	84.4	C16H34S	258.2	585502	25360-09-2	tert-Hexadecanethiol
15.100	89.4	C17H36	240.3	1577172	14905-56-7	Tetradecane, 2,6,10-trimethyl-
15.200	80.6	C16H34S	258.2	785541	25360-09-2	tert-Hexadecanethiol
15.400	88.9	C17H36O	256.3	692706	2490-48-4	1-Hexadecanol, 2-methyl-
15.500	91.3	C16H34	226.3	3969180	544-76-3	Hexadecane
16.100	84.2	C16H34S	258.2	544502	25360-09-2	tert-Hexadecanethiol
16.200	89.4	C16H32	224.3	1358135	6785-23-5	Cyclopentane, undecyl-
16.200	86.7	C17H36O	256.3	933868	2490-48-4	1-Hexadecanol, 2-methyl-
16.700	86.9	C17H36	240.3	1014248	14905-56-7	Tetradecane, 2,6,10-trimethyl-
16.800	83.2	C16H34	226.3	3682268	127204-12-0	Dodecane, 2,2,11,11-tetramethyl-
17.400	83.0	C22H46	310.4	717166	629-97-0	Docosane
19.000	89.9	C20H42	282.3	852795	1000360-43-2	2,2-Dimethyloctadecane