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

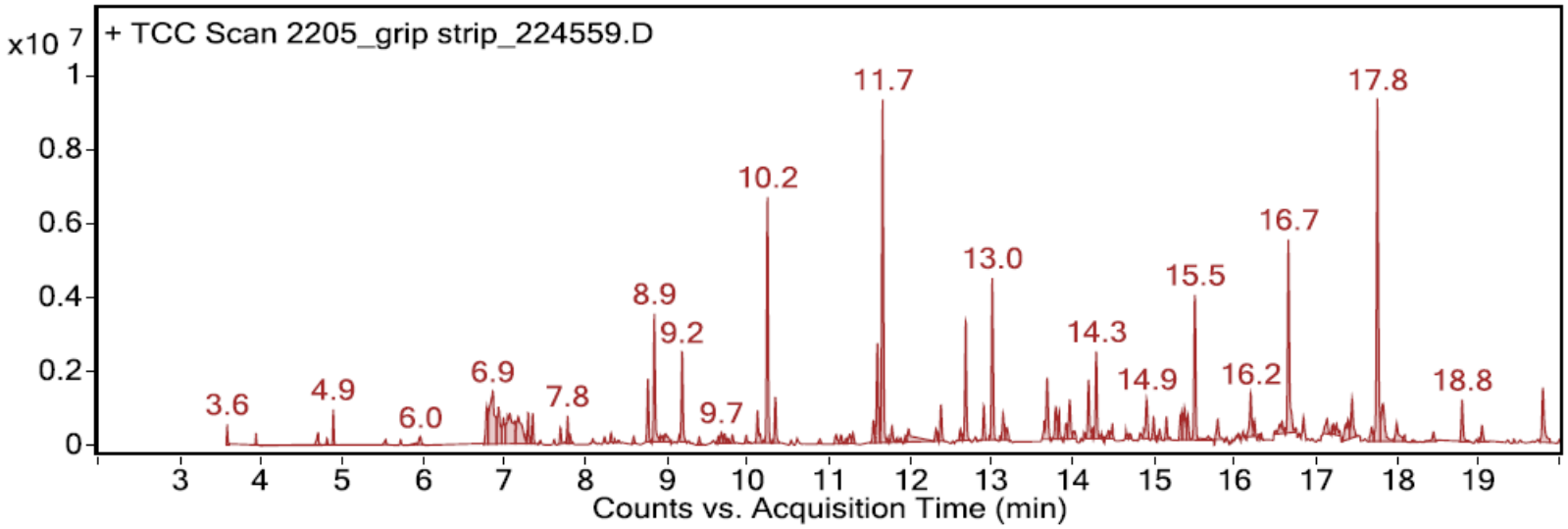
Sample: Grip strip foam backing material

Oddy test result: Temporary

Date GC-MS collected: 6/20/2018

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) 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	402557	64-19-7	Acetic acid
3.900	93.7	C2H8O2Si	92.0	240866	1066-42-8	Silanediol, dimethyl-
4.700	90.8	C5H10O2	102.1	540382	75-98-9	Propanoic acid, 2,2-dimethyl-
4.800	90.4	C6H12O	100.1	182456	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	855216	541-05-9	Cyclotrisiloxane, hexamethyl-
5.500	89.8	C5H10O2	102.1	287504	109-52-4	Pentanoic acid
5.700	85.0	C8H9NO2	151.1	175368	1000222-86-6	Oxime-, methoxy-phenyl-_
6.000	81.6	C7H14O	114.1	166195	111-71-7	Heptanal
6.000	90.4	C6H14O2	118.1	234491	111-76-2	Ethanol, 2-butoxy-
6.800	96.2	C7H6O	106.0	188745	100-52-7	Benzaldehyde
6.900	84.8	C6H12O2	116.1	2509618	142-62-1	Hexanoic acid
6.900	95.3	C8H24O4Si4	296.1	638084	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	82.9	C8H14O	126.1	183964	26118-97-8	6-Hepten-3-one, 4-methyl-
7.300	95.7	C10H22	142.2	613959	124-18-5	Decane
7.400	97.6	C8H16O	128.1	591028	124-13-0	Octanal
7.600	85.6	C10H22	142.2	158100	2051-30-1	Octane, 2,6-dimethyl-
7.700	95.9	C8H18O	130.1	584838	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.0	C10H16	136.1	808724	138-86-3	dl-Limonene
8.100	81.3	C13H28	184.2	283195	62108-32-1	HEPTANE, 2,2,3,4,6,6-HEXAMETHYL-
8.800	97.1	C11H24	156.2	2321430	1120-21-4	Undecane
8.800	97.9	C9H18O	142.1	4484910	124-19-6	Nonanal
9.200	86.5	C30H58O4	482.4	283101	2432-89-5	Decanedioic acid, didecyl ester
9.200	94.0	C10H30O5Si5	370.1	3361407	541-02-6	Cyclopentasiloxane, decamethyl-
9.800	89.3	C20H42O	298.3	348296	2456-28-2	Decane, 1,1'-oxybis-

10.000	96.3	C10H20O	156.2	324060	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.100	93.1	C12H24	168.2	1201020	112-41-4	1-Dodecene
10.200	96.7	C10H8	128.1	340435	275-51-4	Azulene
10.200	95.5	C8H8O3	152.0	141175	119-36-8	Benzoic acid, 2-hydroxy-, methyl ester
10.200	95.5	C12H26	170.2	8869714	112-40-3	Dodecane
10.300	97.8	C10H20O	156.2	1710529	112-31-2	Decanal
10.500	90.9	C8H10O2	138.1	190593	122-99-6	Ethanol, 2-phenoxy-
10.600	82.0	C11H20O2	184.1	189661	103-11-7	2-Propenoic acid, 2-ethylhexyl ester
10.900	85.4	C10H20	140.2	238394	3741-00-2	Cyclopentane, pentyl-
11.300	90.3	C16H32	224.3	327998	629-73-2	1-Hexadecene
11.300	83.6	C20H42	282.3	185565	112-95-8	Eicosane
11.500	94.9	C13H26	182.2	1009010	2437-56-1	1-Tridecene
11.600	95.5	C12H36O6Si6	444.1	3889423	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	95.0	C13H28	184.2	13302077	629-50-5	Tridecane
11.700	92.6	C11H10	142.1	156174	91-57-6	Naphthalene, 2-methyl-
11.800	94.8	C11H22O	170.2	519811	112-44-7	Undecanal
11.900	84.1	C12H21F3O2	254.1	252438	28745-07-5	Acetic acid, trifluoro-, 3,7-dimethyloctyl ester
12.000	84.1	C16H34	226.3	302033	5171-85-7	2,2,4,4,5,5,7,7-Octamethyloctane
12.300	84.4	C13H26	182.2	591650	5617-41-4	Heptylcyclohexane
12.400	90.7	C12H24O3	216.2	1565516	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.600	86.7	C14H30	198.2	555467	6418-41-3	Tridecane, 3-methyl-
12.700	93.1	C12H24O3	216.2	2827086	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.800	87.8	C14H28	196.2	233801	19780-34-8	1-Dodecene, 2-ethyl-
12.900	95.5	C14H28	196.2	1345030	1120-36-1	1-TETRADECENE
13.000	94.4	C14H30	198.2	6410220	629-59-4	Tetradecane
13.100	96.5	C12H24O	184.2	1088287	112-54-9	Dodecanal
13.600	87.0	C17H36	240.3	532105	6008-17-9	5,5-Dibutylnonane
13.700	95.0	C14H28	196.2	1694721	2882-98-6	Cyclopentane, nonyl-
13.800	89.7	C24H50	338.4	559514	646-31-1	Tetracosane
14.000	94.8	C12H26O	186.2	680110	112-53-8	1-Dodecanol
14.100	82.3	C14H28	196.2	169472	19780-34-8	1-Dodecene, 2-ethyl-
14.200	95.6	C15H30	210.2	2434701	13360-61-7	1-Pentadecene
14.300	94.5	C15H32	212.3	3559921	629-62-9	pentadecane
14.400	90.2	C13H26O	198.2	302169	10486-19-8	Tridecanal
14.800	82.1	C16H34	226.3	500724	55045-14-2	Tetradecane, 4-ethyl-
14.900	87.3	C20H42O3S	362.3	809529	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
15.000	94.6	C15H30	210.2	973980	2883-02-5	n-Nonylcyclohexane
15.100	89.7	C20H42	282.3	453690	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
15.200	92.1	C16H34	226.3	881665	2882-96-4	Pentadecane, 3-methyl-
15.300	80.8	C11H22	154.2	479477	19780-74-6	5-Ethyl-1-nonene
15.400	87.9	C16H32	224.3	813149	629-73-2	1-Hexadecene
15.500	92.9	C16H34	226.3	5642814	544-76-3	Hexadecane
15.700	83.7	C29H60O	424.5	257387	25154-56-7	Nonacosanol
15.800	89.0	C16H48O8Si8	592.2	246796	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	91.6	C15H30O2	242.2	776323	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.000	87.0	C13H10O	182.1	163744	119-61-9	Methanone, diphenyl-
16.000	85.3	C18H38	254.3	589076	3892-00-0	Pentadecane, 2,6,10-trimethyl-
16.100	81.3	C17H36	240.3	343939	1000360-41-2	3,3-Diethyltridecane
16.200	92.5	C16H32	224.3	1119499	6785-23-5	Cyclopentane, undecyl-
16.200	87.7	C22H46O3S	390.3	870255	999646-00-5	Sulfurous acid, 2-ethylhexyl tetradecyl ester
16.700	94.9	C17H36	240.3	4454223	629-78-7	Heptadecane
16.800	83.6	C12H26	170.2	332673	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
17.100	84.5	C18H28O2Si3	360.1	227630	17977-72-9	1,1,3,3,5,5-Hexamethyl-1,5-diphenyl-trisiloxane
17.100	87.6	C19H40	268.3	518417	629-92-5	Nonadecane
17.400	82.8	C17H34	238.3	268833	54105-66-7	Cyclohexane, undecyl-
17.400	91.0	C18H38	254.3	440822	6418-44-6	Heptadecane, 3-methyl-
17.700	93.3	C18H38O	270.3	207967	112-92-5	1-Octadecanol
17.800	93.3	C18H38	254.3	4682145	593-45-3	Octadecane
17.800	89.9	C20H42	282.3	531551	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
18.000	90.1	C17H34O2	270.3	397520	110-27-0	Isopropyl myristate
18.400	88.2	C18H36	252.3	394298	7206-19-1	3-Octadecene, (E)-
18.800	95.4	C19H40	268.3	1667450	629-92-5	Nonadecane

19.000	93.3	C17H34O2	270.3	691099	112-39-0	Hexadecanoic acid, methyl ester
19.800	94.6	C20H42	282.3	1683723	112-95-8	Eicosane
20.000	85.4	C19H38O2	298.3	262172	142-91-6	Hexadecanoic acid, 1-methylethyl ester
20.500	86.1	C20H42O	298.3	330137	629-96-9	1-Eicosanol
20.700	91.8	C19H40	268.3	413753	629-92-5	Nonadecane
21.500	87.1	C20H38O4	342.3	244373	999559-04-1	Succinic acid, di(2-ethylhexyl) ester
21.700	87.2	C13H28	184.2	344987	17301-30-3	Undecane, 3,8-dimethyl-