

**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

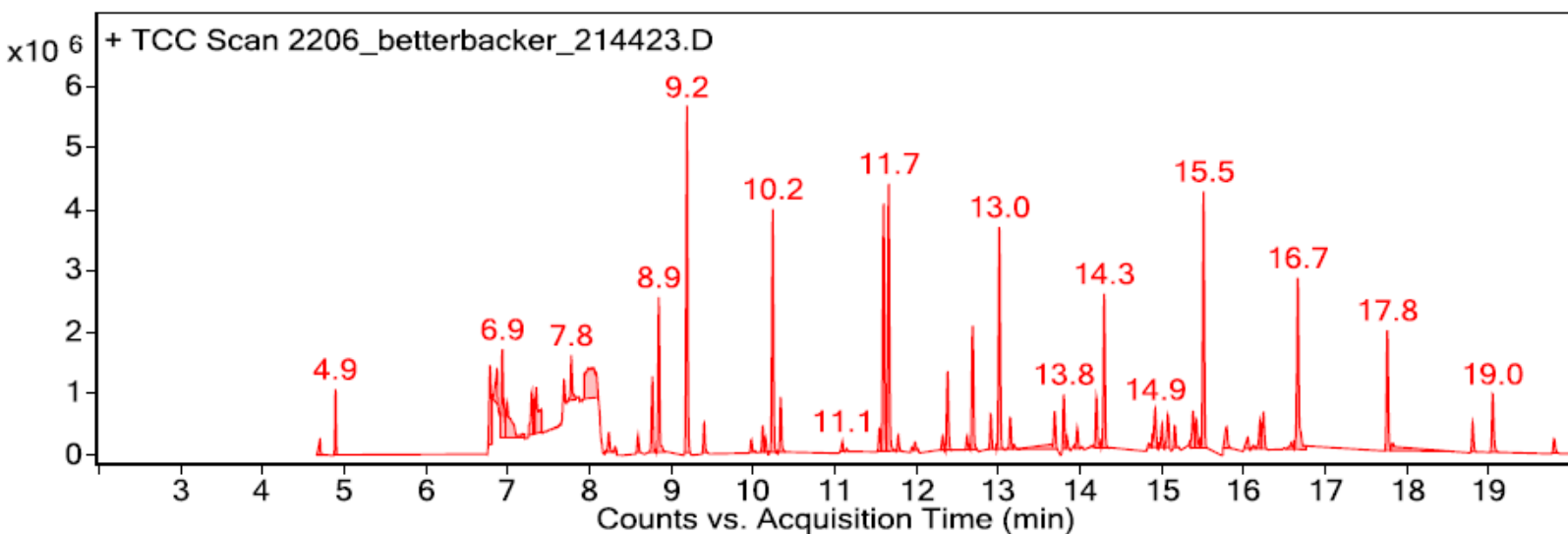
Sample: Better Backer grip strip foam backing material

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) ~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
4.700	91.0	C5H10O2	102.1	405611	75-98-9	Propanoic acid, 2,2-dimethyl-
4.900	92.5	C6H18O3Si3	222.1	1021526	541-05-9	Cyclotrisiloxane, hexamethyl-
6.900	83.8	C6H12O2	116.1	2970485	142-62-1	Hexanoic acid
6.900	95.2	C8H24O4Si4	296.1	1228543	556-67-2	Cyclotetrasiloxane, octamethyl-
7.300	93.4	C10H22	142.2	587308	124-18-5	Decane
7.400	97.3	C8H16O	128.1	476976	124-13-0	Octanal
7.700	90.9	C8H18O	130.1	463466	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.0	C10H16	136.1	951700	138-86-3	dl-Limonene
8.800	97.1	C11H24	156.2	1605249	1120-21-4	Undecane
8.800	97.7	C9H18O	142.1	3271439	124-19-6	Nonanal
9.200	93.8	C10H30O5Si5	370.1	7595931	541-02-6	Cyclopentasiloxane, decamethyl-
10.000	96.1	C10H20O	156.2	315718	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.100	95.3	C12H24	168.2	611367	112-41-4	1-Dodecene
10.200	96.1	C10H8	128.1	340836	275-51-4	Azulene
10.200	96.1	C12H26	170.2	5306719	112-40-3	Dodecane
10.300	97.5	C10H20O	156.2	1244024	112-31-2	Decanal
11.100	82.8	C9H18O2	158.1	353997	112-05-0	Nonanoic acid

11.500	91.9	C13H26	182.2	645637	2437-56-1	1-Tridecene
11.600	95.2	C12H36O6Si6	444.1	5897221	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	95.0	C13H28	184.2	6394649	629-50-5	Tridecane
11.800	93.7	C11H22O	170.2	341303	112-44-7	Undecanal
12.000	88.6	C16H34	226.3	373521	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.300	82.7	C13H26	182.2	388429	5617-41-4	Heptylcyclohexane
12.400	90.5	C12H24O3	216.2	1946366	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.600	83.0	C14H30	198.2	388018	6418-41-3	Tridecane, 3-methyl-
12.700	93.8	C12H24O3	216.2	3171289	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.900	95.5	C14H28	196.2	822694	295-17-0	Cyclotetradecane
13.000	95.1	C14H30	198.2	5285378	629-59-4	Tetradecane
13.100	96.7	C12H24O	184.2	787018	112-54-9	Dodecanal
13.700	90.8	C14H28	196.2	990181	2882-98-6	Cyclopentane, nonyl-
13.800	87.2	C24H50	338.4	367494	646-31-1	Tetracosane
14.000	94.9	C12H26O	186.2	560027	112-53-8	1-Dodecanol
14.200	95.6	C15H30	210.2	1374783	13360-61-7	1-Pentadecene
14.300	94.3	C15H32	212.3	3688180	629-62-9	pentadecane
14.900	86.6	C20H42O3S	362.3	504120	1000309-13-6	Sulfurous acid, hexyl tetradecyl ester
15.000	90.5	C15H30	210.2	635276	2883-02-5	n-Nonylcyclohexane
15.100	90.6	C15H32	212.3	371371	18435-22-8	Tetradecane, 3-methyl-
15.200	93.2	C16H34	226.3	575817	2882-96-4	Pentadecane, 3-methyl-
15.400	89.0	C12H26O	186.2	547688	112-53-8	1-Dodecanol
15.500	93.8	C16H34	226.3	5885817	544-76-3	Hexadecane
15.800	90.4	C16H48O8Si8	592.2	320771	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	89.2	C15H30O2	242.2	490591	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.000	86.9	C18H38	254.3	541458	3892-00-0	Pentadecane, 2,6,10-trimethyl-
16.200	90.6	C16H32	224.3	669133	6785-23-5	Cyclopentane, undecyl-
16.200	92.2	C18H38O	270.3	964214	1000406-38-3	Decyl octyl ether
16.600	83.8	C17H36O	256.3	315483	1454-85-9	1-Heptadecanol
16.700	95.4	C17H36	240.3	4664883	629-78-7	Heptadecane
17.800	92.0	C20H42	282.3	2903624	112-95-8	Eicosane
18.800	95.4	C19H40	268.3	729198	629-92-5	Nonadecane
19.000	93.3	C17H34O2	270.3	1558860	112-39-0	Hexadecanoic acid, methyl ester
19.800	95.1	C20H42	282.3	447771	112-95-8	Eicosane
21.000	95.3	C19H38O2	298.3	930805	112-61-8	Octadecanoic acid, methyl ester