

**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

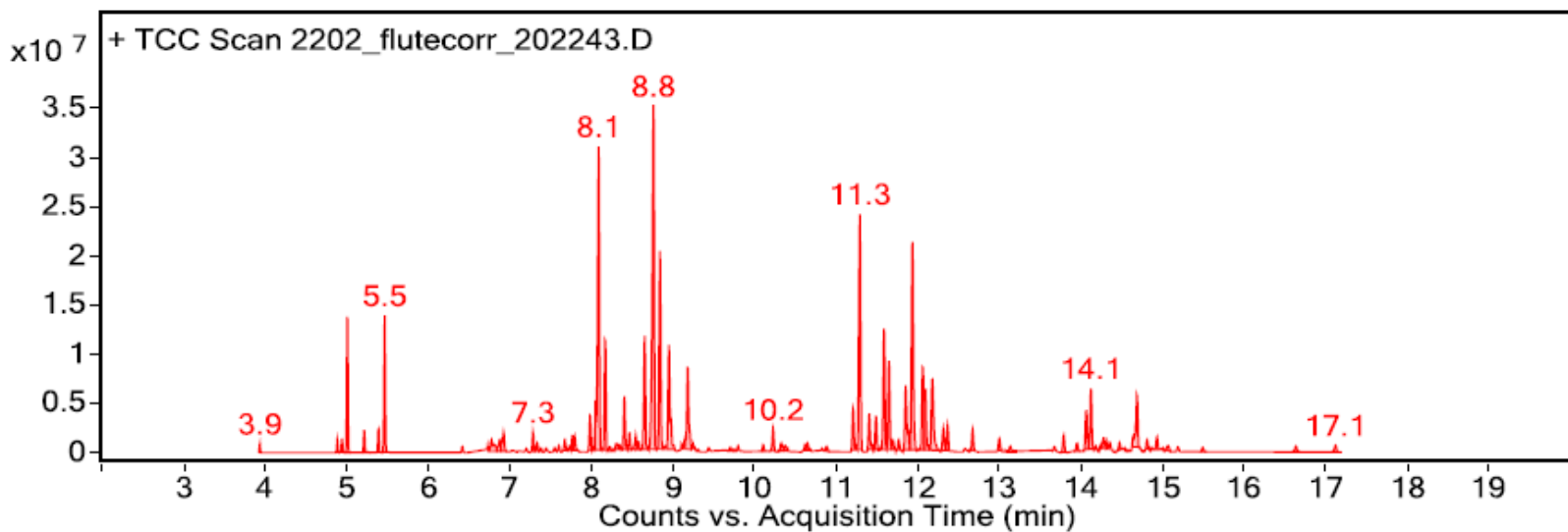
Sample: Lamina Corr FluteCorr white corrugated polypropylene

Oddy test result: Temporary

Date GC-MS collected: 6/26/2018

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
3.900	93.7	C <sub>2</sub> H <sub>8</sub> O <sub>2</sub> Si	92.0	671856	1066-42-8	Silenediol, dimethyl-
4.900	92.5	C <sub>6</sub> H <sub>18</sub> O <sub>3</sub> Si <sub>3</sub>	222.1	1144024	541-05-9	Cyclotrisiloxane, hexamethyl-
4.900	95.1	C <sub>9</sub> H <sub>20</sub>	128.2	1281003	3074-71-3	Heptane, 2,3-dimethyl-
5.000	95.4	C <sub>9</sub> H <sub>20</sub>	128.2	13169033	2213-23-2	Heptane, 2,4-dimethyl-
5.200	94.0	C <sub>9</sub> H <sub>18</sub>	126.1	2208345	19549-87-2	2,4-Dimethyl-1-heptene
5.400	96.3	C <sub>9</sub> H <sub>20</sub>	128.2	2462830	3074-71-3	Heptane, 2,3-dimethyl-
5.500	94.8	C <sub>9</sub> H <sub>20</sub>	128.2	13805284	2216-34-4	Octane, 4-methyl-
6.400	85.4	C <sub>10</sub> H <sub>16</sub>	136.1	728736	80-56-8	.ALPHA.-PINENE, (-)-
6.900	96.2	C <sub>8</sub> H <sub>24</sub> O <sub>4</sub> Si <sub>4</sub>	296.1	1610268	556-67-2	Cyclotetrasiloxane, octamethyl-
7.200	88.7	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.1	684066	109-21-7	Butanoic acid, butyl ester
7.300	90.1	C <sub>10</sub> H <sub>22</sub>	142.2	2380898	15869-93-9	Octane, 3,5-dimethyl-
7.300	92.3	C <sub>8</sub> H <sub>16</sub> O	128.1	1209453	124-13-0	Octanal
7.400	83.5	C <sub>13</sub> H <sub>28</sub>	184.2	673252	17312-82-2	Undecane, 4,6-dimethyl-
7.500	91.9	C <sub>13</sub> H <sub>28</sub>	184.2	652189	17312-83-3	Undecane, 5,7-dimethyl-
7.600	89.8	C <sub>13</sub> H <sub>28</sub>	184.2	741972	62108-25-2	Decane, 2,6,7-trimethyl-
7.700	93.7	C <sub>8</sub> H <sub>18</sub> O	130.1	1204484	104-76-7	1-Hexanol, 2-ethyl-
7.700	83.0	C <sub>9</sub> H <sub>22</sub> O <sub>Si</sub>	174.1	596125	999116-67-7	Triisopropylsilanol
7.800	94.8	C <sub>10</sub> H <sub>16</sub>	136.1	1408502	138-86-3	dl-Limonene
7.800	82.1	C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	152.1	1214872	96392-56-2	1-Phenylpropane-1,2-diol
8.000	93.2	C <sub>12</sub> H <sub>26</sub>	170.2	4973633	52670-34-5	Octane, 2,3,6,7-tetramethyl-
8.000	93.0	C <sub>12</sub> H <sub>26</sub>	170.2	3227446	52670-34-5	Octane, 2,3,6,7-tetramethyl-
8.100	91.3	C <sub>11</sub> H <sub>24</sub>	156.2	43386991	17302-23-7	Nonane, 4,5-dimethyl-

8.200	92.4	C12H26	170.2	14663336	112-40-3	Dodecane
8.200	96.0	C15H32	212.3	881877	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.300	86.1	C13H28	184.2	829089	17301-24-5	Undecane, 2,7-dimethyl-
8.400	88.0	C12H24	168.2	7126534	112-41-4	1-Dodecene
8.500	88.3	C12H24	168.2	2995119	55170-80-4	1-Decene, 2,4-dimethyl-
8.500	94.0	C12H26	170.2	2911252	1636-43-7	Decane, 5,6-dimethyl-
8.700	92.3	C13H28	184.2	16057303	62185-53-9	Nonane, 5-(2-methylpropyl)-
8.800	91.6	C11H24	156.2	58142887	17302-23-7	Nonane, 4,5-dimethyl-
8.800	90.7	C11H24	156.2	27763143	17302-23-7	Nonane, 4,5-dimethyl-
9.000	92.0	C12H26	170.2	19284277	2980-69-0	Undecane, 4-methyl-
9.100	88.6	C11H24	156.2	1453018	17302-23-7	Nonane, 4,5-dimethyl-
9.200	94.7	C10H30O5Si5	370.1	10633986	541-02-6	Cyclopentasiloxane, decamethyl-
9.300	90.6	C13H28	184.2	1082108	17301-32-5	Undecane, 4,7-dimethyl-
9.400	87.5	C13H28	184.2	745193	17312-83-3	Undecane, 5,7-dimethyl-
9.700	86.4	C12H26	170.2	631978	7045-71-8	Undecane, 2-methyl-
9.800	91.5	C13H28	184.2	886468	17312-77-5	Undecane, 2,3-dimethyl-
10.100	94.3	C12H26O	186.2	939652	112-53-8	1-Dodecanol
10.200	95.7	C12H26	170.2	3220019	112-40-3	Dodecane
10.300	96.0	C10H20O	156.2	1402728	112-31-2	Decanal
10.600	81.1	C15H28O2	240.2	1196238	999292-92-1	12-NOR-VITTATALACTONE
10.900	88.2	C19H40	268.3	987894	629-92-5	Nonadecane
11.200	89.4	C12H25Br	248.1	6211489	13187-99-0	2-Bromo dodecane
11.300	90.5	C14H30	198.2	34316416	61141-72-8	Dodecane, 4,6-dimethyl-
11.400	91.2	C14H30	198.2	6141247	61141-72-8	Dodecane, 4,6-dimethyl-
11.500	90.7	C15H32	212.3	5197856	31295-56-4	Dodecane, 2,6,11-trimethyl-
11.600	90.4	C12H36O6Si6	444.1	18181379	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	90.0	C12H26O	186.2	7047321	3913-02-8	1-Octanol, 2-butyl-
11.700	88.4	C13H28	184.2	885950	17453-93-9	Dodecane, 5-methyl-
11.800	89.4	C16H34O	242.3	1911648	2425-77-6	1-Decanol, 2-hexyl-
11.900	88.4	C12H25Br	248.1	10439661	13187-99-0	2-Bromo dodecane
11.900	89.5	C14H30	198.2	34135337	61141-72-8	Dodecane, 4,6-dimethyl-
12.100	91.2	C13H28	184.2	8823326	17301-32-5	Undecane, 4,7-dimethyl-
12.100	80.9	C12H25Br	248.1	4971203	13187-99-0	2-Bromo dodecane
12.200	89.2	C23H48	324.4	15082565	638-67-5	Tricosane
12.300	89.3	C20H42	282.3	3607937	112-95-8	Eicosane
12.400	89.8	C12H24O3	216.2	1968127	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.600	89.4	C13H28	184.2	696927	17453-93-9	Dodecane, 5-methyl-
12.700	93.4	C12H24O3	216.2	3249240	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.000	95.5	C14H30	198.2	2092666	629-59-4	Tetradecane
13.100	94.0	C12H24O	184.2	876206	112-54-9	Dodecanal
13.700	93.7	C14H28	196.2	837444	2882-98-6	Cyclopentane, nonyl-
13.800	80.1	C14H42O7Si7	518.1	2525862	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.000	96.5	C12H26O	186.2	1362035	112-53-8	1-Dodecanol
14.100	86.9	C16H34O	242.3	1925572	999298-90-9	Tridecanol, 2-ethyl-2-methyl-
14.100	88.7	C16H34	226.3	8388300	544-76-3	Hexadecane
14.200	94.9	C15H30	210.2	834137	13360-61-7	1-Pentadecene
14.200	86.7	C19H40	268.3	1154465	629-92-5	Nonadecane
14.300	92.5	C15H32	212.3	1024976	629-62-9	pentadecane
14.300	86.7	C13H28	184.2	810699	17301-30-3	Undecane, 3,8-dimethyl-
14.400	88.3	C14H22O	206.2	1064485	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
14.500	89.2	C12H26O	186.2	1353777	3913-02-8	1-Octanol, 2-butyl-
14.500	89.5	C23H48	324.4	613093	638-67-5	Tricosane
14.600	88.2	C16H34O	242.3	2366478	999298-90-9	Tridecanol, 2-ethyl-2-methyl-
14.700	89.6	C16H34	226.3	9093436	544-76-3	Hexadecane
14.800	89.6	C15H32	212.3	2026441	31295-56-4	Dodecane, 2,6,11-trimethyl-
14.900	90.1	C20H42	282.3	3055359	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
15.100	90.6	C20H42	282.3	1458538	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
15.200	89.9	C16H34	226.3	715772	544-76-3	Hexadecane
15.500	88.0	C15H32	212.3	714490	3891-98-3	Dodecane, 2,6,10-trimethyl-
16.600	90.1	C20H42	282.3	1238840	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
17.100	89.6	C20H42	282.3	1366058	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-