

## 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

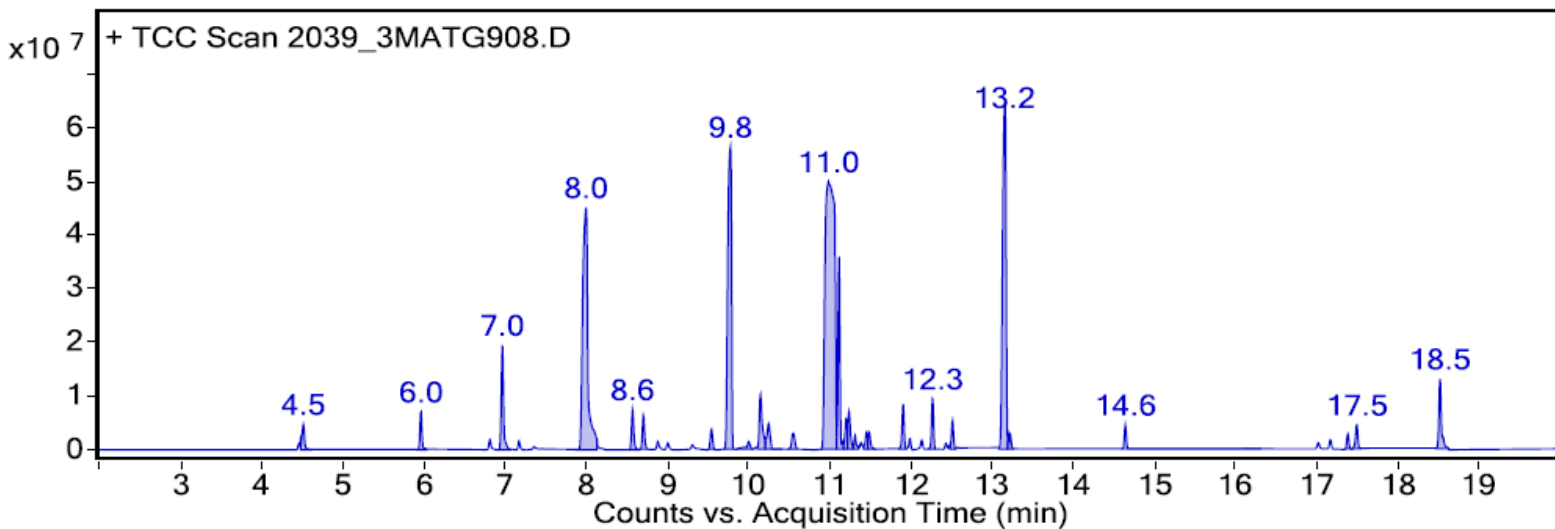
*Alkynes* – can become reactive when exposed to heat or UV light

Sample: 3M Scotch ATG Gold adhesive transfer tape #908

Oddy test result: Temporary

Date GC-MS collected: 02/09/2018

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.



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.800	86.0	Co2	117.9	2545437	124-38-9	Carbon dioxide
4.500	93.1	C4H9NO	87.1	1999087	96-29-7	2-Butanone, oxime
4.500	93.9	C4H9NO	87.1	10781409	96-29-7	2-Butanone, oxime
6.000	96.4	C6H10O	98.1	12254261	108-94-1	Cyclohexanone
6.800	96.0	C10H16	136.1	3760414	79-92-5	Camphene
7.000	97.9	C7H6O	106.0	37615491	100-52-7	Benzaldehyde
7.200	94.8	C8H24O4Si4	296.1	2839749	556-67-2	Cyclotetrasiloxane, octamethyl-
7.400	89.7	C10H20	140.2	1945783	3178-22-1	Cyclohexane, (1,1-dimethylethyl)-
8.000	86.8	C10H22O	158.2	153168486	112-30-1	1-Decanol
8.100	94.3	C7H8O	108.1	2404619	100-51-6	Benzyl Alcohol
8.600	99.0	C8H8O	120.1	14274035	98-86-2	Ethanone, 1-phenyl-
8.700	94.3	C9H18O2	158.1	11637375	1000368-94-7	Formic acid, 2-ethylhexyl ester

8.900	93.6	C8H17Br	192.1	3054123	18908-66-2	Heptane, 3-(bromomethyl)-
9.000	94.4	C8H8O2	136.1	2696632	93-58-3	Benzoic acid, methyl ester
9.300	88.1	C8H18O	130.1	2143949	1653-40-3	1-Heptanol, 6-methyl-
9.500	94.5	C10H30O5Si5	370.1	7802810	541-02-6	Cyclopentasiloxane, decamethyl-
9.800	96.9	C10H20O2	172.1	178697703	103-09-3	Acetic acid, 2-ethylhexyl ester
10.000	83.9	C10H20O2	172.1	2936485	112-14-1	Acetic acid, octyl ester
10.100	95.2	C10H18O	154.1	28561581	124-76-5	Bicyclo[2.2.1]heptan-2-ol, 1,7,7-trimethyl-, exo-
10.200	84.3	C10H22O	158.2	5342749	112-30-1	1-Decanol
10.500	80.9	C7H10O3	142.1	8227339	999053-09-0	1,6-Dioxaspiro[4.4]nonan-2-one
11.000	80.6	C3H7N	57.1	72783329	503-29-7	Azetidine
11.100	91.0	C11H22O2	186.2	58504308	999145-46-3	2-Ethyl-1-hexyl propionate
11.300	87.4	C11H20O2	184.1	3848302	2499-59-4	2-Propenoic acid, octyl ester
11.500	86.4	C8H18O	130.1	3273534	57803-73-3	(S)-(+)-5-Methyl-1-heptanol
11.500	85.4	C6H11NO	113.1	3852260	105-60-2	2H-Azepin-2-one, hexahydro-
11.900	96.2	C12H20O2	196.1	14410830	5655-61-8	Bicyclo[2.2.1]heptan-2-ol, 1,7,7-trimethyl-, acetate, (1S-endo)-
12.000	95.9	C12H36O6Si6	444.1	3508141	540-97-6	Cyclohexasiloxane, dodecamethyl-
12.100	87.7	C19H40	268.3	2972534	1560-88-9	Octadecane, 2-methyl-
12.300	91.5	C12H24O2	200.2	15989247	25415-84-3	n-Butyric acid 2-ethylhexyl ester
12.500	81.1	C13H20O2	208.1	9221716	5888-33-5	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-
13.200	96.8	C13H20O2	208.1	189407048	5888-33-5	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-
13.200	94.4	C13H22O2	210.2	4475261	2756-56-1	Isobornyl propionate
14.600	93.8	C16H34O	242.3	6999073	10143-60-9	bis(2-Ethylhexyl) ether
17.200	84.0	C18H32	248.3	3071867	52873-50-4	1,3-Dimethyl-5-n-hexyladamantane
17.400	80.5	C15H22	202.2	5206047	483-77-2	Calamenene