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

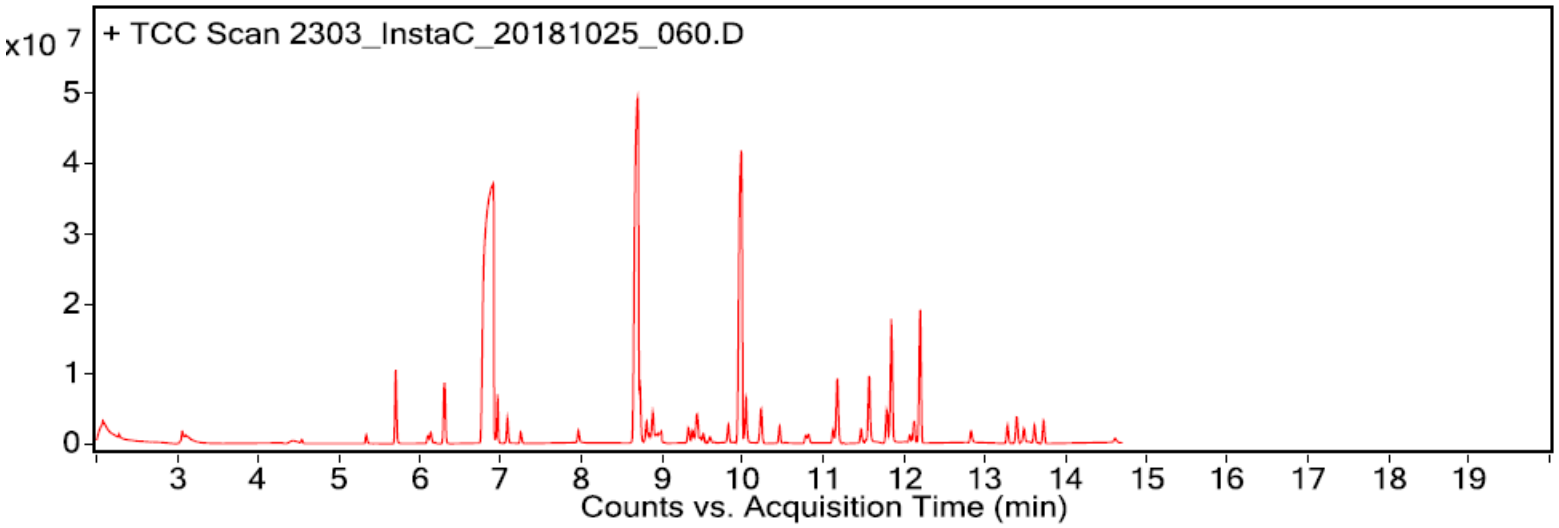
Alkynes – can become reactive when exposed to heat or UV light

Sample: Quality Media and Laminating Solutions (QMLS): Instabond C double-sided Adhesive

Date collected: 10/24/2018

Technique used: SPME with a PDMS/DVB fiber; Agilent 7890B GC and 5977B MS fitted with a GL Sciences OPTIC-4 multimode inlet and LEAP PAL RTC auto-sampler; Pre-heated at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample 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 using the Masshunter Qualitative program. Samples > 80% match with a NIST 17.0 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 11.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.630	98.0	C2H4O2	60.0	33967261	64-19-7	Acetic acid
1.740	93.3	C7H8	92.1	14135572	108-88-3	Benzene, methyl-
2.080	85.5	C5H8O2	100.1	32329969	123-54-6	2,4-Pentanedione
3.060	96.3	C5H8O2	100.1	1759345	123-54-6	Acetylacetone
3.110	86.3	C6H18O3Si3	222.1	9205203	541-05-9	Cyclotrisiloxane, hexamethyl-
4.430	87.4	C7H14O	114.1	2781064	106-35-4	3-Heptanone
5.340	96.1	C7H12O2	128.1	1852746	1540-34-7	2,4-Pentanedione, 3-ethyl-
5.700	98.0	C7H6O	106.0	14802185	100-52-7	Benzaldehyde
6.100	81.3	C6H9D2N	99.1	1561489	19424-31-8	4-METHYLPENTANENITRILE-2,2-D2
6.140	95.0	C6H6O	94.0	2458162	108-95-2	Phenol
6.310	96.1	C8H24O4Si4	296.1	14859967	556-67-2	Cyclotetrasiloxane, octamethyl-
6.910	82.5	C5H9N	83.1	143205938	2769-64-4	Butane, 1-isocyano-
6.970	96.2	C7H8O	108.1	6549279	100-51-6	Benzyl Alcohol
7.250	92.8	C7H10O	110.1	2411193	1193-18-6	2-Cyclohexen-1-one, 3-methyl-
7.970	96.8	C9H18O	142.1	3025049	124-19-6	Nonanal
8.700	95.1	C10H20O2	172.1	154349767	103-09-3	Acetic acid, 2-ethylhexyl ester
8.730	93.1	C10H30O5Si5	370.1	14339830	541-02-6	Cyclopentasiloxane, decamethyl-
8.810	87.3	C10H20O2	172.1	5503441	112-14-1	Acetic acid, octyl ester
8.990	97.5	C25H23NO10	497.1	9972588	71127-22-5	TETRAMETHYL 1-BENZOYLOXY-4,5-DIHYDROPYRIDO(1,2-A)AZEPINE-2,3,4,5-TETRACARBOX...
9.330	95.9	C10H12O2	164.1	3528688	93-92-5	Benzenemethanol, .alpha.-methyl-, acetate
9.510	91.4	C10H12O2	164.1	1796701	939-48-0	Benzoic acid, 1-methylethyl ester
9.600	94.1	C10H20O	156.2	1655202	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
9.820	93.3	C11H20O2	184.1	4359926	103-11-7	2-Ethylhexyl acrylate
10.230	95.9	C10H12O2	164.1	6278494	103-45-7	Acetic acid, 2-phenylethyl ester
10.460	93.2	C11H14O2	178.1	3789488	1000445-45-2	(.+/-.)-1-Phenyl-propan-2-ol, N-(acetyl)
11.120	93.5	C12H24O2	200.2	3194516	25415-84-3	n-Butyric acid 2-ethylhexyl ester
11.170	95.8	C12H36O6Si6	444.1	16891217	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.470	93.7	C9H14O6	218.1	3706628	102-76-1	Triacetin
11.570	91.2	C12H24O3	216.2	17619057	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester

11.790	96.5	C11H14O2	178.1	7971597	122-72-5	3-Phenyl-1-propanol, acetate
11.850	93.4	C12H24O3	216.2	27526913	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.130	95.0	C14H30	198.2	2590830	629-59-4	Tetradecane
12.200	95.4	C13H12	168.1	32099344	643-58-3	1,1'-Biphenyl, 2-methyl-
12.830	84.6	C11H12O4	208.1	3207306	999200-85-3	ETHYLIDENE MONOACETATE MONOBENZOATE
13.280	94.7	C13H12	168.1	4238519	644-08-6	1,1'-Biphenyl, 4-methyl-
13.490	92.9	C16H34O	242.3	3331106	10143-60-9	bis(2-Ethylhexyl) ether
13.620	96.5	C15H24O	220.2	4236497	128-37-0	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-
13.730	94.1	C14H14	182.1	5513438	103-29-7	Benzene, 1,1'-(1,2-ethanediyl)bis-
14.610	90.6	C16H30O4	286.2	1755296	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-