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

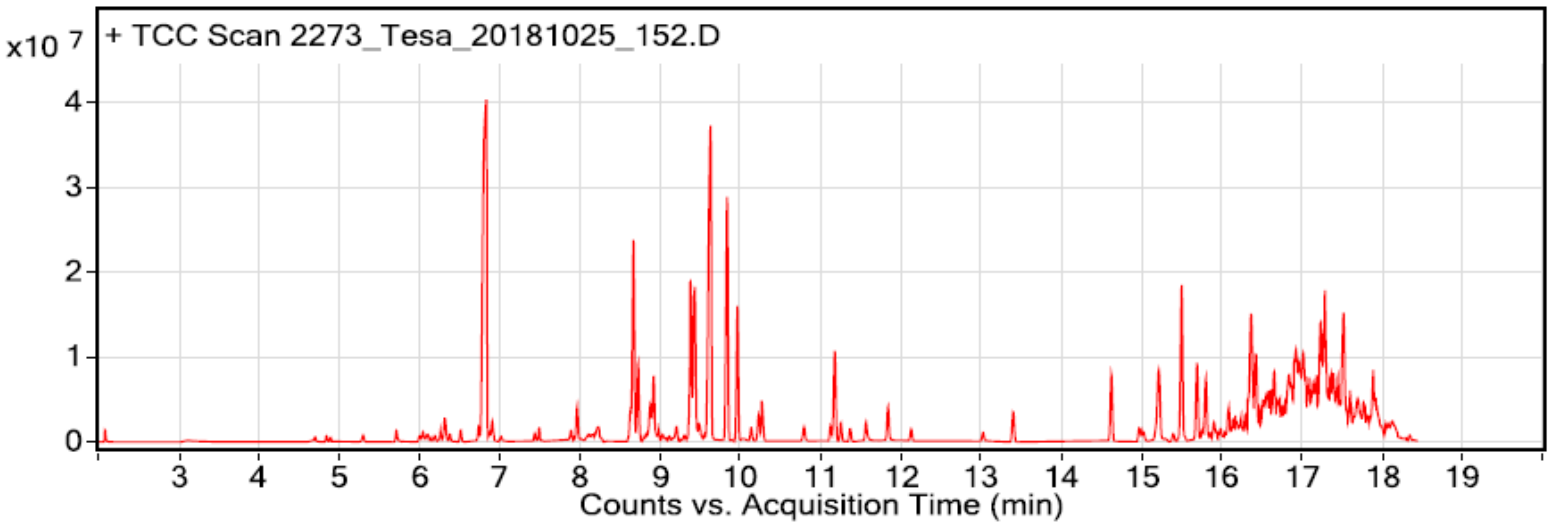
Alkynes – can become reactive when exposed to heat or UV light

Sample: Tesa tape 4985

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 autosampler; Pre-heated at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample injected into 220°C inlet and crotrapped 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 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
1.520	98.0	C2H4O2	60.0	3148745	64-19-7	Acetic acid
1.710	91.9	C7H8	92.1	1052649	108-88-3	Benzene, methyl-
2.080	93.7	C2H8O2Si	92.0	1314654	1066-42-8	Silanediol, dimethyl-
3.120	92.4	C6H18O3Si3	222.1	2058741	541-05-9	Cyclotrisiloxane, hexamethyl-
4.700	95.0	C7H12O2	128.1	1396463	141-32-2	2-Propenoic acid, butyl ester
4.840	97.6	C6H14O2	118.1	1004562	111-76-2	Ethanol, 2-butoxy-
5.300	96.1	C10H16	136.1	1407652	80-56-8	.ALPHA.-PINENE, (-)-
5.710	95.1	C7H6O	106.0	2274717	100-52-7	Benzaldehyde
6.040	94.0	C6H6O	94.0	1550630	108-95-2	Phenol
6.100	84.3	C7H14O2	130.1	991148	111-14-8	Heptanoic acid
6.190	81.1	C8H18O	130.1	1149090	0-00-0	Isooctanols
6.310	96.0	C8H24O4Si4	296.1	3747097	556-67-2	Cyclotetrasiloxane, octamethyl-
6.330	95.3	C10H22	142.2	924612	124-18-5	Decane
6.380	97.4	C8H16O	128.1	1262220	124-13-0	Octanal
6.510	97.2	C10H16	136.1	1989304	13466-78-9	.DELTA.3-Carene
6.740	93.9	C10H14	134.1	2607558	527-84-4	Benzene, 1-methyl-2-(1-methylethyl)-
6.830	84.2	C10H22O	158.2	86577840	112-30-1	1-Decanol
7.020	84.9	C8H18O	130.1	1059221	57803-73-3	(S)-(+)-5-Methyl-1-heptanol
7.440	93.9	C8H18O	130.1	1289588	111-87-5	1-Octanol
7.490	90.1	C6H8O4	144.0	1178116	999056-02-6	(S)-2-Methyl-5-oxotetrahydrofuran-2-carboxylic acid
7.890	97.2	C11H24	156.2	2191299	1120-21-4	Undecane
7.960	97.7	C9H18O	142.1	6552366	124-19-6	Nonanal
8.210	87.6	C13H22F4	254.2	1179462	108377-18-0	1,1,1,2-tetrafluoro-2-tridecene
8.630	88.5	C10H16O	152.1	3737342	464-48-2	Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-, (1S)-
8.670	96.7	C10H20O2	172.1	37655103	103-09-3	Acetic acid, 2-ethylhexyl ester
8.730	94.0	C10H30O5Si5	370.1	12305406	541-02-6	Cyclopentasiloxane, decamethyl-
8.920	96.7	C10H18O	154.1	6922668	89-80-5	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, trans-
9.200	87.2	C12H36O4Si5	384.1	2466463	141-63-9	Pentasiloxane, dodecamethyl-
9.380	91.7	C10H16O	152.1	18059231	3767-44-0	ENDO-ISOCAMPHONONE
9.430	94.1	C10H20O	156.2	32300108	937-05-3	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-
9.480	95.1	C10H20O	156.2	1328709	112-31-2	Decanal
9.630	95.7	C10H20O	156.2	90963358	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
9.830	95.8	C11H20O2	184.1	50081755	103-11-7	2-Ethylhexyl acrylate
9.960	91.5	C11H22O2	186.2	25252794	999145-46-3	2-Ethyl-1-hexyl propionate

10.130	86.4	C10H16O	152.1	2675628	499-71-8	2-Cyclohexen-1-one, 2-methyl-5-(1-methylethyl)-, (S)-
10.230	92.0	C10H16N2	164.1	5034444	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
10.270	95.2	C10H16O	152.1	6098520	499-74-1	2-Cyclohexen-1-one, 6-methyl-3-(1-methylethyl)-
10.790	93.0	C13H28	184.2	3012172	629-50-5	Tridecane
11.120	93.5	C12H24O2	200.2	2914923	25415-84-3	n-Butyric acid 2-ethylhexyl ester
11.180	95.1	C12H36O6Si6	444.1	19684770	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.250	84.5	C12H16	160.1	2189573	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.370	85.1	C12H16	160.1	2463869	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.570	86.1	C12H24O3	216.2	4256989	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.840	92.9	C12H24O3	216.2	7234415	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.130	95.1	C14H30	198.2	2137780	629-59-4	Tetradecane
13.400	80.5	C14H42O7Si7	518.1	6729012	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.620	83.7	C11H20O	168.2	14139272	99992-19-5	4a(2H)-Naphthalenemethanol, octahydro-
15.400	86.8	C16H48O8Si8	592.2	1808479	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.500	84.8	C11H20O	168.2	33492259	99992-19-5	4a(2H)-Naphthalenemethanol, octahydro-
17.160	81.0	C10H15NO5	229.1	1805454	999260-10-6	4-Hydroxy-5,7-(methanoepoxy)-2-methylfuran[2,3-c]pyrano[3,4-c]isooxazolidine
17.180	80.5	C24H38O4	390.3	3507413	999646-44-3	di - isobornyl succinate
18.000	81.4	C13H15N3O	229.1	1064805	999260-74-9	3,7,7-Trimethyl-7,8-diydro-1H-pyrazolo[3,4-b]quinolin-5(6H)-one