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

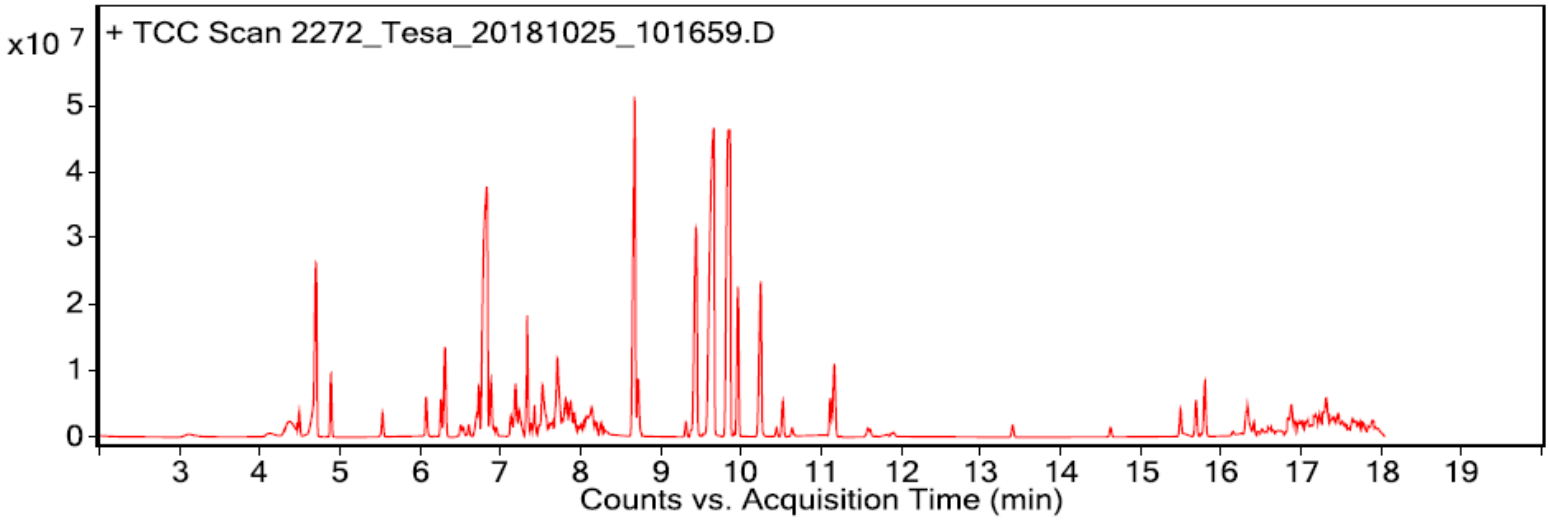
Alkynes – can become reactive when exposed to heat or UV light

Sample: Tesa tape 4965

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) 11.5 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
1.730	93.8	C7H8	92.1	21765602	999007-26-6	4-Ethynylcyclopentene
3.110	92.0	C6H18O3Si3	222.1	4661378	541-05-9	Cyclotrisiloxane, hexamethyl-
4.120	95.0	C7H14O	114.1	4406972	123-19-3	4-Heptanone
4.370	90.7	C5H10O2	102.1	18133286	592-84-7	Formic acid, butyl ester
4.490	86.5	C8H18O	130.1	6346481	142-96-1	n-Butyl ether
4.700	96.1	C7H12O2	128.1	60117270	141-32-2	2-Propenoic acid, butyl ester
4.890	96.1	C7H14O2	130.1	13119565	590-01-2	Propanoic acid, butyl ester
5.530	96.5	C10H16	136.1	5750988	79-92-5	Camphene
6.080	88.0	C6H10O2	114.1	9618727	504-85-8	3-Pentenoic acid, 4-methyl-
6.260	96.2	C8H16O2	144.1	8139240	109-21-7	Butanoic acid, butyl ester
6.310	97.1	C8H24O4Si4	296.1	23002920	556-67-2	Cyclotetrasiloxane, octamethyl-
6.510	87.4	C10H16	136.1	2109307	13466-78-9	.DELTA.3-Carene
6.540	82.3	C14H30O3S	278.2	1880916	999397-36-4	Sulfurous acid, 2-ethylhexyl isohexyl ester
6.610	95.9	C10H16	136.1	2766182	99-86-5	.ALPHA. TERPINENE
6.710	90.5	C12H26	170.2	4319740	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
6.730	93.3	C10H14	134.1	5846944	25155-15-1	Benzene, methyl(1-methylethyl)-
6.830	83.9	C10H22O	158.2	97838485	112-30-1	1-Decanol
6.880	90.2	C11H24	156.2	9789491	62016-19-7	Octane, 6-ethyl-2-methyl-
6.950	92.3	C13H28	184.2	2501561	62108-26-3	Decane, 2,6,8-trimethyl-
7.130	89.6	C12H26	170.2	2738022	52670-34-5	Octane, 2,3,6,7-tetramethyl-
7.190	91.5	C15H32	212.3	15284290	31295-56-4	Dodecane, 2,6,11-trimethyl-
7.240	94.1	C15H32	212.3	10777695	31295-56-4	Dodecane, 2,6,11-trimethyl-
7.330	93.1	C15H32	212.3	16249197	31295-56-4	Dodecane, 2,6,11-trimethyl-
7.430	89.9	C13H28	184.2	4501974	62108-22-9	Decane, 2,5,9-trimethyl-
7.530	80.6	C13H28	184.2	15230087	6117-97-1	Dodecane, 4-methyl-
7.620	81.0	C18H38	254.3	2665153	3892-00-0	Pentadecane, 2,6,10-trimethyl-
7.820	91.2	C11H24	156.2	9002568	17302-23-7	Nonane, 4,5-dimethyl-
7.880	90.6	C13H28	184.2	13832195	17301-32-5	Undecane, 4,7-dimethyl-
7.930	92.5	C15H32	212.3	6364635	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.010	88.0	C10H22	142.2	5285797	17302-01-1	3-Ethyl-3-methylheptane
8.140	87.9	C13H28	184.2	12140196	62108-24-1	Decane, 2,6,6-trimethyl-
8.200	85.6	C13H28	184.2	2798334	17312-63-9	Nonane, 5-butyl-
8.260	88.8	C15H32	212.3	4113106	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.310	90.1	C11H24	156.2	2931194	17302-23-7	Nonane, 4,5-dimethyl-

8.680	96.7	C10H20O2	172.1	91829202	103-09-3	Acetic acid, 2-ethylhexyl ester
8.720	93.5	C10H30O5Si5	370.1	11158721	541-02-6	Cyclopentasiloxane, decamethyl-
9.320	89.9	C11H16	148.1	3628303	1595-16-0	Benzene, 1-methyl-4-(1-methylpropyl)-
9.450	94.9	C10H20O	156.2	79148388	937-05-3	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-
9.660	95.7	C10H20O	156.2	183208701	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
9.970	91.4	C11H22O2	186.2	36991001	999145-46-3	2-Ethyl-1-hexyl propionate
10.250	93.8	C10H16N2	164.1	49329047	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
10.450	89.2	C12H25Br	248.1	2187962	13187-99-0	2-Bromo dodecane
10.530	91.7	C14H30	198.2	9198129	61141-72-8	Dodecane, 4,6-dimethyl-
10.640	89.7	C14H30	198.2	2465911	61141-72-8	Dodecane, 4,6-dimethyl-
11.120	92.6	C12H24O2	200.2	8839763	25415-84-3	n-Butyric acid 2-ethylhexyl ester
11.170	95.6	C12H36O6Si6	444.1	18300939	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.620	81.3	C8H14O3	158.1	1884966	13984-57-1	Hexanoic acid, 5-oxo-, ethyl ester
13.400	80.4	C14H42O7Si7	518.1	3330489	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.620	83.9	C11H20O	168.2	2505151	99992-19-5	4a(2H)-Naphthalenemethanol, octahydro-
15.490	85.2	C11H20O	168.2	7355807	99992-19-5	4a(2H)-Naphthalenemethanol, octahydro-