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 4959

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.

+ TCC Scan 2274_Tesa_20181025_065.D
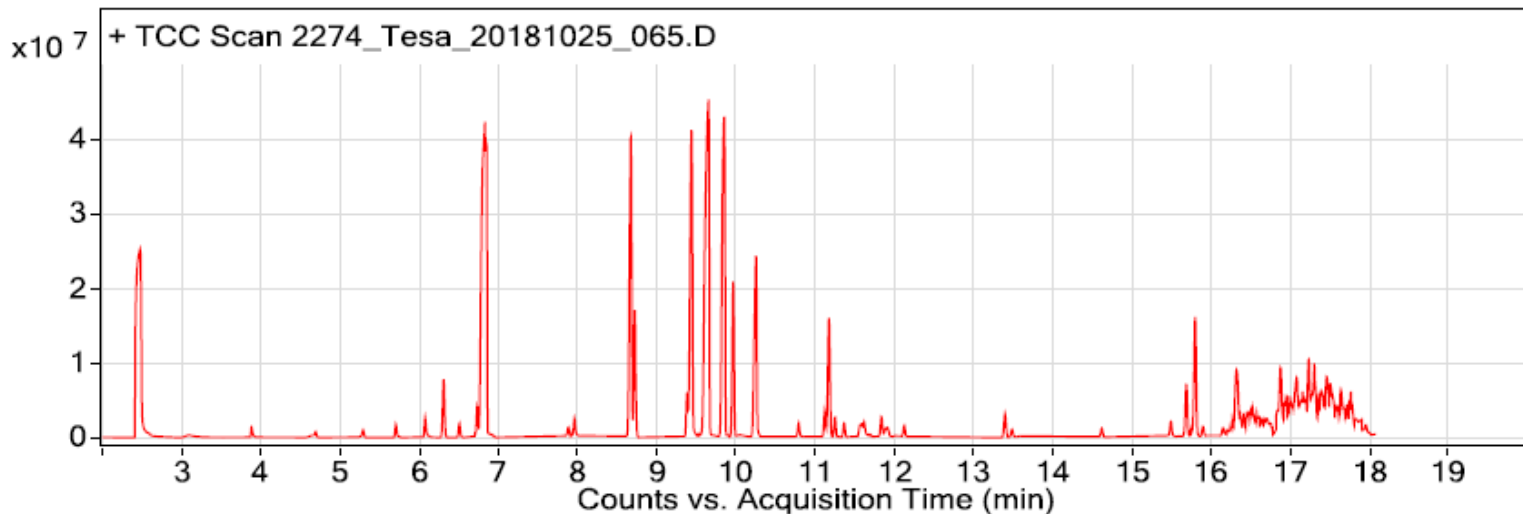
RT	Score	Formula	MW	Area	CAS #	Name
1.920	94.7	C4H10O	74.1	1730415	71-36-3	1-Butanol
2.460	83.5	C13H24Br2O5	418.0	17655031	999682-55-9	Ethyl (2RS,3SR)-2-bromo-2-bromomethyl-3[(2-methoxyethoxy)methoxy]hexanoate
3.090	91.6	C6H18O3Si3	222.1	2706456	541-05-9	Cyclotrisiloxane, hexamethyl-
3.880	95.6	C6H12O2	116.1	1918338	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
4.690	94.1	C7H12O2	128.1	2235316	141-32-2	2-Propenoic acid, butyl ester
5.290	97.5	C10H16	136.1	1918776	80-56-8	.ALPHA.-PINENE, (-)-
5.710	96.1	C7H6O	106.0	2700046	100-52-7	Benzaldehyde
6.080	89.9	C6H10O2	114.1	4175500	504-85-8	3-Pentenoic acid, 4-methyl-
6.310	96.4	C8H24O4Si4	296.1	13280397	556-67-2	Cyclotetrasiloxane, octamethyl-
6.510	96.4	C10H16	136.1	2731816	13466-78-9	.DELTA.3-Carene
6.730	94.2	C10H14	134.1	5608833	25155-15-1	Benzene, methyl(1-methylethyl)-
6.780	82.4	C15H30	210.2	1774071	84979-99-7	decamethylcyclopentan
6.850	86.5	C10H22O	158.2	126009661	112-30-1	1-Decanol
7.880	97.4	C11H24	156.2	2137837	1120-21-4	Undecane
7.960	95.8	C9H18O	142.1	4050122	124-19-6	Nonanal
8.670	96.7	C10H20O2	172.1	74245192	103-09-3	Acetic acid, 2-ethylhexyl ester
8.720	95.1	C10H30O5Si5	370.1	22732140	541-02-6	Cyclopentasiloxane, decamethyl-
9.380	90.9	C12H26	170.2	4810677	112-40-3	Dodecane
9.440	95.5	C10H20O	156.2	63648064	937-05-3	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-
9.650	95.6	C10H20O	156.2	160144034	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
9.830	80.9	C16H25NO2	263.2	3102950	999356-39-6	1-Piperidino-5-(4-hydroxyphenoxy)pentane
9.850	96.5	C11H20O2	184.1	108026394	103-11-7	2-Ethylhexyl acrylate
9.970	91.4	C11H22O2	186.2	33865046	999145-46-3	2-Ethyl-1-hexyl propionate
10.250	94.1	C10H16N2	164.1	52771643	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
10.790	95.1	C13H28	184.2	2881971	629-50-5	Tridecane
11.120	93.5	C12H24O2	200.2	5431752	25415-84-3	n-Butyric acid 2-ethylhexyl ester
11.180	95.3	C12H36O6Si6	444.1	29936005	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.250	86.2	C12H16	160.1	2737246	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.370	85.3	C12H16	160.1	3006089	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
11.620	83.4	C8H14O3	158.1	2496183	13984-57-1	Hexanoic acid, 5-oxo-, ethyl ester
11.840	93.8	C12H24O3	216.2	3729989	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.130	94.6	C14H30	198.2	2377100	629-59-4	Tetradecane
13.400	80.4	C14H42O7Si7	518.1	5835858	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.490	94.2	C16H34O	242.3	1742165	10143-60-9	bis(2-Ethylhexyl) ether

14.620	81.8		C11H20O	168.2	2113628	99992-19-5 4a(2H)-Naphthalenemethanol, octahydro-
15.490	80.7		C11H20O	168.2	3804656	99992-19-5 4a(2H)-Naphthalenemethanol, octahydro-
15.900	81.4		C19H28O	272.2	2191301	999383-09-9 13-Acetyl[11]paracyclophane
17.720	81.7		C20H32	272.3	7807523	20070-61-5 Kaur-16-ene, (8.beta.,13.beta.)-
17.780	84.5		C20H32	272.3	8860017	35241-40-8 (4aS,4bR,10aS)-7-Isopropyl-1,1,4a-trimethyl-1,2,3,4,4a,4b,5,6,10,10a-decahydrophenanthrene