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

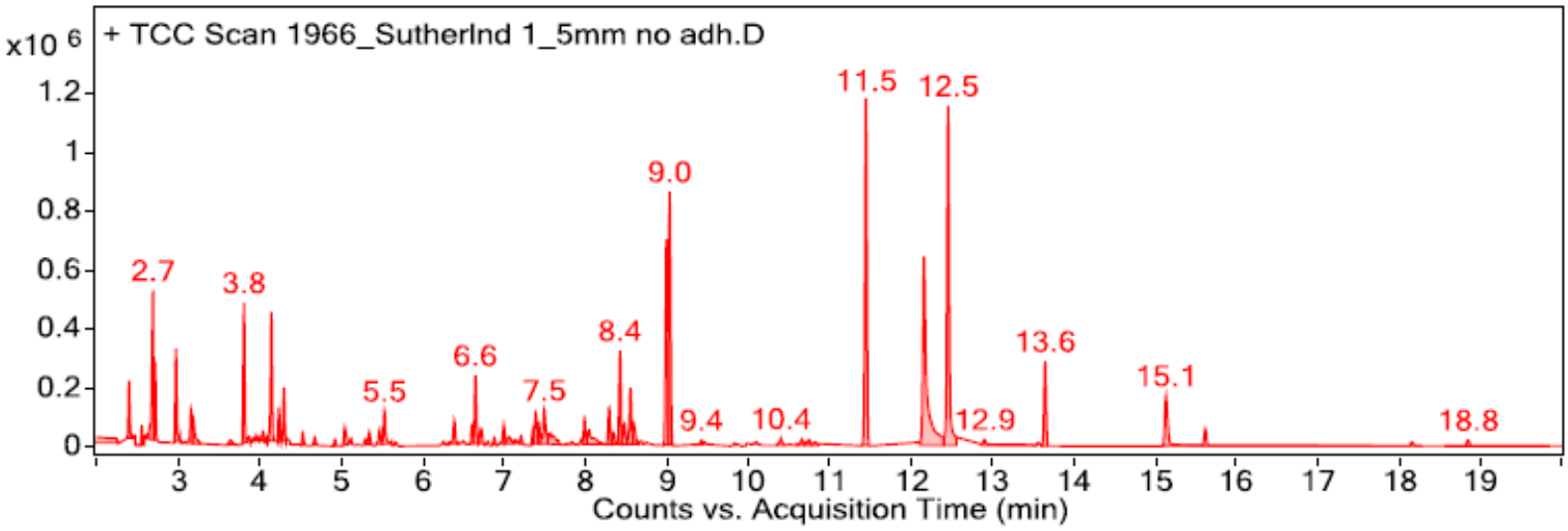
Sample: Sutherland Felt Company; 1.5 mm polyester felt, white

Oddy test result: Temporary

Date GC-MS collected: 12/23/2017

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.

VOCs not highlighted are because they were also observed in blanks: (1) ~12.2 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) ~12.5 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.400	88.0	C5H10O3	118.1	398486	110-49-6	Ethanol, 2-methoxy-, acetate
2.500	94.4	C3H10OSi	90.1	78226	1066-40-6	Silanol, trimethyl-
2.600	84.4	C4H8O	72.1	70100	2919-23-5	Cyclobutanol
2.700	97.2	C2H4O2	60.0	346008	64-19-7	Acetic acid
2.700	91.8	C4H8O2	88.1	322329	141-78-6	Acetic acid, ethyl ester
3.000	89.0	C4H10O	74.1	414875	71-36-3	1-Butanol
3.200	84.3	C2H8O2Si	92.0	197165	1066-42-8	Silanediol, dimethyl-
3.200	87.3	C5H10O	86.1	80722	110-62-3	Pentanal
3.800	94.8	C7H8	92.1	635362	108-88-3	Benzene, methyl-
4.000	82.1	C15H19NO3	261.1	26894	0-00-0	(1R,4R,5R)-2-Benzyl-7,7-dimethyl-6,8-dioxa-2-azabicyclo[3.4.0]nonan-4-one
4.100	89.1	C4H8O3	104.0	31927	5981-06-6	1,3,5-Trioxepane
4.100	96.5	C6H12O	100.1	457146	66-25-1	Hexanal
4.200	98.2	C2Cl4	163.9	187226	127-18-4	Tetrachloroethylene
4.300	92.0	C6H18O3Si3	222.1	239256	541-05-9	Cyclotrisiloxane, hexamethyl-
4.400	87.6	C16H13NO2	251.1	22714	116705-58-9	1-(Pent-4-ynyl)pyrano[3,4-b]indol-3-one
4.500	92.0	C5H4O2	96.0	68367	98-01-1	2-Furancarboxaldehyde
4.700	91.6	C6H12O2	116.1	47874	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
4.900	94.6	C8H10	106.1	33466	100-41-4	Benzene, ethyl-
5.000	97.2	C8H10	106.1	137058	106-42-3	Benzene, 1,4-dimethyl-
5.100	88.2	C6H11N	97.1	28066	628-73-9	Hexanenitrile
5.300	92.6	C8H16O	128.1	32388	111-13-7	2-Octanone
5.300	94.1	C8H8	104.1	76186	100-42-5	Styrene
5.500	89.7	C7H14O	114.1	95652	111-71-7	Heptanal
5.500	92.9	C6H14O2	118.1	123476	111-76-2	Ethanol, 2-butoxy-
6.300	92.2	C13H28	184.2	24317	17312-57-1	Dodecane, 3-methyl-
6.400	98.0	C7H6O	106.0	156973	100-52-7	Benzaldehyde

6.600	94.6	C6H6O	94.0	100893	108-95-2	Phenol
6.600	94.3	C8H24O4Si4	296.1	382861	556-67-2	Cyclotetrasiloxane, octamethyl-
6.700	91.2	C8H24O4Si4	296.1	139035	556-67-2	Cyclotetrasiloxane, octamethyl-
6.900	89.3	C9H12	120.1	49498	0-00-0	unidentified C3-benzene
7.000	94.3	C8H16O	128.1	108442	124-13-0	Octanal
7.100	87.6	C8H16O	128.1	24672	124-13-0	Octanal
7.200	88.1	C7H16O3	148.1	39443	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.200	91.9	C6H4Cl2	146.0	38752	106-46-7	Benzene, 1,4-dichloro-
7.400	91.0	C10H14	134.1	87019	25155-15-1	Benzene, methyl(1-methylethyl)-
7.400	96.0	C8H18O	130.1	224519	104-76-7	1-Hexanol, 2-ethyl-
7.400	93.7	C10H16	136.1	83153	138-86-3	dl-Limonene
7.500	89.4	C7H8O	108.1	369621	100-51-6	Benzyl Alcohol
7.600	80.2	C8H11F6NO	251.1	30279	999321-46-7	1-(Bistrifluoromethylamino-oxy)-1-methylcyclopentane
7.900	85.5	C7H12O4	160.1	23236	105-53-3	Propanedioic acid, diethyl ester
8.000	97.3	C8H8O	120.1	78720	98-86-2	Ethanone, 1-phenyl-
8.300	93.6	C9H12O	136.1	226232	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.300	84.7	C9H12O	136.1	93867	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.400	97.0	C8H8O2	136.1	292398	93-58-3	Benzoic acid, methyl ester
8.500	90.0	C8H8O2	136.1	158983	93-58-3	Benzoic acid, methyl ester
8.600	93.4	C9H18O	142.1	205605	124-19-6	Nonanal
8.600	94.5	C9H18O	142.1	108153	124-19-6	Nonanal
9.000	92.2	C10H30O5Si5	370.1	1107719	541-02-6	Cyclopentasiloxane, decamethyl-
9.000	90.1	C10H30O5Si5	370.1	1441354	541-02-6	Cyclopentasiloxane, decamethyl-
9.400	88.6	C12H24O2	200.2	31007	999180-60-3	DIMETHYL OCTANYL ACETATE
9.800	84.2	C8H12D2O	128.1	23079	79640-11-2	4,4-Dideuterio-6,6-dimethylcyclohexanone
10.100	82.4	C12H24	168.2	24350	55170-80-4	1-Decene, 2,4-dimethyl-
10.400	84.7	C8H16Cl2	182.1	39369	21948-46-9	1,2-Dichlorooctane
10.700	89.0	C8H18O	130.1	37821	26952-21-6	Isooctanol
11.400	91.0	C12H36O6Si6	444.1	2013440	540-97-6	Cyclohexasiloxane, dodecamethyl-
12.200	92.8	C12H24O3	216.2	1864933	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.500	93.1	C12H24O3	216.2	2121722	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.900	85.7	C12H24O	184.2	27535	112-54-9	Dodecanal
15.100	96.3	C12H14O4	222.1	264208	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
15.200	95.1	C16H30O4	286.2	125776	74381-40-1	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
15.600	90.4	C16H48O8Si8	592.2	105090	556-68-3	Cyclooctasiloxane, hexadecamethyl-
18.200	93.2	C16H22O4	278.2	28214	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
18.800	93.1	C12H10O2S	218.0	42362	127-63-9	Benzene, 1,1'-sulfonylbis-