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

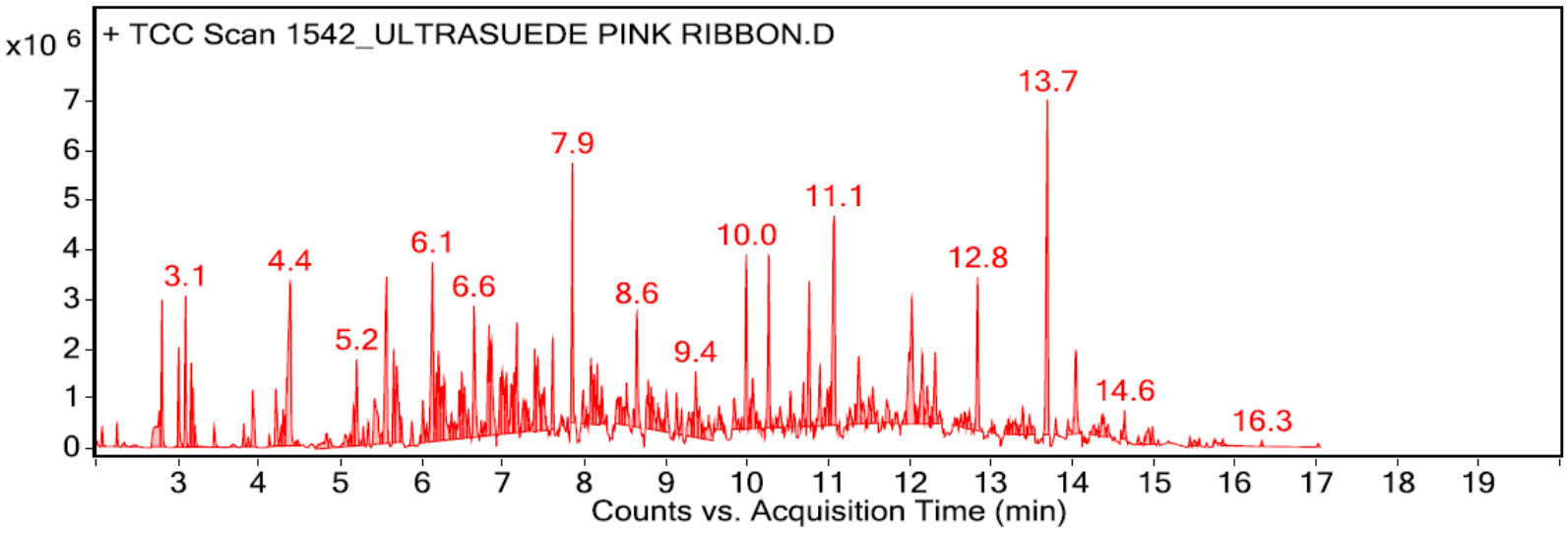
Sample: Toray Ultrasuede HP pink ribbon style 5522 color 6659 fabric

Oddy test result: Temporary

Date GC-MS collected: 12/22/2016

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) 4.5 min: methoxy-phenyl oxime; (2) 10.8 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 11.1 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.500	84.0	C3H6O	58.0	371942	67-64-1	Acetone
1.700	94.0	C3H10OSi	90.1	201542	1066-40-6	Silanol, trimethyl-
1.800	98.6	C4H8O	72.1	868567	123-72-8	Butanal
1.800	97.6	C4H8O2	88.1	115795	141-78-6	Acetic acid, ethyl ester
1.900	98.5	C4H8O	72.1	139192	109-99-9	Furan, tetrahydro-
2.000	98.5	C2H4O2	60.0	917957	64-19-7	Acetic acid
2.300	96.1	C5H10O	86.1	420137	110-62-3	Pentanal
2.700	85.8	C2H7N	45.1	1752324	124-40-3	Methanamine, N-methyl-
2.800	96.2	C5H12O	88.1	1138423	71-41-0	1-Pentanol
2.800	98.5	C7H8	92.1	2513896	108-88-3	Benzene, methyl-
3.000	98.9	C3H7NO	73.1	2274799	68-12-2	Formamide, N,N-dimethyl-
3.100	97.6	C6H12O	100.1	3164468	66-25-1	Hexanal
3.200	96.7	C6H12O2	116.1	1656049	106-36-5	Propanoic acid, propyl ester
3.200	91.7	C6H18O3Si3	222.1	1107966	541-05-9	Cyclotrisiloxane, hexamethyl-
3.200	96.0	C6H12O2	116.1	318290	123-86-4	Acetic acid, butyl ester
3.400	98.5	C5H4O2	96.0	542164	98-01-1	Furfural
3.800	85.8	C8H10	106.1	533197	95-47-6	Benzene, 1,2-dimethyl-
3.900	92.3	C6H14O	102.1	160996	111-27-3	1-Hexanol
3.900	98.3	C8H10	106.1	1648739	1330-20-7	XYLENE
4.100	97.3	C7H14O	114.1	262235	110-43-0	2-Heptanone
4.200	91.0	C8H8	104.1	1326395	100-42-5	Styrene
4.200	95.1	C8H10	106.1	411698	106-42-3	Benzene, 1,4-dimethyl-

4.300	93.5	C9H20	128.2	300341	111-84-2	Nonane
4.300	97.0	C7H14O	114.1	493161	111-71-7	Heptanal
4.400	96.6	C6H14O2	118.1	6079872	111-76-2	Ethanol, 2-butoxy-
4.500	82.4	C4H6O2	86.0	177544	96-48-0	2(3H)-Furanone, dihydro-
5.100	97.4	C9H12	120.1	254129	0-00-0	unidentified C3-benzene
5.100	84.8	C7H12O	112.1	266644	18829-55-5	2-Heptenal, (E)-
5.100	85.7	C10H22	142.2	169964	17301-94-9	Nonane, 4-methyl-
5.200	94.4	C9H12	120.1	928113	611-14-3	Benzene, 1-ethyl-2-methyl-
5.200	97.8	C9H12ClN	169.1	2384602	999105-63-5	N-benzylidene-dimethylammonium chloride
5.300	95.1	C9H12	120.1	535353	526-73-8	Benzene, 1,2,3-trimethyl-
5.300	95.4	C8H24O4Si4	296.1	689120	556-67-2	Cyclotetrasiloxane, octamethyl-
5.400	89.0	C9H12	120.1	631024	98-82-8	Benzene, (1-methylethyl)-
5.400	87.0	C6H6O	94.0	2239532	108-95-2	Phenol
5.500	80.3	C9H10	118.1	322591	637-50-3	Benzene, 1-propenyl-
5.600	88.4	C9H14O	138.1	523818	3777-69-3	Furan, 2-pentyl-
5.600	97.5	C6H10O4	146.1	4743089	111-55-7	1,2-Ethanediol, diacetate
5.700	94.0	C9H12	120.1	2424973	108-67-8	Benzene, 1,3,5-trimethyl-
5.700	96.7	C10H22	142.2	1754236	124-18-5	Decane
5.700	88.1	C6H14O3	134.1	689605	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
5.700	95.0	C8H16O	128.1	613839	124-13-0	Octanal
5.900	84.7	C7H16O3	148.1	751722	20324-32-7	2-Propanol, 1-(2-methoxy-1-methylethoxy)-
6.000	83.0	C6H4Cl2	146.0	204497	541-73-1	Benzene, 1,3-dichloro-
6.000	82.7	C12H26	170.2	998091	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
6.100	94.3	C9H12	120.1	578693	108-67-8	Mesitylene
6.100	85.4	C10H16	136.1	167209	99-83-2	l-Phellandrene
6.100	98.0	C8H18O	130.1	6282882	104-76-7	1-Hexanol, 2-ethyl-
6.200	98.6	C10H16	136.1	1464935	138-86-3	dl-Limonene
6.200	91.6	C11H24	156.2	1267094	62016-19-7	Octane, 6-ethyl-2-methyl-
6.300	84.7	C7H8O	108.1	509448	100-51-6	Benzyl Alcohol
6.400	86.2	C6H13NO2	131.1	329933	646-14-0	Hexane, 1-nitro-
6.500	88.9	C12H26	170.2	2496138	62199-06-8	Heptane, 5-ethyl-2,2,3-trimethyl-
6.500	92.7	C13H28	184.2	1049926	62108-22-9	Decane, 2,5,9-trimethyl-
6.600	90.9	C10H22	142.2	4155229	2051-30-1	Octane, 2,6-dimethyl-
6.700	92.9	C8H8O	120.1	590797	98-86-2	Ethanone, 1-phenyl-
6.800	92.1	C13H28	184.2	3384029	17301-25-6	Undecane, 2,8-dimethyl-
6.900	93.3	C10H14	134.1	165347	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-

7.100	92.8	C11H24	156.2	681036	62016-19-7	Octane, 6-ethyl-2-methyl-
7.100	93.2	C11H24	156.2	827564	62016-19-7	Octane, 6-ethyl-2-methyl-
7.200	91.9	C12H26	170.2	2248294	17312-54-8	Decane, 3,7-dimethyl-
7.400	84.6	C12H24	168.2	1043002	74630-54-9	3-Undecene, 9-methyl-, (E)-
7.400	87.3	C13H28	184.2	2562678	62108-32-1	HEPTANE, 2,2,3,4,6,6-HEXAMETHYL-
7.500	81.9	C13H28	184.2	1162568	62238-00-0	Decane, 2,2,9-trimethyl-
7.500	93.5	C10H14	134.1	200865	488-23-3	Benzene, 1,2,3,4-tetramethyl-
7.900	96.8	C10H20O2	172.1	3923486	103-09-3	Acetic acid, 2-ethylhexyl ester
8.000	82.7	C12H26	170.2	1003207	1632-70-8	Undecane, 5-methyl-
8.100	85.9	C17H36O3S	320.2	1089678	999508-28-5	Sulfurous acid, 2-ethylhexyl nonyl ester
8.100	85.7	C12H26	170.2	461084	7045-71-8	Undecane, 2-methyl-

8.200	82.9	C13H28	184.2	936430	62338-09-4	Decane, 2,2,3-trimethyl-
8.200	86.8	C13H28	184.2	552557	62238-13-5	Decane, 2,3,7-trimethyl-
8.400	90.6	C10H20O	156.2	1063600	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(.+/-.)-
8.500	86.0	C8H18O3	162.1	625291	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
8.500	85.1	C12H19F5O2	290.1	1099089	999429-60-3	Pentafluoropropionic acid, nonyl ester
8.600	81.8	C10H8	128.1	319058	91-20-3	Naphthalene
8.600	96.2	C8H8O3	152.0	346900	119-36-8	Benzoic acid, 2-hydroxy-, methyl ester
8.800	82.9	C13H24O3	228.2	290486	1000383-25-7	Carbonic acid, decyl vinyl ester
9.000	82.4	C11H20O2	184.1	957168	103-11-7	2-Propenoic acid, 2-ethylhexyl ester
9.100	89.5	C11H22O2	186.2	1521377	999145-46-3	2-Ethyl-1-hexyl propionate
9.200	89.1	C16H34	226.3	321441	56292-69-4	Tetradecane, 2,5-dimethyl-
9.400	87.7	C15H32O	228.2	886703	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
9.700	84.0	C10H22O	158.2	916234	112-30-1	1-Decanol
9.700	84.4	C15H30	210.2	282726	645-10-3	1,7-Dimethyl-4-(1-methylethyl)cyclodecane
9.800	87.9	C10H12O2	164.1	524864	7473-98-5	2-Hydroxy-iso-butyrophenone
10.000	86.4	C13H28	184.2	479049	629-50-5	Tridecane

10.300	87.1	C12H26	170.2	5057209	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
10.500	83.1	C7H12O5	176.1	1007893	102-62-5	Glycerol 1,2-diacetate
10.600	88.0	C12H16	160.1	331491	1076-69-3	5,6,7,8,9,10-Hexahydrobenzocyclooctene
10.700	88.5	C20H42O	298.3	970475	1000406-38-4	Dodecyl octyl ether
10.800	90.5	C12H24O3	216.2	5121600	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
10.900	90.4	C13H28	184.2	985662	17312-57-1	Dodecane, 3-methyl-
11.000	85.7	C14H30	198.2	584910	6418-41-3	Tridecane, 3-methyl-
11.100	93.1	C12H24O3	216.2	7997182	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
11.300	86.1	C16H32	224.3	255145	629-73-2	1-Hexadecene
11.400	95.5	C14H30	198.2	1875929	629-59-4	Tetradecane
11.400	80.3	C13H12	168.1	240829	101-81-5	Diphenylmethane
11.500	80.1	C20H42O	298.3	895130	999453-83-2	Diisodecyl ether
11.700	86.7	C15H24	204.2	326797	4630-07-3	4.beta.H,5.alpha.-Eremophila-1(10),11-diene
12.000	82.0	C15H32	212.3	887411	56292-66-1	Tridecane, 2,5-dimethyl-
12.000	92.9	C10H10O4	194.1	2343476	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
12.000	84.0	C14H28	196.2	863441	2882-98-6	Cyclopentane, nonyl-
12.200	87.6	C16H34	226.3	463678	55045-11-9	Tridecane, 5-propyl-
12.200	94.3	C14H20O2	220.1	867105	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
12.300	84.4	C15H32	212.3	321580	18435-22-8	Tetradecane, 3-methyl-
12.300	89.2	C12H26O	186.2	857330	112-53-8	1-Dodecanol
12.600	80.4	C14H14	182.1	188155	605-39-0	2,2'-Dimethylbiphenyl
12.600	86.5	C15H32	212.3	757560	3891-98-3	Dodecane, 2,6,10-trimethyl-
12.800	88.7	C16H34	226.3	2439452	59222-86-5	Tetradecane, 2,2-dimethyl-
13.200	80.4	C20H42O3S	362.3	521730	999598-59-4	Sulfurous acid, hexyl tetradecyl ester
13.700	94.3	C16H30O4	286.2	9873872	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
13.800	88.8	C15H32	212.3	550633	3891-98-3	Dodecane, 2,6,10-trimethyl-
14.000	80.8	C14H30O2	230.2	333900	4536-30-5	Ethanol, 2-(dodecyloxy)-
14.100	86.8	C15H30O2	242.2	951039	10233-13-3	Dodecanoic acid, 1-methylethyl ester
14.400	86.1	C15H22	202.2	518448	74708-73-9	1,4-Methanobenzocyclodecene, 1,2,3,4,4a,5,8,9,12,12a-decahydro-
14.600	85.4	C16H16	208.1	443536	6416-39-3	1H-Indene, 2,3-dihydro-1-methyl-3-phenyl-
15.000	90.7	C18H20	236.2	415141	3910-35-8	1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-
15.600	91.8	C16H16	208.1	212094	7614-93-9	Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-
15.700	86.1	C18H20	236.2	105706	1000111-58-0	2,4-Diphenyl-4-methyl-1-pentene
15.900	86.1	C17H34O2	270.3	108541	110-27-0	Isopropyl myristate
16.300	83.7	C10H24N2	172.2	155292	3529-09-7	2-Dibutylaminoethylamine