

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

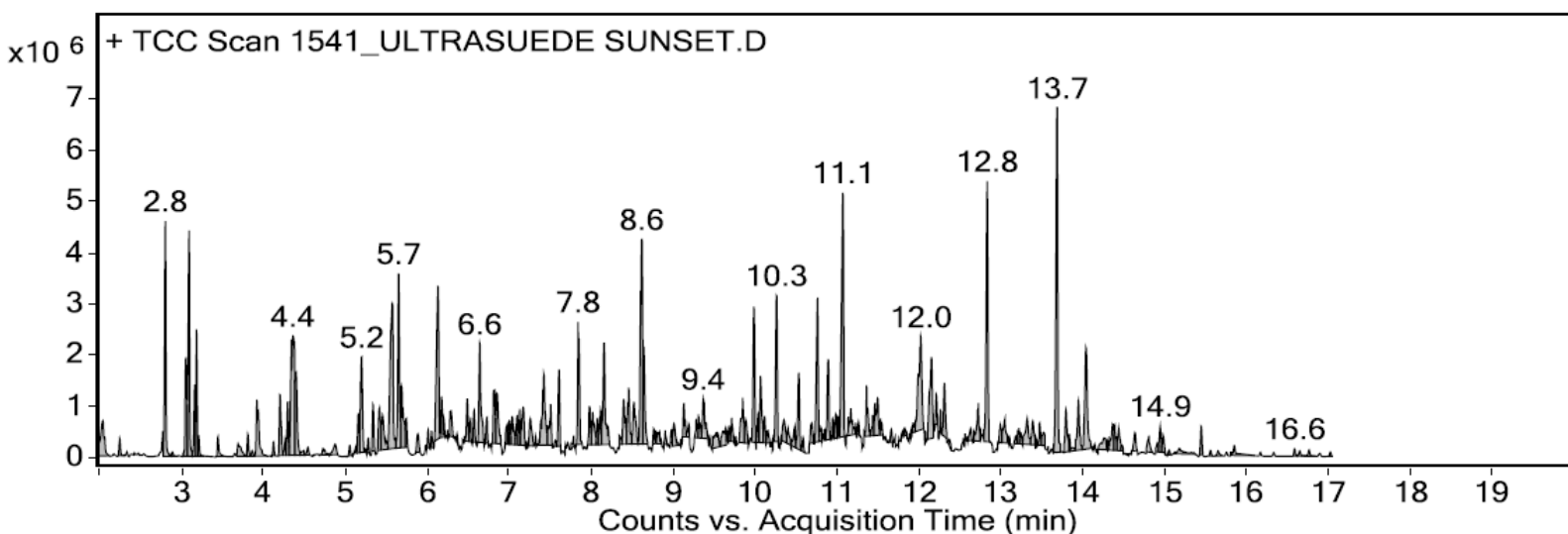
Sample: Toray Ultrasuede HP sunset (yellow) style 5522 color 6661 fabric

Oddy test result: Temporary

Date GC-MS collected: 12/26/2016

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	97.8	C2H6O	46.0	83866	64-17-5	Ethanol
1.500	92.9	C3H6O	58.0	312306	67-64-1	Acetone
1.700	92.9	C3H10OSi	90.1	177562	1066-40-6	Silanol, trimethyl-
1.800	98.4	C4H8O	72.1	799898	123-72-8	Butanal
1.800	97.5	C4H8O2	88.1	107260	141-78-6	Acetic acid, ethyl ester
1.900	95.8	C4H8O	72.1	139305	109-99-9	Furan, tetrahydro-
2.000	98.3	C2H4O2	60.0	1233501	64-19-7	Acetic acid
2.200	96.7	C5H10O	86.1	358126	110-62-3	Pentanal
2.300	82.3	C5H10O2	102.1	118290	109-60-4	Acetic acid, propyl ester
2.800	95.2	C5H12O	88.1	714955	71-41-0	1-Pentanol
2.800	96.8	C7H8	92.1	4418782	108-88-3	Benzene, methyl-
3.100	97.8	C3H7NO	73.1	2610929	68-12-2	Formamide, N,N-dimethyl-
3.100	97.7	C6H12O	100.1	3386020	66-25-1	Hexanal
3.200	96.8	C6H12O2	116.1	1381744	106-36-5	Propanoic acid, propyl ester
3.200	91.7	C6H18O3Si3	222.1	2275130	541-05-9	Cyclotrisiloxane, hexamethyl-
3.200	94.9	C6H12O2	116.1	229155	123-86-4	Acetic acid, butyl ester
3.400	97.3	C5H4O2	96.0	558989	98-01-1	Furfural
3.800	93.6	C8H10	106.1	392772	0-00-0	METHYLLAURATE
3.900	85.4	C6H14O	102.1	177142	111-27-3	1-Hexanol
3.900	98.3	C8H10	106.1	1700151	1330-20-7	XYLENE
3.900	97.0	C4H9NO	87.1	490811	127-19-5	N,N-Dimethylacetamide
4.100	97.1	C7H14O	114.1	304735	110-43-0	2-Heptanone
4.200	90.3	C8H8	104.1	1395585	100-42-5	Styrene
4.200	93.9	C8H10	106.1	388082	106-42-3	Benzene, 1,4-dimethyl-

4.300	93.2	C9H20	128.2	270864	111-84-2	Nonane
4.300	96.5	C7H14O	114.1	471982	111-71-7	Heptanal
4.400	85.4	C8H15NO3	173.1	1963816	999114-56-5	O-(tert-Butoxycarbonyl)-N-isopropylidene oxime
4.400	95.7	C6H14O2	118.1	5223352	111-76-2	Ethanol, 2-butoxy-
4.500	85.2	C8H9NO2	151.1	455110	1000222-86-6	Oxime-, methoxy-phenyl-
5.100	97.4	C9H12	120.1	310163	0-00-0	unidentified C3-benzene
5.100	92.3	C10H22	142.2	141178	52896-95-4	Heptane, 2,3,4-trimethyl-
5.200	91.9	C9H12	120.1	1102698	620-14-4	Benzene, 1-ethyl-3-methyl-
5.200	98.1	C9H12ClN	169.1	2782157	999105-63-5	N-benzylidene-dimethylammonium chloride
5.300	95.0	C9H12	120.1	483097	526-73-8	Benzene, 1,2,3-trimethyl-
5.300	95.3	C8H24O4Si4	296.1	1388942	556-67-2	Cyclotetrasiloxane, octamethyl-
5.500	81.4	C9H10	118.1	549183	637-50-3	Benzene, 1-propenyl-
5.600	89.1	C9H14O	138.1	608299	3777-69-3	Furan, 2-pentyl-
5.600	97.5	C6H10O4	146.1	5727996	111-55-7	1,2-Ethanediol, diacetate
5.600	83.9	C5H10O2	102.1	426257	109-52-4	Pentanoic acid
5.700	94.9	C9H12	120.1	2386066	526-73-8	Benzene, 1,2,3-trimethyl-
5.700	97.1	C10H22	142.2	1525075	124-18-5	Decane
5.700	91.1	C6H14O3	134.1	690269	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
5.700	95.3	C8H16O	128.1	826081	124-13-0	Octanal
5.900	84.6	C7H16O3	148.1	842631	20324-32-7	2-Propanol, 1-(2-methoxy-1-methylethoxy)-
6.000	90.9	C6H4Cl2	146.0	134638	106-46-7	Benzene, 1,4-dichloro-
6.100	93.9	C9H12	120.1	610292	108-67-8	Benzene, 1,3,5-trimethyl-
6.100	85.0	C10H14	134.1	133846	99-87-6	Benzene, 1-methyl-4-(1-methylethyl)-
6.100	98.1	C8H18O	130.1	6244837	104-76-7	1-Hexanol, 2-ethyl-
6.200	97.4	C10H16	136.1	1118660	138-86-3	dl-Limonene
6.200	90.6	C11H24	156.2	754388	62016-19-7	Octane, 6-ethyl-2-methyl-
6.300	95.2	C5H9NO	99.1	985852	872-50-4	2-Pyrrolidinone, 1-methyl-
6.300	84.0	C7H12O2	128.1	162302	2210-28-8	Methacrylic acid, propyl ester
6.400	82.2	C6H13NO2	131.1	325613	646-14-0	Hexane, 1-nitro-
6.500	83.5	C9H20	128.2	398327	3522-94-9	Hexane, 2,2,5-trimethyl-
6.600	91.7	C10H22	142.2	2592140	2051-30-1	Octane, 2,6-dimethyl-
6.700	87.6	C6H18O3Si3	222.1	367375	541-05-9	Cyclotrisiloxane, hexamethyl-
6.700	91.6	C8H8O	120.1	683968	98-86-2	Ethanone, 1-phenyl-
6.800	93.7	C13H28	184.2	1897100	17301-25-6	Undecane, 2,8-dimethyl-
6.900	92.0	C10H14	134.1	158478	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-
7.000	81.2	C10H14	134.1	527943	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-
7.100	87.2	C13H28	184.2	358272	62185-53-9	Nonane, 5-(2-methylpropyl)-
7.100	88.4	C11H24	156.2	415801	54166-32-4	Octane, 2,6,6-trimethyl-
7.200	94.7	C13H28	184.2	1559423	17301-25-6	Undecane, 2,8-dimethyl-
7.300	93.1	C9H18O	142.1	1027466	124-19-6	Nonanal
7.400	84.6	C12H24	168.2	585938	74630-54-9	3-Undecene, 9-methyl-, (E)-
7.400	91.3	C12H26	170.2	1506141	1071-31-4	2,2,7,7-Tetramethyloctane
7.700	85.1	C8H24O4Si4	296.1	181761	556-67-2	Cyclotetrasiloxane, octamethyl-
7.900	95.7	C10H20O2	172.1	3038112	103-09-3	Acetic acid, 2-ethylhexyl ester
8.100	88.4	C17H36O3S	320.2	930596	999508-28-5	Sulfurous acid, 2-ethylhexyl nonyl ester

8.100	80.6	C12H26	170.2	420955	7045-71-8	Undecane, 2-methyl-
8.200	82.0	C12H26	170.2	707421	1071-31-4	2,2,7,7-Tetramethyloctane
8.400	93.1	C10H20O	156.2	1841965	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(+/-)-
8.500	90.0	C8H18O3	162.1	769904	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
8.500	85.1	C12H24	168.2	1116520	112-41-4	1-Dodecene
8.600	93.7	C10H8	128.1	414372	91-20-3	Naphthalene
8.600	98.1	C8H8O3	152.0	5988748	119-36-8	Benzoic acid, 2-hydroxy-, methyl ester
9.100	83.4	C11H22O2	186.2	1047972	999145-46-3	2-Ethyl-1-hexyl propionate
9.400	87.7	C15H32O	228.2	731493	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
9.700	84.0	C15H32O	228.2	305760	6750-34-1	1-Dodecanol, 3,7,11-trimethyl-
9.800	85.7	C10H12O2	164.1	452289	7473-98-5	2-Hydroxy-iso-butyrophenone
10.000	86.2	C13H28	184.2	384258	629-50-5	Tridecane
10.300	87.3	C9H20	128.2	4389837	16747-25-4	Hexane, 2,2,3-trimethyl-
10.500	86.3	C7H12O5	176.1	1076778	25395-31-7	1,2,3-Propanetriol, diacetate
10.600	86.6	C12H16	160.1	300280	1076-69-3	5,6,7,8,9,10-Hexahydrobenzocyclooctene
10.700	88.1	C20H42O	298.3	796799	1000406-38-4	Dodecyl octyl ether
10.800	88.7	C12H24O3	216.2	4700109	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
10.900	91.2	C13H28	184.2	873090	17312-57-1	Dodecane, 3-methyl-
11.000	80.5	C14H30	198.2	436118	6418-41-3	Tridecane, 3-methyl-
11.100	92.8	C12H24O3	216.2	8321496	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
11.300	93.0	C16H32	224.3	269139	295-65-8	Cyclohexadecane
11.400	94.3	C14H30	198.2	1605400	629-59-4	Tetradecane
11.400	83.5	C13H12	168.1	276954	101-81-5	Diphenylmethane
11.700	88.5	C15H24	204.2	308821	475-20-7	Longifolene
12.000	83.1	C17H36	240.3	741405	6008-17-9	5,5-Dibutylnonane
12.000	95.1	C10H10O4	194.1	2232951	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
12.000	86.0	C14H28	196.2	752276	2882-98-6	Cyclopentane, nonyl-
12.200	85.6	C21H44	296.3	308369	54833-23-7	Eicosane, 10-methyl-
12.200	94.5	C14H20O2	220.1	889190	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
12.300	91.6	C12H26O	186.2	954756	112-53-8	1-Dodecanol
12.600	86.0	C14H14	182.1	171365	605-39-0	2,2'-Dimethylbiphenyl
12.600	84.5	C15H32	212.3	659388	3891-98-3	Dodecane, 2,6,10-trimethyl-
12.800	88.7	C16H34	226.3	2665142	59222-86-5	Tetradecane, 2,2-dimethyl-
13.700	94.9	C16H30O4	286.2	6175383	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
13.800	90.9	C15H32	212.3	639750	3891-98-3	Dodecane, 2,6,10-trimethyl-
14.000	85.4	C14H26O3	242.2	729970	1000382-54-9	Carbonic acid, undecyl vinyl ester
14.100	91.9	C15H30O2	242.2	1045832	10233-13-3	Dodecanoic acid, 1-methylethyl ester
14.400	85.4	C15H22	202.2	482054	74708-73-9	1,4-Methanobenzocyclodecene, 1,2,3,4,4a,5,8,9,12,12a-decahydro-
14.600	85.7	C16H16	208.1	399197	6416-39-3	1H-Indene, 2,3-dihydro-1-methyl-3-phenyl-
14.900	83.1	C9H20	128.2	564302	16747-25-4	Hexane, 2,2,3-trimethyl-
15.000	90.5	C18H20	236.2	333906	3910-35-8	1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-
15.600	88.2	C16H16	208.1	140162	7614-93-9	Benzene, 1,1'-(3-methyl-1-propene-1,3-diyl)bis-
15.700	82.4	C15H21N3O2	275.2	147411	64739-60-2	1-.alpha.-Cumyl-4-tert-butylurazole
15.900	91.2	C17H34O2	270.3	192324	110-27-0	Isopropyl myristate
16.200	82.5	C16H22O4	278.2	84763	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester