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

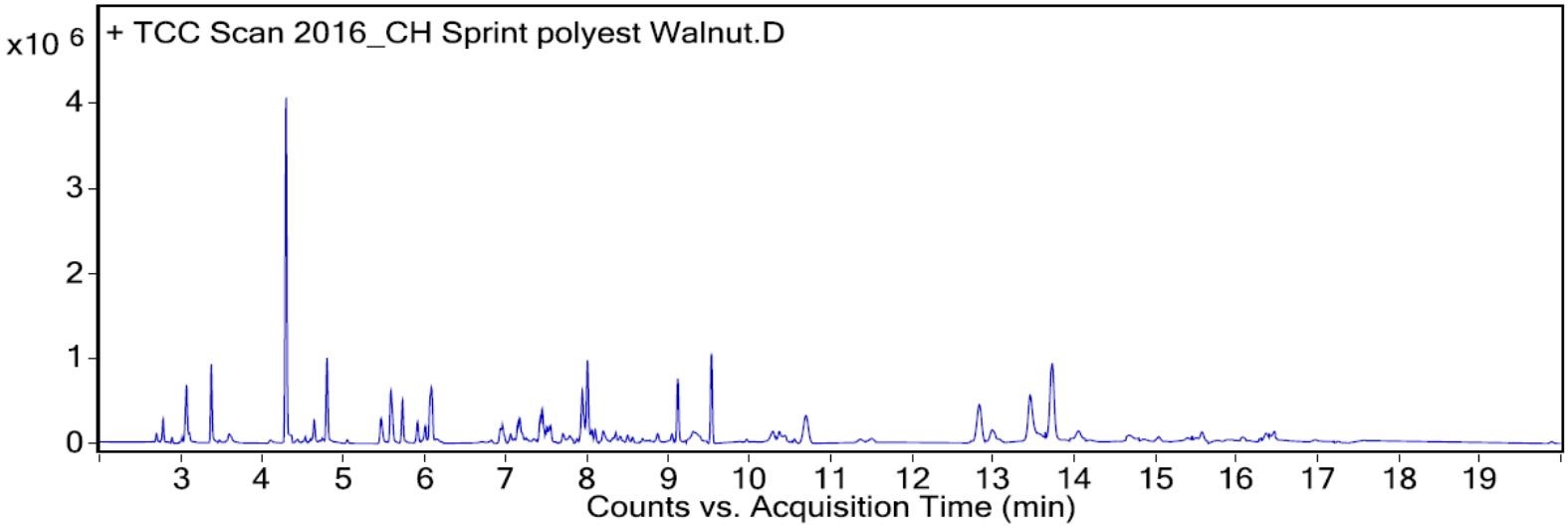
Sample: Clarence House Decortex Sprint polyester fabric; Walnut

Oddy test result: Temporary

Date collected: 12/14/2017

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 library are reported.

VOCs not highlighted are because they were also observed in blanks: (2) 13.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (3) 13.7 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.698	92.1	C3H6O	58.0	162483	67-64-1	2-Propanone
2.780	95.2	C3H6O2	74.0	203091	79-20-9	Acetic acid, methyl ester
2.890	94.3	C3H10OSi	90.1	90745	1066-40-6	Silanol, trimethyl-
3.008	91.8	C4H8O	72.1	71859	78-93-3	2-Butanone
3.068	98.3	C2H4O2	60.0	927492	64-19-7	Acetic acid
3.374	93.7	C4H10O	74.1	1292757	71-36-3	1-Butanol
3.473	82.0	CH3NO	45.0	85091	865-40-7	Methane, nitroso-
4.104	83.3	C6H14O2	118.1	127982	1569-01-3	2-Propanol, 1-propoxy-
4.294	95.0	C7H8	92.1	6054419	108-88-3	Benzene, methyl-
4.437	88.5	C4H8O2	88.1	126897	107-92-6	Butanoic acid
4.535	94.6	C8H16	112.1	82868	2511-91-3	Cyclopropane, pentyl-
4.642	93.9	C6H12O	100.1	515161	66-25-1	Hexanal
4.750	93.5	C2Cl4	163.9	83391	127-18-4	Tetrachloroethylene
4.792	91.4	C6H18O3Si3	222.1	265532	541-05-9	Cyclotrisiloxane, hexamethyl-
4.800	93.7	C6H12O2	116.1	1252785	123-86-4	Acetic acid, butyl ester
5.048	91.1	C5H4O2	96.0	77550	98-01-1	2-Furancarboxaldehyde
5.463	98.6	C8H10	106.1	424454	100-41-4	Ethylbenzene
5.482	90.9	C6H12O3	132.1	220058	108-65-6	1-Methoxy-2-propyl ester of acetic acid
5.588	97.8	C8H10	106.1	1406313	106-42-3	Benzene, 1,4-dimethyl-
5.730	91.6	C8H18O	130.1	792187	142-96-1	n-Butyl ether
6.011	95.2	C7H14O	114.1	227355	111-71-7	Heptanal
6.089	88.3	C7H14O2	130.1	612608	590-01-2	Propanoic acid, butyl ester
6.825	96.3	C9H12	120.1	61136	103-65-1	Benzene, propyl-
6.935	90.4	C9H12	120.1	274920	0-00-0	unidentified C3-benzene
6.959	82.8	C10H10O3	178.1	264372	67519-26-0	1,4-[13C]-4-Oxo-4-phenylbutanoic acid
6.983	87.1	C9H12	120.1	118672	0-00-0	unidentified C3-benzene

7.062	90.3	C9H12	120.1	161694	526-73-8	Benzene, 1,2,3-trimethyl-
7.104	86.2	C6H12O2	116.1	68856	142-62-1	Hexanoic acid
7.151	92.2	C6H6O	94.0	291922	108-95-2	Phenol
7.176	95.7	C8H24O4Si4	296.1	383084	556-67-2	Cyclotetrasiloxane, octamethyl-
7.205	84.4	C9H12	120.1	101579	98-82-8	Benzene, (1-methylethyl)-
7.423	93.4	C8H16O2	144.1	416125	109-21-7	Butanoic acid, butyl ester
7.452	94.7	C9H12	120.1	575145	526-73-8	Benzene, 1,2,3-trimethyl-
7.506	90.6	C10H22	142.2	168238	124-18-5	Decane
7.553	92.7	C8H16O	128.1	226681	124-13-0	Octanal
7.708	95.3	C7H16O3	148.1	215365	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.880	92.8	C9H12	120.1	87613	526-73-8	Benzene, 1,2,3-trimethyl-
7.930	94.0	C10H14	134.1	213724	25155-15-1	Benzene, methyl(1-methylethyl)-
7.947	97.0	C8H18O	130.1	1259886	104-76-7	1-Hexanol, 2-ethyl-
8.010	97.2	C10H16	136.1	1362122	138-86-3	dl-Limonene
8.066	86.8	C7H8O	108.1	103735	1121-54-6	1-Formyl-1,3-cyclohexadiene and 1-Formyl-1,4-cyclohexadiene
8.105	93.4	C9H10	118.1	267463	873-49-4	Benzene, cyclopropyl-
8.203	94.2	C5H9NO	99.1	333566	872-50-4	2-Pyrrolidinone, 1-methyl-
8.355	91.7	C15H32	212.3	108445	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.415	82.1	C10H14	134.1	171609	999041-84-9	3-Ethylidene-1-methyl-1,4-cycloheptadiene
8.504	88.7	C10H22	142.2	94234	2051-30-1	Octane, 2,6-dimethyl-
8.565	94.1	C8H8O	120.1	131968	98-86-2	Ethanone, 1-phenyl-
8.688	89.6	C13H28	184.2	85089	62238-15-7	Decane, 2,3,4-trimethyl-
8.787	89.5	C8H24O4Si4	296.1	95899	556-67-2	Cyclotetrasiloxane, octamethyl-
9.050	84.7	C13H28	184.2	184338	17301-32-5	Undecane, 4,7-dimethyl-
9.122	97.6	C9H18O	142.1	1189456	124-19-6	Nonanal
9.310	85.9	C10H16	136.1	376626	138-86-3	dl-Limonene
9.538	88.7	C10H30O5Si5	370.1	1651628	541-02-6	Cyclopentasiloxane, decamethyl-
9.970	84.2	C9H16O	140.1	80267	18829-56-6	2-Nonenal, (E)-
10.294	93.1	C9H18O	142.1	503045	124-19-6	Nonanal
10.372	92.4	C8H18O3	162.1	204703	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.450	83.1	C10H8	128.1	66523	2471-84-3	1H-Indene, 1-methylene-
10.560	87.0	C14H30	198.2	64993	629-59-4	Tetradecane
10.701	87.6	C10H30O5Si5	370.1	1422430	541-02-6	Cyclopentasiloxane, decamethyl-
11.511	97.0	C20H42	282.3	81479	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
12.841	90.2	C12H36O6Si6	444.1	1803356	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.464	92.4	C12H24O3	216.2	2629405	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.735	92.6	C12H24O3	216.2	3326164	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
14.058	91.1	C35H72	492.6	179881	630-07-9	Pentatriacontane
14.687	82.6	C30H58O4	482.4	143792	2432-89-5	Decanedioic acid, didecyl ester
15.401	88.3	C31H64	436.5	149783	630-04-6	Hentriacontane
15.510	86.1	C14H22O	206.2	155243	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
15.580	88.2	C9H20	128.2	366793	16747-25-4	Hexane, 2,2,3-trimethyl-
16.086	90.0	C16H34	226.3	100092	999254-30-5	2,6,10 - trimethyl - tridecane (WITHOUT stereochemistry)
16.396	83.3	C12H11NO4	233.1	80265	33745-25-4	2H-Isoindole-2-acetic acid, 1,3-dihydro-.alpha.-methyl-1,3-dioxo-, methyl ester
16.477	92.0	C35H72	492.6	191859	630-07-9	Pentatriacontane
16.978	83.7	C13H28	184.2	111986	17301-28-9	Undecane, 3,6-dimethyl-
17.582	89.7	C15H32	212.3	104533	31295-56-4	Dodecane, 2,6,11-trimethyl-
19.888	92.2	C12H10O2S	218.0	63683	127-63-9	Benzene, 1,1'-sulfonylbis-