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

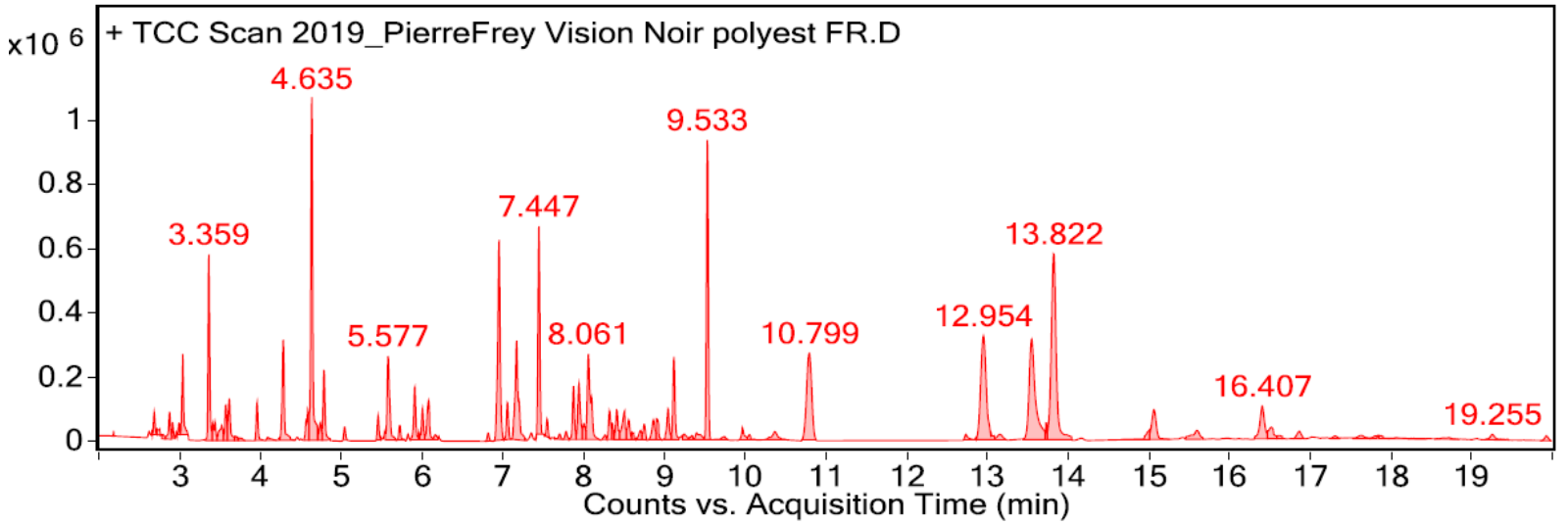
Sample: Pierre Frey Vizion polyester fabric with flame retardant; Noir

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: (1) 13.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 13.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.615	94.6	C2H7N	45.1	50260	124-40-3	Methanamine, N-methyl-
2.682	86.9	C5H10O3	118.1	131125	110-49-6	Ethanol, 2-methoxy-, acetate
2.871	87.7	C3H10OSi	90.1	138914	1066-40-6	Silanol, trimethyl-
2.957	92.1	C4H6O2	86.0	35237	431-03-8	2,3-Butanedione
2.991	89.8	C4H8O	72.1	35013	123-72-8	Butanal
3.033	98.3	C2H4O2	60.0	330957	64-19-7	Acetic acid
3.358	93.8	C4H10O	74.1	825129	71-36-3	1-Butanol
3.434	93.4	C7H16	100.1	95608	589-34-4	Hexane, 3-methyl-
3.517	81.6	C23H48	324.4	49836	638-67-5	Tricosane
3.567	90.4	C2H8O2Si	92.0	174101	1066-42-8	Silanediol, dimethyl-
3.612	95.1	C7H16	100.1	185966	142-82-5	Heptane
3.734	80.2	C4H8O2	88.1	30214	513-86-0	Acetoin
3.956	95.5	C2H3NS	73.0	174908	556-61-6	Methane, isothiocyanato-
4.264	95.3	C5H12O	88.1	133102	71-41-0	1-Pentanol
4.281	94.9	C7H8	92.1	428511	108-88-3	Benzene, methyl-
4.568	89.1	C3H7NO	73.1	218443	68-12-2	Formamide, N,N-dimethyl-
4.633	97.2	C6H12O	100.1	988307	66-25-1	Hexanal
4.740	93.0	C2Cl4	163.9	62427	127-18-4	Tetrachloroethylene
4.784	95.4	C6H18O3Si3	222.1	238694	541-05-9	Cyclotrisiloxane, hexamethyl-
4.792	93.8	C6H12O2	116.1	114488	123-86-4	Acetic acid, butyl ester
5.040	90.8	C5H4O2	96.0	77617	98-01-1	2-Furancarboxaldehyde
5.456	92.9	C8H10	106.1	126445	0-00-0	METHYLLAURATE
5.542	99.4	C6H14O	102.1	50555	111-27-3	1-Hexanol
5.580	96.9	C8H10	106.1	553875	106-42-3	Benzene, 1,4-dimethyl-
5.724	90.7	C8H18O	130.1	74858	142-96-1	Butane, 1,1'-oxybis-
5.825	91.8	C8H16O	128.1	32984	111-13-7	2-Octanone
5.909	84.7	C8H10	106.1	299819	95-47-6	Benzene, 1,2-dimethyl-
6.005	96.6	C7H14O	114.1	164191	111-71-7	Heptanal

6.081	86.3	C7H14O2	130.1	167891	590-01-2	Propanoic acid, butyl ester
6.819	91.7	C9H12	120.1	43361	0-00-0	unidentified C3-benzene
6.953	97.7	C7H6O	106.0	1221303	100-52-7	Benzaldehyde
7.057	94.3	C9H12	120.1	209551	526-73-8	Benzene, 1,2,3-trimethyl-
7.145	94.3	C6H6O	94.0	161186	108-95-2	Phenol
7.172	95.7	C8H24O4Si4	296.1	428012	556-67-2	Cyclotetrasiloxane, octamethyl-
7.201	93.8	C9H12	120.1	198527	622-96-8	Benzene, 1-ethyl-4-methyl-
7.447	95.3	C9H12	120.1	1089487	526-73-8	Benzene, 1,2,3-trimethyl-
7.549	90.7	C8H16O	128.1	122906	124-13-0	Octanal
7.784	89.4	C6H4Cl2	146.0	42864	106-46-7	Benzene, 1,4-dichloro-
7.876	93.7	C9H12	120.1	292187	108-67-8	Benzene, 1,3,5-trimethyl-
7.944	96.4	C8H18O	130.1	383765	104-76-7	1-Hexanol, 2-ethyl-
8.006	90.4	C10H16	136.1	46711	138-86-3	dl-Limonene
8.060	96.5	C7H8O	108.1	433733	100-51-6	Benzenemethanol
8.100	92.2	C9H10	118.1	119613	873-66-5	E-1-phenylpropene
8.322	85.3	C10H14	134.1	69796	135-98-8	Benzene, (1-methylpropyl)-
8.355	93.8	C15H32	212.3	57046	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.415	88.1	C10H14	134.1	183791	18368-95-1	1,3,8-p-Menthatriene
8.560	87.7	C8H8O	120.1	259684	98-86-2	Ethanone, 1-phenyl-
8.752	89.8	C10H14	134.1	40398	25155-15-1	Benzene, methyl(1-methylethyl)-
8.916	84.3	C9H12	120.1	201457	620-14-4	Benzene, 1-ethyl-3-methyl-
9.120	97.2	C9H18O	142.1	285827	124-19-6	Nonanal
9.536	88.6	C10H30O5Si5	370.1	1438822	541-02-6	Cyclopentasiloxane, decamethyl-
10.370	83.1	C9H18O	142.1	125290	124-19-6	Nonanal
10.799	88.8	C10H30O5Si5	370.1	1245096	541-02-6	Cyclopentasiloxane, decamethyl-
12.737	89.1	C16H30O4	286.2	50124	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
12.957	89.1	C12H36O6Si6	444.1	1534525	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.027	91.2	C12H24O3	216.2	50451	999223-22-6	3-Hydroxy-2,2-dimethylhexyl ester of butanoic acid
13.160	83.5	C26H54	366.4	92041	630-01-3	Hexacosane
13.550	92.1	C12H24O3	216.2	1604502	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.825	92.8	C12H24O3	216.2	2324312	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
16.521	99.1	C19H40	268.3	24802	629-92-5	Nonadecane
16.867	83.8	C25H22O2	354.2	56750	999584-37-0	3-Acetyl-2-methyl-9b-(1-naphthyl)-3aH-benzo[e]cyclohexa[1,2-b]furan
17.638	85.3	C17H36	240.3	142785	629-78-7	Heptadecane
19.257	93.3	C16H22O4	278.2	41083	84-69-5	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
19.936	93.3	C12H10O2S	218.0	49446	127-63-9	Benzene, 1,1'-sulfonylbis-