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

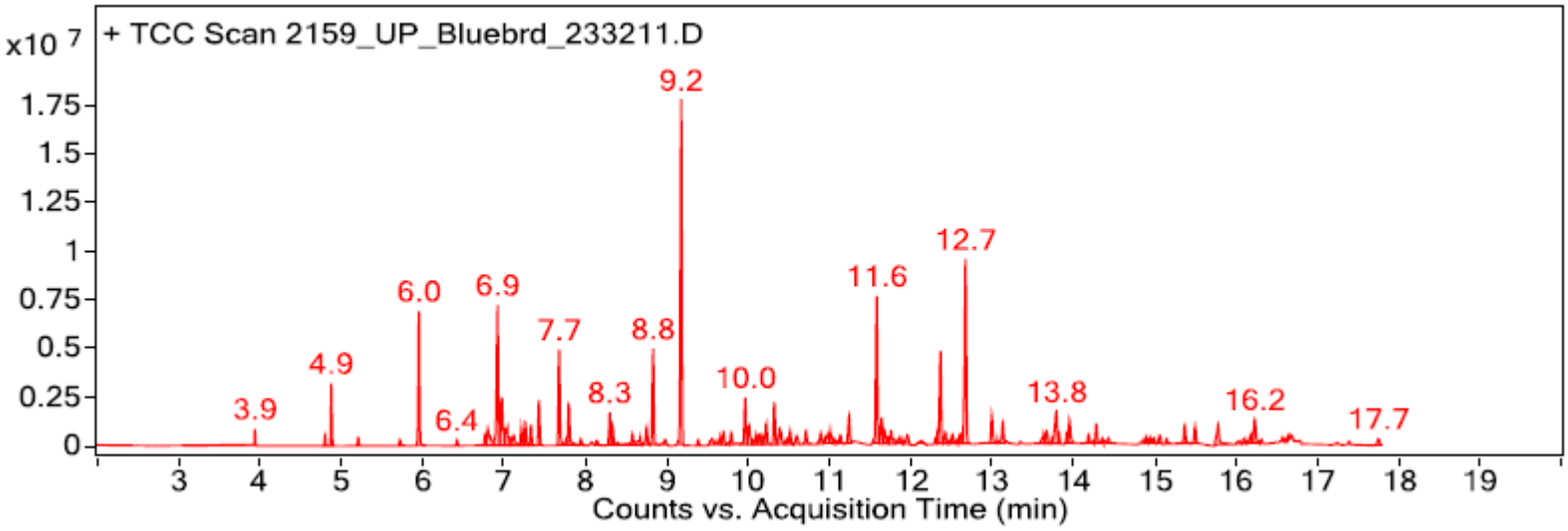
Sample: University Products; Perma-Cor e-flute corrugated cardboard; blue board

Oddy test result: Permanent

Date collected: 05/14/2018

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) 5.7 min: methoxyphenyl oxime; (2) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.700	90.2	CH3NO	45.0	1742182	865-40-7	Methane, nitroso-
3.900	93.7	C2H8O2Si	92.0	675966	1066-42-8	Silanediol, dimethyl-
4.800	96.6	C6H12O	100.1	502014	66-25-1	Hexanal
4.900	92.5	C6H18O3Si3	222.1	2880041	541-05-9	Cyclotrisiloxane, hexamethyl-
5.200	95.2	C6H12O2	116.1	451596	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.700	83.8	C8H9NO2	151.1	350313	1000222-86-6	Oxime-, methoxy-phenyl-_
6.000	96.9	C6H14O2	118.1	7716520	111-76-2	Ethanol, 2-butoxy-
6.400	93.1	C7H16O2	132.1	341461	5131-66-8	2-Propanol, 1-butoxy-
6.800	94.7	C7H6O	106.0	825863	100-52-7	Benzaldehyde
6.800	95.4	C7H16O	116.1	396560	111-70-6	1-Heptanol
6.900	87.2	C6H6O	94.0	3026854	108-95-2	Phenol
6.900	95.2	C8H24O4Si4	296.1	7611095	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	82.9	C8H14O	126.1	290857	110-93-0	6-Methyl-5-hepten-2-one
7.200	98.8	C7H16O3	148.1	1076765	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	95.0	C7H16O3	148.1	1553209	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	97.7	C8H16O	128.1	880231	124-13-0	Octanal
7.400	98.2	C7H16O3	148.1	2898083	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.700	97.4	C8H18O	130.1	6164764	104-76-7	1-Hexanol, 2-ethyl-
7.800	85.9	C10H16	136.1	471581	138-86-3	dl-Limonene
7.800	95.8	C7H8O	108.1	2403363	100-51-6	Benzyl Alcohol
7.900	88.1	C6H13NO2	131.1	239195	646-14-0	Hexane, 1-nitro-
8.100	85.8	C13H28	184.2	319554	17301-32-5	Undecane, 4,7-dimethyl-
8.300	92.9	C10H20O	156.2	755071	18479-58-8	7-Octen-2-ol, 2,6-dimethyl-
8.700	82.4	C9H18	126.1	369599	4316-65-8	1-Hexene, 3,5,5-trimethyl-
8.800	96.6	C9H18O	142.1	6196905	124-19-6	Nonanal
8.900	83.0	C12H26	170.2	240739	2980-69-0	Undecane, 4-methyl-
9.000	93.2	C8H10O	122.1	293003	60-12-8	Benzeneethanol

9.100	81.8	C11H20Cl2O2	254.1	333591	83004-99-3	Dichloroacetic acid, nonyl ester
9.200	95.5	C10H30O5Si5	370.1	22961759	541-02-6	Cyclopentasiloxane, decamethyl-
9.700	87.9	C10H18O	154.1	348340	491-07-6	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, cis-
9.800	89.5	C12H22Cl2O2	268.1	867420	83005-00-9	Dichloroacetic acid, decyl ester
10.000	97.9	C10H20O	156.2	3340235	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(.+/-.)-
10.000	88.7	C8H18O3	162.1	663126	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	84.0	C16H32	224.3	394205	629-73-2	1-Hexadecene
10.100	80.4	C10H8	128.1	515676	275-51-4	Azulene
10.200	97.1	C8H8O3	152.0	410070	119-36-8	Methyl salicylate
10.200	82.1	C12H26	170.2	1395801	112-40-3	Dodecane
10.300	91.4	C10H20O	156.2	2820905	112-31-2	Decanal
10.400	94.0	C13H28	184.2	893340	17312-82-2	Undecane, 4,6-dimethyl-
10.500	90.7	C8H10O2	138.1	1036840	122-99-6	Ethanol, 2-phenoxy-
10.700	83.1	C7H5NS	135.0	1041849	95-16-9	Benzothiazole
10.900	92.3	C9H12O2	152.1	803253	770-35-4	1-Phenoxypropan-2-ol
11.100	91.5	C13H28	184.2	675132	17312-77-5	Undecane, 2,3-dimethyl-
11.200	93.7	C18H38O	270.3	2130250	1000406-38-3	Decyl octyl ether
11.600	95.7	C12H36O6Si6	444.1	10492160	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	95.2	C13H28	184.2	1222217	629-50-5	Tridecane
11.800	97.4	C11H22O	170.2	1107353	112-44-7	Undecanal
11.900	87.2	C14H30	198.2	605248	13287-21-3	Tridecane, 6-methyl-
12.000	82.0	C16H30O4	286.2	423892	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
12.000	89.7	C16H34	226.3	491056	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	90.2	C12H24O3	216.2	6879071	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.400	94.2	C14H30	198.2	445240	26730-12-1	Tridecane, 4-methyl-
12.500	87.4	C14H30	198.2	882556	1560-96-9	Tridecane, 2-methyl-
12.700	93.4	C12H24O3	216.2	13752226	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.000	95.2	C14H30	198.2	2313568	629-59-4	Tetradecane
13.100	97.9	C12H24O	184.2	1728635	112-54-9	Dodecanal
13.800	87.3	C21H44	296.3	475964	54833-23-7	Eicosane, 10-methyl-
13.900	90.2	C15H32	212.3	253470	18435-22-8	Tetradecane, 3-methyl-
14.000	96.2	C12H26O	186.2	1062119	112-53-8	1-Dodecanol
14.200	94.1	C15H30	210.2	794802	13360-61-7	1-Pentadecene
14.300	94.1	C15H32	212.3	1486588	629-62-9	pentadecane
14.400	89.5	C14H22O	206.2	483173	96-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)-
14.400	94.1	C13H26O	198.2	415263	10486-19-8	Tridecanal
15.000	87.3	C15H30	210.2	524447	2883-02-5	n-Nonylcyclohexane
15.100	86.8	C18H38	254.3	268838	593-45-3	Octadecane
15.100	90.9	C16H34	226.3	380982	2882-96-4	Pentadecane, 3-methyl-
15.500	91.2	C16H34	226.3	1305303	544-76-3	Hexadecane
15.800	90.2	C16H48O8Si8	592.2	573518	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	92.7	C15H30O2	242.2	1206002	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.000	87.1	C16H34	226.3	487030	55045-11-9	Tridecane, 5-propyl-
16.200	90.8	C16H32	224.3	739026	6785-23-5	Cyclopentane, undecyl-
16.200	91.6	C16H34O	242.3	996343	629-82-3	Octane, 1,1'-oxybis-
16.300	86.6	C15H22O2	234.2	355879	999275-15-3	1-(4-ISOPROPYLPHENYL)-2-METHYLPROPYL ACETATE
16.600	89.1	C17H34	238.3	793630	6765-39-5	1-Heptadecene
16.600	82.0	C13H28	184.2	517607	62108-21-8	Decane, 6-ethyl-2-methyl-
17.400	89.0	C17H34	238.3	267159	54105-66-7	Cyclohexane, undecyl-
17.700	87.7	C19H40	268.3	266331	1000360-41-0	5,5-Diethylpentadecane