

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

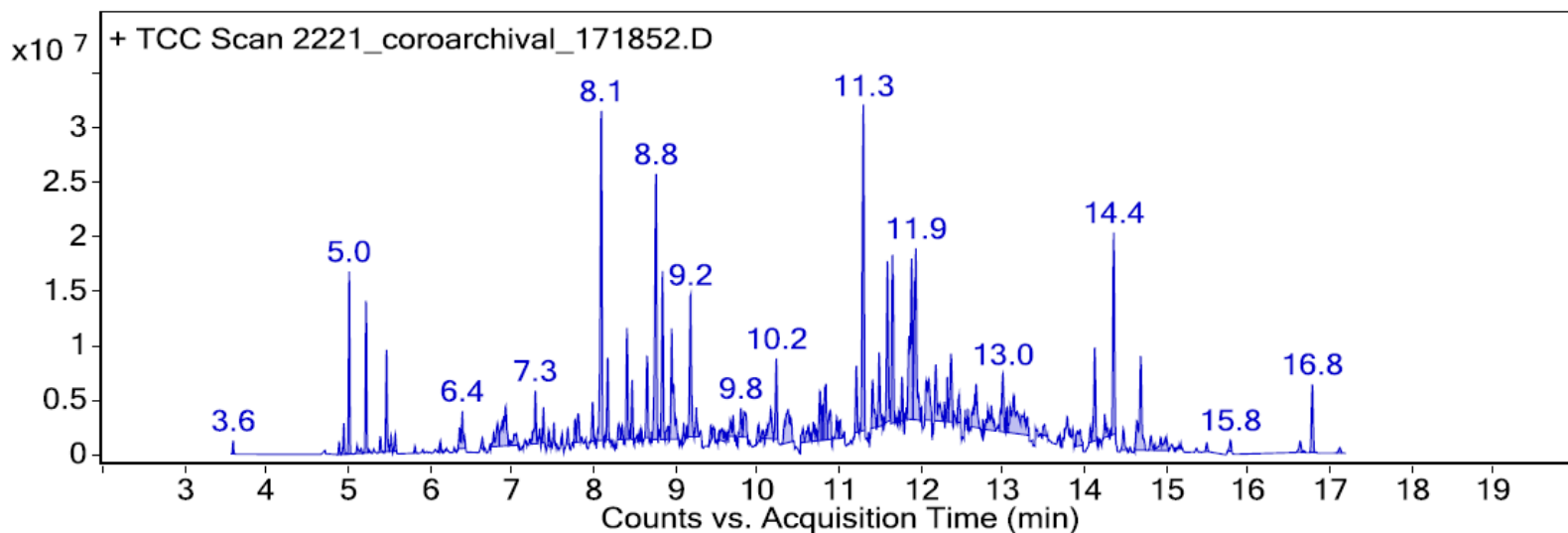
Sample: Coroplast archival

Oddy test result: Temporary

Date collected: 06/29/2018

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



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.600	98.0	C2H4O2	60.0	1039266	64-19-7	Acetic acid
4.700	88.2	C5H10O2	102.1	658292	75-98-9	Propanoic acid, 2,2-dimethyl-
4.900	91.2	C6H18O3Si3	222.1	1091813	541-05-9	Cyclotrisiloxane, hexamethyl-
4.900	94.9	C9H20	128.2	2411283	3074-71-3	Heptane, 2,3-dimethyl-
5.000	95.4	C9H20	128.2	15827418	2213-23-2	Heptane, 2,4-dimethyl-
5.100	83.0	C8H14O	126.1	930932	22319-24-0	2-Hepten-4-one, 2-methyl-
5.200	81.4	C9H20	128.2	505127	3074-77-9	Hexane, 3-ethyl-4-methyl-
5.200	90.7	C9H18	126.1	14212061	19549-87-2	2,4-Dimethyl-1-heptene
5.400	96.3	C9H20	128.2	1881902	3074-71-3	Heptane, 2,3-dimethyl-
5.500	94.9	C9H20	128.2	6129384	2216-34-4	Octane, 4-methyl-
5.600	90.0	C10H22	142.2	1069492	2613-61-8	Heptane, 2,4,6-trimethyl-
5.800	82.3	C10H20	140.2	616681	1000152-79-7	Cyclopentane, 1,2,3,4,5-pentamethyl-
5.900	84.3	C9H20	128.2	506869	111-84-2	Nonane
6.400	80.5	C12H24	168.2	925205	64723-36-0	Cyclopropane, 1-(2-methylbutyl)-1-(1-methylpropyl)-
6.400	90.5	C8H16O	128.1	1494830	6137-06-0	2-Heptanone, 4-methyl-
6.400	83.2	C10H16	136.1	1218535	80-56-8	.ALPHA.-PINENE, (-)-
6.600	83.6	C10H20	140.2	2264940	19689-18-0	4-Decene
6.800	87.4	C10H20	140.2	837259	4057-42-5	2-Octene, 2,6-dimethyl-
6.900	89.9	C6H6O	94.0	2523418	108-95-2	Phenol
6.900	93.2	C8H24O4Si4	296.1	2391363	556-67-2	Cyclotetrasiloxane, octamethyl-
7.200	96.7	C7H16O3	148.1	1047274	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	90.5	C5H11O2	103.1	1007146	999013-01-3	O-Ethyl-1,3-dioxolanium
7.300	85.4	C10H22	142.2	2862254	15869-93-9	Octane, 3,5-dimethyl-
7.400	92.3	C10H22	142.2	2168209	4110-44-5	Octane, 3,3-dimethyl-
7.400	89.5	C7H16O3	148.1	570788	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN

7.500	84.5	C16H34	226.3	885127	56292-69-4	Tetradecane, 2,5-dimethyl-
7.500	83.6	C18H38	254.3	900837	3892-00-0	Pentadecane, 2,6,10-trimethyl-
7.600	91.3	C7H9N	107.1	2170488	100-45-8	4-Cyanocyclohexene
7.700	90.7	C8H18O	130.1	2939163	104-76-7	1-Hexanol, 2-ethyl-
7.800	89.7	C10H16	136.1	1958632	138-86-3	dl-Limonene
7.800	93.1	C7H8O	108.1	1455287	100-51-6	Benzenemethanol
8.000	90.5	C12H26	170.2	6086835	52670-34-5	Octane, 2,3,6,7-tetramethyl-
8.000	86.9	C13H28	184.2	2468324	62185-53-9	Nonane, 5-(2-methylpropyl)-
8.100	91.2	C12H26	170.2	44382564	112-40-3	Dodecane
8.200	90.9	C12H26	170.2	10036524	112-40-3	Dodecane
8.300	81.7	C15H32	212.3	1305764	3891-98-3	Dodecane, 2,6,10-trimethyl-
8.400	88.0	C12H24	168.2	12890358	112-41-4	1-Dodecene
8.500	87.8	C12H24	168.2	7039121	112-41-4	1-Dodecene
8.500	85.3	C14H30O3S	278.2	1281271	999397-36-4	Sulfurous acid, 2-ethylhexyl isohexyl ester
8.700	93.4	C13H28	184.2	9214870	62185-53-9	Nonane, 5-(2-methylpropyl)-
8.800	91.4	C12H26	170.2	40174866	112-40-3	Dodecane
8.800	89.6	C15H32	212.3	20767277	3891-98-3	Dodecane, 2,6,10-trimethyl-
8.900	91.2	C11H24	156.2	12213385	62016-19-7	Octane, 6-ethyl-2-methyl-
9.100	85.1	C15H32	212.3	1760156	3891-98-3	Dodecane, 2,6,10-trimethyl-
9.200	95.5	C10H30O5Si5	370.1	17105084	541-02-6	Cyclopentasiloxane, decamethyl-
9.300	81.4	C13H28	184.2	1648591	62238-11-3	Decane, 2,3,5-trimethyl-
9.400	85.3	C10H20O2	172.1	1737853	103-09-3	Acetic acid, 2-ethylhexyl ester
9.600	86.3	C12H26	170.2	1675268	17312-44-6	2,3-Dimethyldecane
9.700	88.3	C12H26	170.2	1790030	7045-71-8	Undecane, 2-methyl-
9.800	87.3	C12H26	170.2	1458662	1002-43-3	Undecane, 3-methyl-
10.000	89.1	C8H18O3	162.1	1514705	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	83.1	C15H30	210.2	1515341	27251-68-9	pentadecene
10.100	90.5	C10H8	128.1	811208	91-20-3	Naphthalene
10.200	93.4	C12H26	170.2	10865579	112-40-3	Dodecane
10.300	91.0	C10H20O	156.2	2945125	112-31-2	Decanal
10.700	83.9	C16H34O3S	306.2	1415222	999472-82-1	Sulfurous acid, pentyl undecyl ester
10.700	80.9	C7H5NS	135.0	1926162	95-16-9	Benzothiazole
10.800	88.7	C6H14O3	134.1	3756715	25265-71-8	2-Propanol, 1,1'-oxybis-
10.800	87.2	C19H40O3S	348.3	1796830	999571-16-6	Sulfurous acid, 2-ethylhexyl undecyl ester
10.800	86.0	C10H22O3	190.2	5619597	29911-28-2	2-Propanol, 1-(2-butoxy-1-methylethoxy)-
11.100	86.7	C13H28	184.2	1011724	17312-75-3	Nonane, 5-methyl-5-propyl-
11.200	87.5	C12H25Br	248.1	11099535	13187-99-0	2-Bromo dodecane
11.300	90.3	C14H30	198.2	47735147	61141-72-8	Dodecane, 4,6-dimethyl-
11.400	91.5	C13H28	184.2	6303376	17301-30-3	Undecane, 3,8-dimethyl-
11.500	90.9	C20H42	282.3	5925504	112-95-8	Eicosane
11.500	92.9	C10H14O	150.1	976276	585-34-2	Phenol, 3-(1,1-dimethylethyl)-
11.600	91.5	C12H36O6Si6	444.1	19572985	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	89.1	C11H24O	172.2	24721233	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
11.700	80.6	C14H30	198.2	1219462	629-59-4	Tetradecane
11.800	89.0	C11H24O	172.2	8994683	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
11.900	83.5	C13H28	184.2	7745361	629-50-5	Tridecane
11.900	87.8	C11H24O	172.2	18964547	91337-07-4	2-Isopropyl-5-methyl-1-heptanol
11.900	89.9	C15H32	212.3	29152713	629-62-9	pentadecane
12.200	88.9	C13H28	184.2	17676877	31081-18-2	Nonane, 3-methyl-5-propyl-
12.300	90.8	C13H28	184.2	7213902	31081-18-2	Nonane, 3-methyl-5-propyl-
12.400	83.0	C12H24O3	216.2	5684314	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.400	85.0	C20H42	282.3	2555767	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
12.500	81.9	C12H26	170.2	3167669	55258-15-6	Hexane, 2,2,3,4,5,5-Hexamethyl-, (DL)-
12.600	83.8	C16H34	226.3	5107294	5171-85-7	2,2,4,4,5,5,7,7-Octamethyloctane
12.600	86.0	C14H30	198.2	2771914	5171-86-8	3,3,4,4-Tetraethylhexane
12.700	86.9	C12H24O3	216.2	10539399	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.800	86.8	C17H36O3S	320.2	7897452	999508-28-5	Sulfurous acid, 2-ethylhexyl nonyl ester
12.900	81.7	C14H28	196.2	1316925	295-17-0	Cyclotetradecane
13.000	93.0	C14H30	198.2	8662402	629-59-4	Tetradecane
13.100	81.3	C14H28O	212.2	2922893	124-25-4	Tetradecanal
13.200	80.2	C16H30O4	286.2	3550691	1000309-34-1	Oxalic acid, 6-ethyloct-3-yl isobutyl ester
13.600	84.8	C33H68	464.5	1615899	630-05-7	Tritriacontane
13.800	80.3	C14H42O7Si7	518.1	2975348	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.800	87.6	C21H44	296.3	848187	54833-23-7	Eicosane, 10-methyl-

13.900	88.0	C14H20O2	220.1	1387735	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
14.100	88.1	C16H34O	242.3	2633977	999298-90-9	Tridecanol, 2-ethyl-2-methyl-
14.100	88.6	C16H34	226.3	13190755	544-76-3	Hexadecane
14.200	85.1	C12H24	168.2	823050	294-62-2	Cyclododecane
14.200	84.9	C12H25I	296.1	796667	4292-19-7	Dodecane, 1-iodo-
14.300	89.5	C13H28	184.2	817790	17312-82-2	Undecane, 4,6-dimethyl-
14.400	80.6	C15H24O	220.2	22473121	999235-71-9	4P-2P
14.500	85.7	C24H50O	354.4	2390636	1000406-38-6	Hexadecyl octyl ether
14.600	89.3	C13H26O2	214.2	714052	111-82-0	Dodecanoic acid, methyl ester
14.700	89.6	C16H34	226.3	6267429	544-76-3	Hexadecane
14.800	89.0	C20H42	282.3	1915557	504-44-9	Hexadecane, 2,6,11,15-tetramethyl-
14.900	89.1	C20H42	282.3	2029183	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
15.000	91.5	C15H30	210.2	677522	2883-02-5	n-Nonylcyclohexane
15.100	89.1	C20H42	282.3	1290450	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
15.100	86.6	C16H34	226.3	636234	2882-96-4	Pentadecane, 3-methyl-
15.200	84.8	C20H42	282.3	536221	112-95-8	Eicosane
15.500	89.2	C16H34	226.3	1187291	3891-99-4	2,6,10-Trimethyltridecane
15.800	91.0	C16H48O8Si8	592.2	714525	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	92.6	C17H26O2	262.2	1776962	14035-34-8	2,6-Bis(1,1-dimethylethyl)-4-(1-oxopropyl)phenol
16.600	90.9	C20H42	282.3	2311128	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
16.800	95.3	C15H22O2	234.2	9141615	5444-75-7	Benzoic acid, 2-ethylhexyl ester
17.100	87.0	C20H42	282.3	1003701	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-