

**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

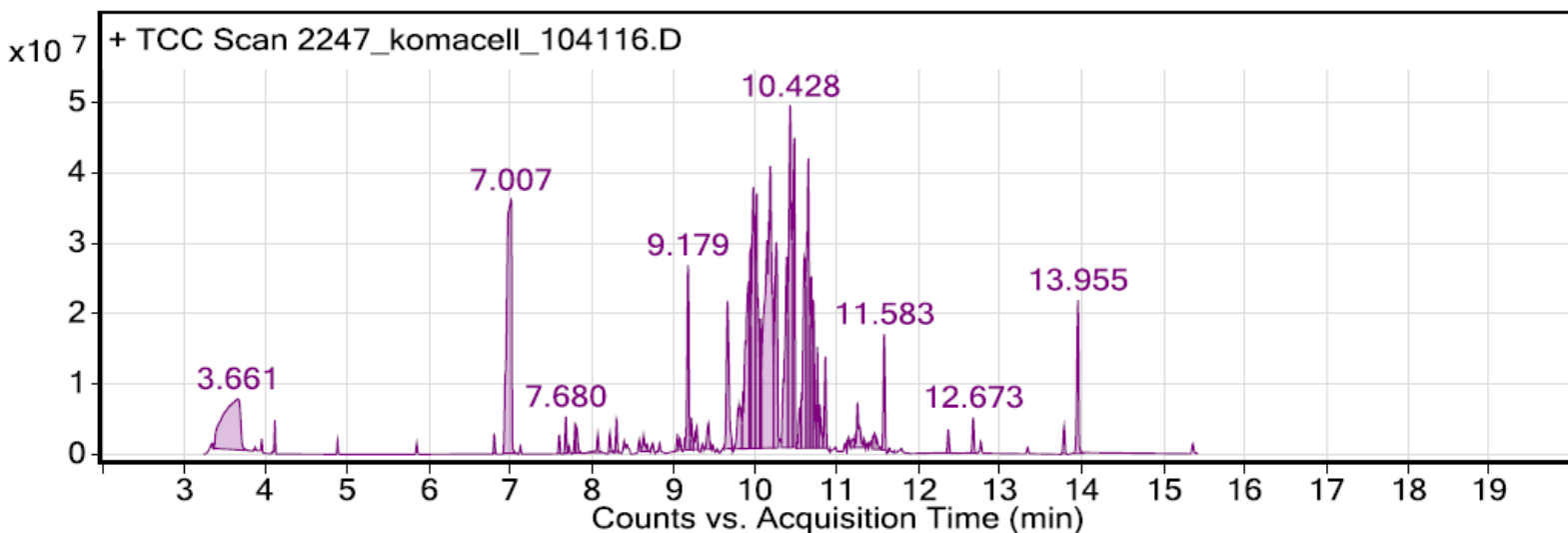
Sample: Kommerling Komacel foamed polyvinyl chloride board

Oddy test result: Permanent

Date collected: 07/24/2018

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



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.338	89.2	C5H8O2	100.1	3884780	80-62-6	Methyl methacrylate
3.660	88.7	C5H8O2	100.1	125459154	80-62-6	Methyl methacrylate
3.874	91.7	C4H10O	74.1	1507989	71-36-3	1-Butanol
3.953	93.7	C2H8O2Si	92.0	1444867	1066-42-8	Silanediol, dimethyl-
4.114	91.0	C5H8O2	100.1	4320961	80-62-6	Methyl methacrylate
4.883	92.5	C6H18O3Si3	222.1	1720482	541-05-9	Cyclotrisiloxane, hexamethyl-
5.853	99.4	C8H8	104.1	1647092	100-42-5	Styrene
6.803	97.9	C7H6O	106.0	3346348	100-52-7	Benzaldehyde
6.936	96.1	C8H24O4Si4	296.1	11991888	556-67-2	Cyclotetrasiloxane, octamethyl-
6.965	92.3	C6H6O	94.0	43143305	108-95-2	Phenol
6.999	83.6	C7H10N2O2	154.1	49105994	999073-76-9	Cyclopentyl diazoacetate
7.123	98.7	C6H10O4	146.1	1286625	111-55-7	1,2-Ethanediol, diacetate
7.598	92.8	C12H26	170.2	3209843	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.679	97.4	C8H18O	130.1	6224249	104-76-7	1-Hexanol, 2-ethyl-
7.717	89.1	C12H26	170.2	1417446	13475-82-6	Heptane, 2,2,4,6,6-pentamethyl-
7.790	90.5	C11H24	156.2	3511209	62016-19-7	Octane, 6-ethyl-2-methyl-
7.803	95.6	C7H8O	108.1	1270269	100-51-6	Benzyl Alcohol
7.815	84.7	C5H9NO	99.1	3501536	872-50-4	2-Pyrrolidinone, 1-methyl-
8.071	91.7	C10H22	142.2	3584417	2051-30-1	Octane, 2,6-dimethyl-
8.219	90.7	C15H32	212.3	4215849	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.302	90.8	C8H8O	120.1	6468558	98-86-2	Ethanone, 1-phenyl-
8.394	93.7	C13H28	184.2	2781452	62238-12-4	Decane, 2,3,6-trimethyl-
8.430	81.2	C8H15NO3	173.1	1290461	999114-56-5	O-(tert-Butoxycarbonyl)-N-isopropylidene oxime
8.633	87.3	C7H10O4	158.1	1496414	617-52-7	Butanedioic acid, methylene-, dimethyl ester
8.676	86.7	C9H20O	144.2	1624895	999057-76-9	2,6-dimethyl-1-heptanol
8.744	93.3	C13H28	184.2	2616488	17301-32-5	Undecane, 4,7-dimethyl-
8.828	91.5	C9H18O	142.1	2469660	124-19-6	Nonanal
9.043	86.9	C9H20O	144.2	2885856	143-08-8	1-Nonanol
9.082	89.6	C9H18O2	158.1	1801878	111-11-5	Octanoic acid, methyl ester

9.145	90.4	C9H20O	144.2	3574476	143-08-8	1-Nonanol
9.177	96.1	C10H30O5Si5	370.1	37148688	541-02-6	Cyclopentasiloxane, decamethyl-
9.215	90.0	C9H20O	144.2	8387909	98982-97-9	1-Heptanol, 2,4-dimethyl-,
9.282	89.9	C9H20O	144.2	7402002	98982-97-9	1-Heptanol, 2,4-dimethyl-,
9.426	83.4	C10H17F3O2	226.1	10186129	1000365-19-7	2-Propyl-1-Pentanol, trifluoroacetate
9.480	84.6	C12H24	168.2	1996919	17799-46-1	1-Heptene, 2-pentyl-
9.603	86.6	C10H22O	158.2	1675530	2051-33-4	1-Hexanol, 5-methyl-2-(1-methylethyl)-
9.661	90.5	C12H24	168.2	24082289	112-41-4	1-Dodecene
9.792	82.8	C16H32	224.3	21474048	629-73-2	1-Hexadecene
9.881	81.6	C10H21F	160.2	17891407	334-56-5	Decane, 1-fluoro-
9.915	80.5	C10H18O	154.1	15513203	999076-45-4	3,3-Dipropylcyclobutanone
9.979	85.9	C8H10O4	170.1	69446964	2274-11-5	Ethylene diacrylate
10.032	84.8	C12H24	168.2	65904383	74630-42-5	1-Undecene, 7-methyl-
10.110	83.4	C10H14F6O	264.1	4913920	113487-29-9	1,1,2,2,3-hexafluoro-4-decanone
10.146	86.8	C10H22O	158.2	111212594	106-21-8	1-Octanol, 3,7-dimethyl-
10.185	80.7	C9H20O	144.2	38802916	143-08-8	1-Nonanol
10.233	85.8	C5H10N2O	114.1	5236663	999019-54-9	(S)-5-(Aminomethyl)-2-pyrrolidone
10.260	87.6	C10H20	140.2	64547882	62238-07-7	Cyclopropane, 1-methyl-2-(3-methylpentyl)-
10.479	81.7	C12H22O2	198.2	51853039	688-84-6	2-Ethylhexyl methacrylate
10.543	87.1	C12H24	168.2	12297071	74630-42-5	1-Undecene, 7-methyl-
10.650	86.4	C8H16	112.1	57730229	4126-78-7	Cycloheptane, methyl-
10.716	92.6	C10H22O	158.2	35770903	112-30-1	1-Decanol
10.760	93.9	C12H24	168.2	11993950	74663-85-7	Cyclopropane, nonyl-
10.860	93.2	C10H20	140.2	21412586	53366-38-4	Cyclopentane, (2-methylbutyl)-
10.984	84.7	C11H22	154.2	2620460	41977-34-8	Cyclopropane, 1-butyl-1-methyl-2-propyl-
11.100	84.3	C13H28O	200.2	2313882	112-70-9	n-Tridecan-1-ol
11.253	94.9	C10H22O	158.2	11759974	112-30-1	1-Decanol
11.365	86.2	C13H28O	200.2	2376097	112-70-9	1-Tridecanol
11.417	85.1	C9H20O	144.2	4412978	110453-78-6	(S)-(+)-6-Methyl-1-octanol
11.489	89.7	C16H32	224.3	6329060	295-65-8	Cyclohexadecane
11.582	96.1	C12H36O6Si6	444.1	24718155	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.644	89.1	C13H28	184.2	1602187	629-50-5	Tridecane
12.367	90.1	C12H24O3	216.2	4665799	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.672	93.2	C12H24O3	216.2	7152021	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.765	95.7	C13H20O2	208.1	2328571	5888-33-5	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-
13.339	92.7	C13H20O2	208.1	1283813	128-51-8	Nonyl acetate
13.784	80.3	C14H42O7Si7	518.1	5651579	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.955	97.1	C12H26O	186.2	32962660	112-53-8	1-Dodecanol