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

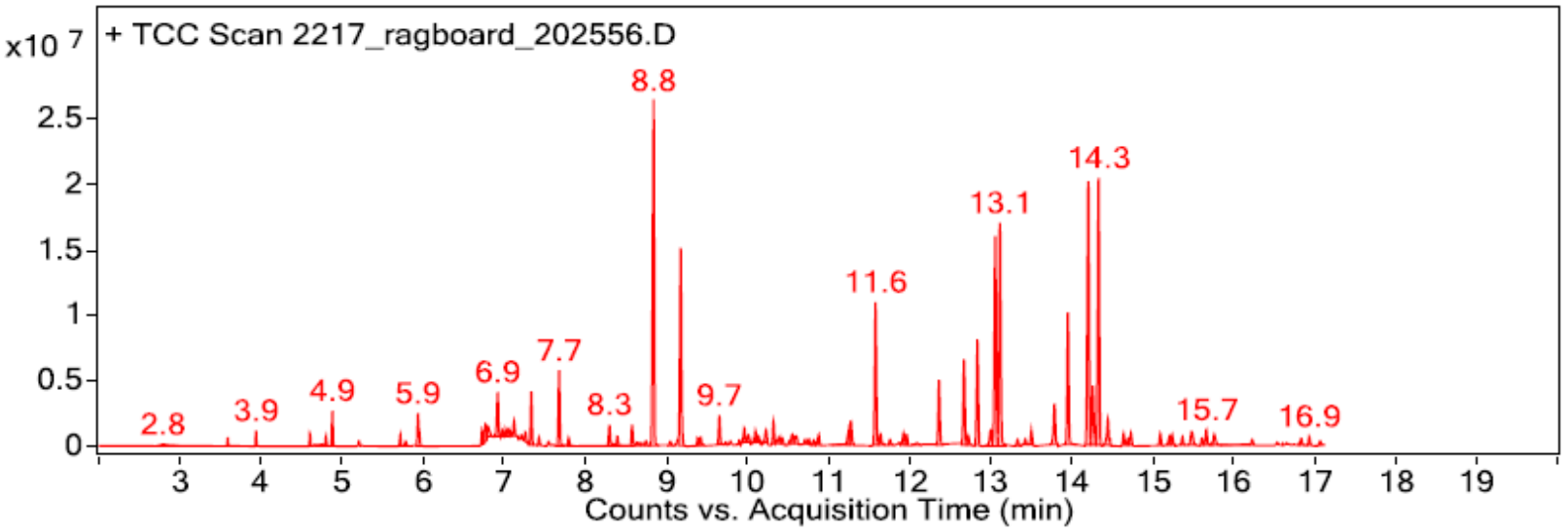
Sample: Rising museum rag matboard antique omega moulding co R405602

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) 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
2.800	92.3	C8H18	114.1	1010289	540-84-1	Pentane, 2,2,4-trimethyl-
3.600	97.9	C2H4O2	60.0	548075	64-19-7	Acetic acid
3.900	93.7	C2H8O2Si	92.0	894102	1066-42-8	Silanediol, dimethyl-
4.800	96.9	C6H12O	100.1	794264	66-25-1	Hexanal
4.900	92.4	C6H18O3Si3	222.1	2430703	541-05-9	Cyclotrisiloxane, hexamethyl-
5.200	92.9	C6H12O2	116.1	429980	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.700	85.8	C8H9NO2	151.1	876254	1000222-86-6	Oxime-, methoxy-phenyl-_
5.800	92.7	C6H12O	100.1	427659	108-93-0	Cyclohexanol
5.900	87.6	C7H14O	114.1	2387064	111-71-7	N HEPTANAL
6.000	84.8	C6H14O2	118.1	1171231	111-76-2	Ethanol, 2-butoxy-
6.800	98.1	C7H6O	106.0	505393	100-52-7	Benzaldehyde
6.800	87.7	C7H16O	116.1	789647	111-70-6	1-Heptanol
6.900	84.3	C6H6O	94.0	962544	108-95-2	Phenol
6.900	96.1	C8H24O4Si4	296.1	3448407	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	81.9	C8H14O2	142.1	583704	3681-71-8	3-Hexen-1-ol, acetate, (Z)-
7.000	82.9	C8H14O	126.1	626982	110-93-0	6-Methyl-5-hepten-2-one
7.300	92.8	C7H16O3	148.1	446002	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	97.4	C8H16O	128.1	3274762	124-13-0	Octanal
7.400	99.5	C7H16O3	148.1	391711	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.500	94.7	C6H14O3	134.1	509836	110-98-5	2-Propanol, 1,1'-oxybis-
7.700	97.4	C8H18O	130.1	6958944	104-76-7	1-Hexanol, 2-ethyl-
7.800	94.5	C7H8O	108.1	837561	100-51-6	Benzyl Alcohol
8.700	80.5	C16H34O	242.3	533091	629-82-3	Octane, 1,1'-oxybis-
8.800	80.9	C13H28	184.2	600806	62108-27-4	Decane, 2,4,6-trimethyl-
8.800	97.4	C9H18O	142.1	37943219	124-19-6	Nonanal
9.200	95.1	C10H30O5Si5	370.1	19721889	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	94.6	C16H11NO2S	281.1	654133	70453-75-7	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one
9.400	95.4	C10H20O2	172.1	867590	103-09-3	Acetic acid, 2-ethylhexyl ester

9.700	95.7	C9H16O	140.1	3120321	18829-56-6	2-Nonenal, (E)-
10.000	93.3	C10H20O	156.2	1232957	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.100	83.6	C17H32O3	284.2	952241	1000382-90-8	Carbonic acid, prop-1-en-2-yl tridecyl ester
10.300	91.9	C10H20O	156.2	2465129	112-31-2	Decanal
10.500	86.4	C8H10O2	138.1	538197	122-99-6	Ethanol, 2-phenoxy-
10.600	84.9	C11H20O2	184.1	1016607	103-11-7	2-Ethylhexyl acrylate
10.700	83.7	C7H5NS	135.0	716487	95-16-9	Benzothiazole
10.800	88.7	C6H14O3	134.1	477852	25265-71-8	2-Propanol, 1,1'-oxybis-
10.800	88.5	C10H22O3	190.2	727496	29911-28-2	2-Propanol, 1-(2-butoxy-1-methylethoxy)-
10.900	93.0	C10H12O	148.1	978561	2550-26-7	2-Butanone, 4-phenyl-
11.200	96.6	C10H22O	158.2	1004542	112-30-1	1-Decanol
11.300	93.2	C10H12O2	164.1	999075	2315-68-6	n-Propyl benzoate
11.300	87.0	C15H32	212.3	807589	31295-56-4	Dodecane, 2,6,11-trimethyl-
11.600	95.9	C12H36O6Si6	444.1	15532016	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	89.8	C13H28	184.2	1165560	629-50-5	Tridecane
11.800	93.7	C11H22O	170.2	548892	112-44-7	Undecanal
11.900	82.4	C13H28	184.2	772987	31081-18-2	Nonane, 3-methyl-5-propyl-
12.000	91.4	C16H34	226.3	492031	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	89.3	C12H24O3	216.2	6946647	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	93.5	C12H24O3	216.2	9488114	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.700	91.0	C14H42O5Si6	458.2	779176	107-52-8	Hexasiloxane, tetradecamethyl-
12.800	97.0	C12H10	154.1	11807222	92-52-4	1,1'-Biphenyl
13.000	94.3	C14H30	198.2	1658182	629-59-4	Tetradecane
13.100	95.3	C13H12	168.1	23504010	643-58-3	1,1'-Biphenyl, 2-methyl-
13.100	96.1	C12H10O	170.1	15621844	101-84-8	Benzene, 1,1'-oxybis-
13.100	86.8	C15H30O	226.2	1149681	2765-11-9	Pentadecanal-
13.300	93.3	C14H14	182.1	741933	605-39-0	2,2'-Dimethylbiphenyl
13.400	88.1	C12H26O	186.2	628926	10522-26-6	2-Methyl-1-undecanol
13.500	97.7	C13H12	168.1	1462105	101-81-5	Diphenylmethane
13.800	80.3	C14H42O7Si7	518.1	4404862	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.000	97.0	C12H26O	186.2	13438255	112-53-8	1-Dodecanol
14.200	95.5	C13H12	168.1	31297039	644-08-6	1,1'-Biphenyl, 4-methyl-
14.300	95.3	C14H14	182.1	6112036	1000404-88-5	1,1'-biphenyl, 2,6-dimethyl-
14.300	86.7	C15H32	212.3	1181346	629-62-9	pentadecane
14.300	95.0	C13H12	168.1	15119449	101-81-5	Diphenylmethane
14.400	88.4	C15H30O	226.2	542914	2765-11-9	Pentadecanal-
14.400	95.4	C14H14	182.1	2564198	1000404-88-5	1,1'-biphenyl, 2,6-dimethyl-
14.600	90.3	C14H14	182.1	1364990	103-29-7	Benzene, 1,1'-(1,2-ethanediyl)bis-
15.100	85.4	C13H16O3	220.1	1319943	999233-92-8	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID
15.200	87.2	C13H16O3	220.1	736352	999233-92-8	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID
15.500	95.6	C14H14	182.1	1214586	613-33-2	4,4'-Dimethylbiphenyl
15.500	86.7	C16H34	226.3	901943	544-76-3	Hexadecane
15.600	95.8	C14H14	182.1	863746	613-33-2	4,4'-Dimethylbiphenyl
15.700	95.8	C14H28O	212.2	1386645	124-25-4	Tetradecanal
15.800	89.9	C16H48O8Si8	592.2	1115906	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.800	84.3	C15H30O2	242.2	395424	10233-13-3	Dodecanoic acid, 1-methylethyl ester
16.200	90.2	C16H34O	242.3	650393	629-82-3	Octane, 1,1'-oxybis-
16.600	84.5	C17H36	240.3	430657	629-78-7	Heptadecane
16.800	85.4	C14H28O	212.2	738601	124-25-4	Tetradecanal