

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

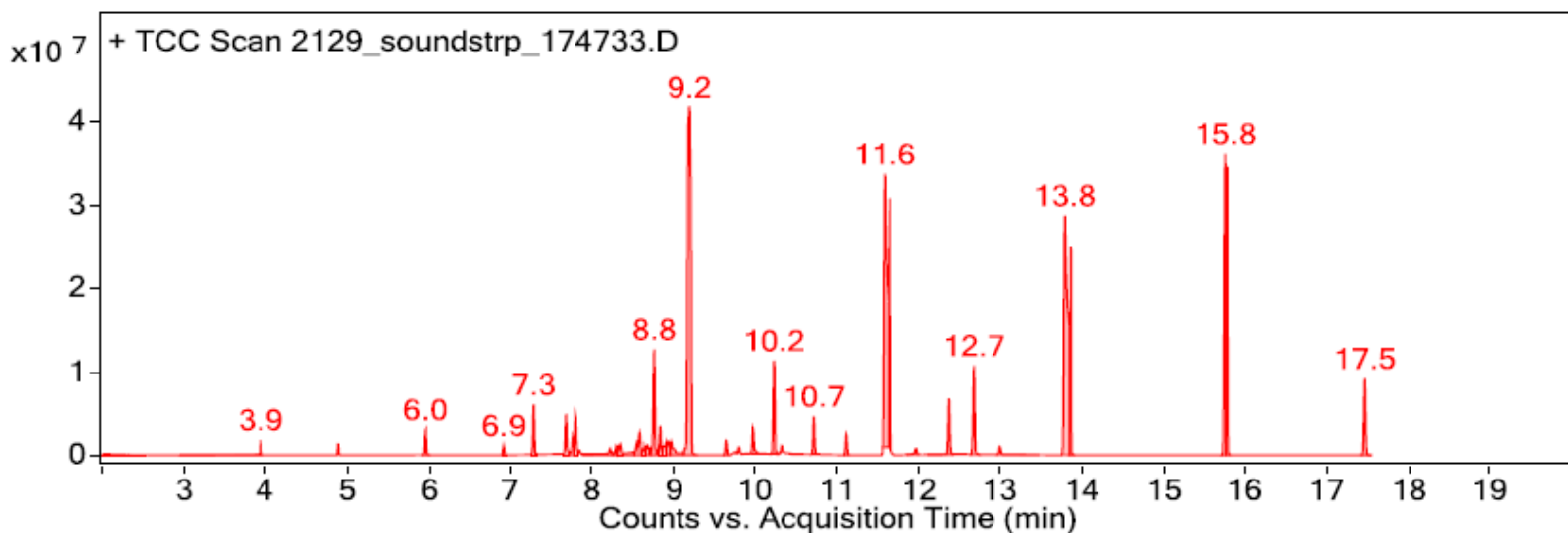
Sample: CR Laurence; CRL EZ Glaze soundstrip 1/4" x 1/4"; extruded silicone

Oddy test result: Temporary

Date GC-MS collected: 4/10/2018

Technique used: SPME Arrow 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 sample at 60°C for 20 minutes; fiber exposure to sample at 60°C for 20 minutes; fiber injected into 220°C inlet and cryotrapped 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
2.000	89.5	C3H10OSi	90.1	1716851	1066-40-6	Silanol, trimethyl-
3.900	93.7	C2H8O2Si	92.0	1237610	1066-42-8	Silenediol, dimethyl-
4.900	92.5	C6H18O3Si3	222.1	1188735	541-05-9	Cyclotrisiloxane, hexamethyl-
6.000	96.9	C6H14O2	118.1	3405085	111-76-2	Ethanol, 2-butoxy-
6.900	93.7	C8H24O4Si4	296.1	1325743	556-67-2	Cyclotetrasiloxane, octamethyl-
7.300	96.9	C10H22	142.2	6988514	124-18-5	Decane
7.700	97.4	C8H18O	130.1	6784459	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.3	C10H16	136.1	2751100	138-86-3	dl-Limonene
7.800	90.8	C7H8O	108.1	3663595	100-51-6	Benzyl Alcohol
8.200	93.7	C15H32	212.3	1255261	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.300	92.1	C20H42	282.3	1446359	112-95-8	Eicosane
8.500	91.2	C11H24	156.2	2215890	17302-23-7	Nonane, 4,5-dimethyl-
8.700	87.4	C10H22	142.2	1419077	17301-94-9	Nonane, 4-methyl-
8.800	96.7	C11H24	156.2	17730397	1120-21-4	Undecane
8.800	94.5	C9H18O	142.1	4547618	124-19-6	Nonanal
8.900	86.0	C13H28	184.2	1506939	17301-27-8	Undecane, 2,10-dimethyl-
9.000	84.2	C13H28O	200.2	3909786	112-70-9	1-Tridecanol
9.200	94.4	C10H30O5Si5	370.1	68120816	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	83.9	C8H24O4Si4	296.1	48392816	556-67-2	Cyclotetrasiloxane, octamethyl-
9.600	97.3	C12H36O4Si5	384.1	2347336	141-63-9	Pentasiloxane, dodecamethyl-
9.800	90.5	C17H36O	256.3	1216458	1000406-39-1	Decyl heptyl ether
10.000	98.0	C10H20O	156.2	4613011	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.200	95.5	C12H26	170.2	15454762	112-40-3	Dodecane
10.300	90.2	C10H20O	156.2	1679265	112-31-2	Decanal
11.600	95.0	C12H36O6Si6	444.1	118317026	540-97-6	Cyclohexasiloxane, dodecamethyl-

11.600	85.6	C12H23FO4	250.2	7993878	107900-37-8	(R)-4-(1-ethoxyethoxy)-3-fluoro-4-methyl-1-pentanol acetate
11.700	90.1	C26H54O4Si2	486.4	3126404	999740-34-7	1-(t-Butoxy)-2-methyl-2-[(t-butyl(dimethyl)silyloxy)carbonyl]ethyl]-3-[(t-but...
12.000	97.2	C16H34	226.3	1301614	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.400	90.2	C12H24O3	216.2	9287984	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	93.7	C12H24O3	216.2	14951094	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.000	95.4	C14H30	198.2	1424402	629-59-4	Tetradecane
13.800	82.5	C14H42O7Si7	518.1	112720967	107-50-6	Cycloheptasiloxane, tetradecamethyl-
15.800	88.7	C16H48O8Si8	592.2	84539076	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.500	85.0	C18H54O9Si9	666.2	13342789	556-71-8	Cyclononasiloxane, octadecamethyl-