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

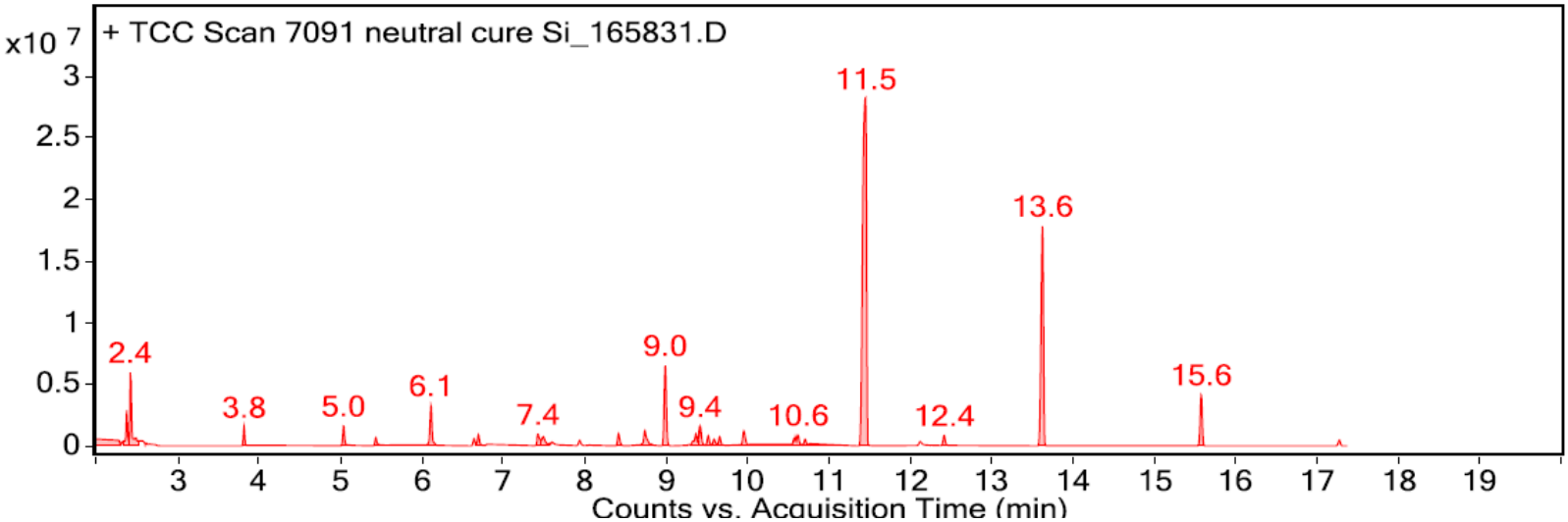
Sample: Dow Corning 7091 black silicone sealant

Oddy test result: Permanent

Date GC-MS collected: 12/8/2017

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) ~12.1 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) ~12.4 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.400	97.9	C2H6O	46.0	2662358	64-17-5	Ethanol
2.400	97.1	C3H6O	58.0	6496074	67-64-1	2-Propanone
2.700	82.6	C4H8O2	88.1	929936	50468-21-8	(2S,3S)-2,3-epoxybutanol
3.800	97.5	C7H8	92.1	1987096	108-88-3	Benzene, methyl-
5.000	92.7	C5H8O3	116.0	2672884	105-45-3	Butanoic acid, 3-oxo-, methyl ester
5.400	90.9	C6H10O3	130.1	1269994	141-97-9	Butanoic acid, 3-oxo-, ethyl ester
6.100	94.2	C6H10O3	130.1	6015401	141-97-9	Ethyl acetoacetate
6.600	94.0	C8H24O4Si4	296.1	1105193	556-67-2	Cyclotetrasiloxane, octamethyl-
6.700	91.8	C7H12O3	144.1	1434117	542-08-5	Butanoic acid, 3-oxo-, 1-methylethyl ester
7.400	96.1	C10H16	136.1	1039534	138-86-3	dl-Limonene
7.500	91.8	C8H18O	130.1	1971147	817-91-4	1-Heptanol, 4-methyl-
7.600	98.0	C8H18O	130.1	847033	7212-53-5	5-Methyl-1-heptanol
7.900	93.4	C7H12O4	160.1	862306	105-53-3	Propanedioic acid, diethyl ester
8.400	97.0	C8H8O2	136.1	1912073	93-58-3	Benzoic acid, methyl ester
8.700	89.9	C8H18O	130.1	3101891	1653-40-3	1-Heptanol, 6-methyl-
9.000	94.1	C10H30O5Si5	370.1	12431685	541-02-6	Cyclopentasiloxane, decamethyl-
9.400	81.1	C8H18O	130.1	2035013	1070-32-2	1-Heptanol, 3-methyl-
9.400	87.1	C10H20O2	172.1	2814905	112-14-1	Acetic acid, octyl ester
9.500	87.8	C10H20O2	172.1	1359591	112-14-1	Acetic acid, octyl ester
9.600	84.6	C10H20O2	172.1	998339	112-14-1	n-Octyl acetate
9.700	90.3	C10H20O2	172.1	1229441	103-09-3	Acetic acid, 2-ethylhexyl ester
10.000	87.0	C11H20O2	184.1	2509282	2499-59-4	2-Propenoic acid, octyl ester
10.600	81.4	C9H16O2	156.1	1036451	2499-95-8	n-Hexyl acrylate
10.600	90.9	C11H20O2	184.1	1735012	2499-59-4	2-Propenoic acid, octyl ester
10.700	87.2	C11H20O2	184.1	949982	2499-59-4	2-Propenoic acid, octyl ester
11.400	84.2	C31H23Cl	430.1	12129511	999697-50-3	(p-Chlorophenyl)methano-bis(4-biphenyl)
11.500	81.3	C12H36O6Si6	444.1	81263521	540-97-6	Cyclohexasiloxane, dodecamethyl-

12.100	93.6	C12H24O3	216.2	1036431	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.400	93.4	C12H24O3	216.2	1579096	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.600	82.8	C14H42O7Si7	518.1	37479465	107-50-6	Cycloheptasiloxane, tetradecamethyl-
15.600	91.1	C16H48O8Si8	592.2	7433309	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.300	84.8	C18H54O9Si9	666.2	848058	556-71-8	OCTADECAMETHYLCYCLONONASILOXANE