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

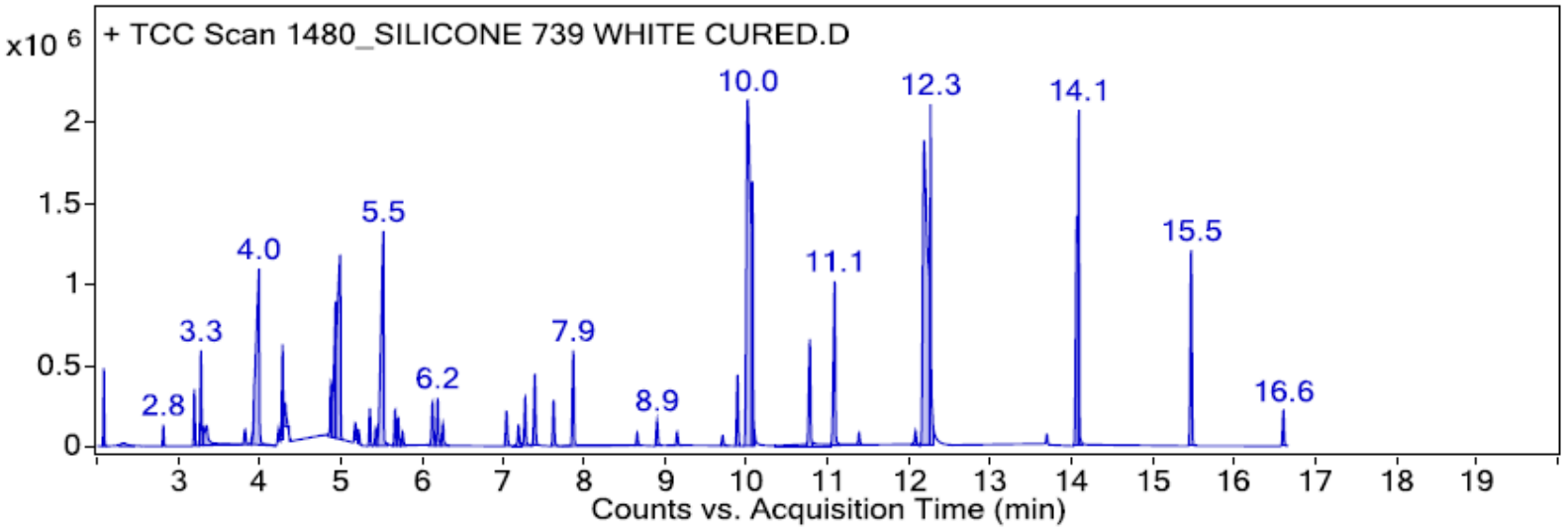
Sample: Dow Corning 739 white silicone sealant, cured 72 hours

Oddy test result: Permanent

Date GC-MS collected: 8/31/2016

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) 10.8 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 11.1 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.500	96.5	CH4O	32.0	775177	67-56-1	Methyl Alcohol
1.600	92.5	C2H6O	46.0	1265962	64-17-5	Ethanol
1.600	97.5	C3H6O	58.0	3492968	67-64-1	2-Propanone
1.600	95.7	C3H8O	60.1	2392331	67-63-0	Isopropyl Alcohol
2.100	96.3	C6H6	78.0	372567	71-43-2	Benzene
2.800	97.5	C7H8	92.1	121922	108-88-3	Benzene, methyl-
3.200	91.6	C6H18O3Si3	222.1	362066	541-05-9	Cyclotrisiloxane, hexamethyl-
3.300	88.4	C5H8O3	116.0	677316	105-45-3	Butanoic acid, 3-oxo-, methyl ester
3.300	82.7	C5H8O3	116.0	334608	105-45-3	Butanoic acid, 3-oxo-, methyl ester
3.900	97.0	C8H10	106.1	241508	106-42-3	Benzene, 1,4-dimethyl-
4.000	92.5	C5H8O3	116.0	2841869	105-45-3	Butanoic acid, 3-oxo-, methyl ester
4.300	86.3	C6H10O3	130.1	764469	141-97-9	Butanoic acid, 3-oxo-, ethyl ester
4.900	80.5	C7H12O3	144.1	242142	542-08-5	Butanoic acid, 3-oxo-, 1-methylethyl ester
5.000	91.9	C6H10O3	130.1	3814478	141-97-9	Butanoic acid, 3-oxo-, ethyl ester
5.200	86.7	C9H12	120.1	150015	620-14-4	Benzene, 1-ethyl-3-methyl-
5.200	86.1	C9H12	120.1	174775	98-82-8	Benzene, (1-methylethyl)-
5.400	95.9	C8H24O4Si4	296.1	280441	556-67-2	Cyclotetrasiloxane, octamethyl-
5.500	91.2	C7H12O3	144.1	2720402	542-08-5	Butanoic acid, 3-oxo-, 1-methylethyl ester
5.700	94.9	C9H12	120.1	274384	526-73-8	Benzene, 1,2,3-trimethyl-
5.700	96.2	C10H22	142.2	169656	124-18-5	Decane
5.800	95.2	C8H16O	128.1	91212	124-13-0	Octanal
6.100	97.0	C8H18O	130.1	412498	104-76-7	1-Hexanol, 2-ethyl-
6.200	98.9	C10H16	136.1	270400	138-86-3	dl-Limonene
6.300	80.9	C7H8O	108.1	123312	100-51-6	Benzyl alcohol
7.200	95.3	C11H24	156.2	160426	1120-21-4	Undecane

7.300	96.0	C9H18O	142.1	371809	124-19-6	Nonanal
7.400	88.0	C8H12OSi	152.1	657920	999069-77-6	Dimethyl(phenyl)silanol
7.900	97.2	C10H20O2	172.1	760281	103-09-3	Acetic acid, 2-ethylhexyl ester
9.100	80.3	C11H22O2	186.2	113802	999145-46-3	2-Ethyl-1-hexyl propionate
9.900	84.4	C15H14N2O3	270.1	603556	999375-81-1	6,7-Dihydroxy-1-(2-amino-5-hydroxyphenyl)-3,4-dihydroisoquinoline Dihydrobro...
10.800	89.6	C12H24O3	216.2	994726	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.100	94.3	C12H24O3	216.2	1633150	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
11.400	93.0	C14H30	198.2	106272	629-59-4	Tetradecane
12.100	83.9	C13H26O2	214.2	136180	16387-18-1	Propanoic acid, 2,2-dimethyl-, 2-ethylhexyl ester
13.700	84.0	C16H30O4	286.2	91702	6846-50-0	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-
14.100	81.7	C16H27NO3Si	309.2	621183	999480-54-2	2-(Trimethylsilyl)ethyl 1-oxo-2-azaspiro[5.5]undec-8-ene-2-carboxylate