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

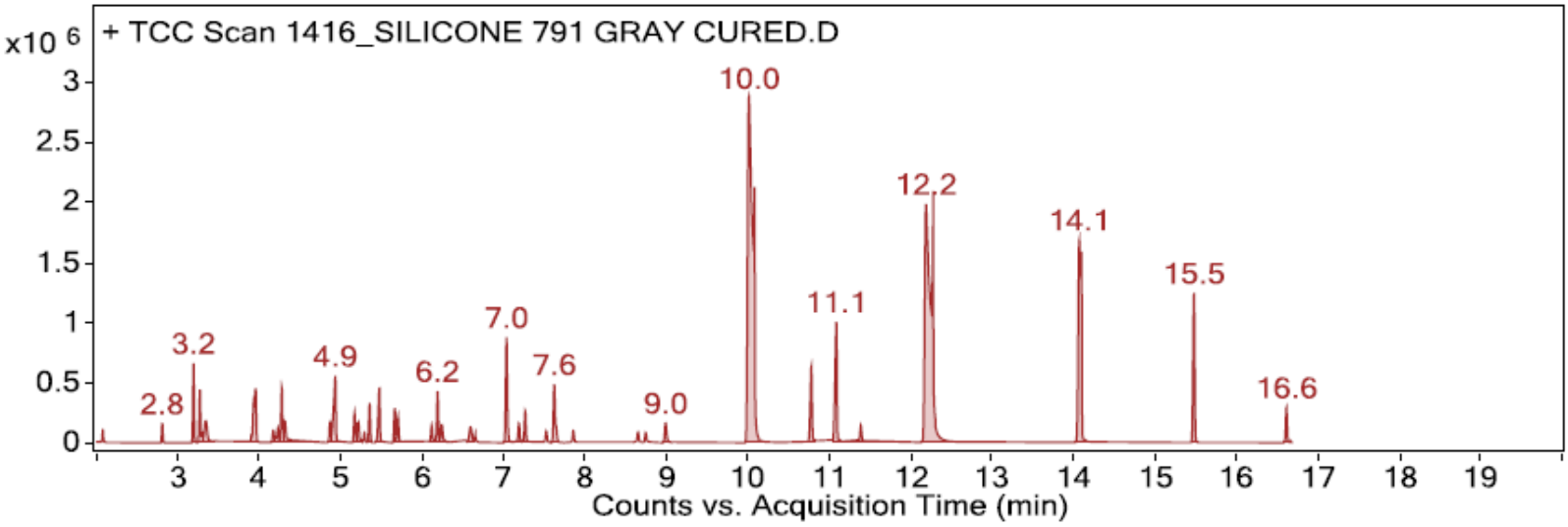
Sample: Dow Corning 791 gray silicone building sealant cured 22 days

Oddy test result: Temporary

Date GC-MS collected: 8/18/2016

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) 4.2 min: methoxy-phenyl-oxime; (2) ~10.8 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) ~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	631026	67-56-1	Methyl Alcohol
1.500	95.5	C2H6O	46.0	764797	64-17-5	Ethanol
1.600	97.5	C3H6O	58.0	2049482	67-64-1	2-Propanone
1.600	95.9	C3H8O	60.1	1021142	67-63-0	Isopropyl Alcohol
2.100	80.2	C4H10O	74.1	99089	71-36-3	1-Butanol
2.800	97.6	C7H8	92.1	154803	108-88-3	Benzene, methyl-
3.200	91.6	C6H18O3Si3	222.1	695723	541-05-9	Cyclotrisiloxane, hexamethyl-
3.300	88.8	C5H8O3	116.0	480669	105-45-3	Butanoic acid, 3-oxo-, methyl ester
3.300	91.2	C5H8O3	116.0	433487	105-45-3	Butanoic acid, 3-oxo-, methyl ester
3.900	98.3	C8H10	106.1	309565	1330-20-7	XYLENE
4.000	94.0	C5H8O3	116.0	706829	105-45-3	Butanoic acid, 3-oxo-, methyl ester
4.200	85.2	C8H9NO2	151.1	215934	1000222-86-6	Oxime-, methoxy-phenyl-_
4.200	96.6	C8H10	106.1	108991	1330-20-7	XYLENE
4.300	84.1	C6H10O3	130.1	403136	141-97-9	Butanoic acid, 3-oxo-, ethyl ester
4.300	85.6	C6H10O3	130.1	274940	141-97-9	Butanoic acid, 3-oxo-, ethyl ester
4.900	93.8	C6H10O3	130.1	1003900	141-97-9	Ethyl acetoacetate
5.200	85.3	C9H12	120.1	146342	0-00-0	unidentified C3-benzene
5.300	89.7	C9H12	120.1	99945	526-73-8	Benzene, 1,2,3-trimethyl-
5.400	95.9	C8H24O4Si4	296.1	384581	556-67-2	Cyclotetrasiloxane, octamethyl-
5.500	91.6	C7H12O3	144.1	655174	542-08-5	Butanoic acid, 3-oxo-, 1-methylethyl ester
5.700	94.9	C9H12	120.1	350874	0-00-0	unidentified C3-benzene
5.700	93.4	C10H22	142.2	252850	124-18-5	Decane
6.100	83.3	C11H17F5O2	276.1	205746	1000365-51-1	2-Ethyl-1-hexanol, pentafluoropropionate

6.200	98.9	C10H16	136.1	352581	138-86-3	dl-Limonene
6.200	80.3	C7H8O	108.1	123709	100-51-6	Benzyl alcohol
6.600	84.3	C6H18O3Si3	222.1	170737	541-05-9	Cyclotrisiloxane, hexamethyl-
7.200	96.2	C11H24	156.2	204064	1120-21-4	Undecane
7.300	97.5	C9H18O	142.1	329653	124-19-6	Nonanal
7.600	84.9	C8H24O4Si4	296.1	157222	556-67-2	Cyclotetrasiloxane, octamethyl-
7.900	95.1	C10H20O2	172.1	115095	103-09-3	Acetic acid, 2-ethylhexyl ester
8.700	95.4	C12H26	170.2	112688	112-40-3	Dodecane
8.700	94.4	C10H20O	156.2	98908	112-31-2	Decanal
10.100	84.7	C19H10F4N2	342.1	667882	999558-26-8	3-Cyano-2-(4'-fluorophenyl)-6-phenyl-4-(trifluoromethyl)pyridine
10.800	88.6	C12H24O3	216.2	963053	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.100	93.7	C12H24O3	216.2	1640230	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
11.400	96.6	C14H30	198.2	188095	629-59-4	Tetradecane