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

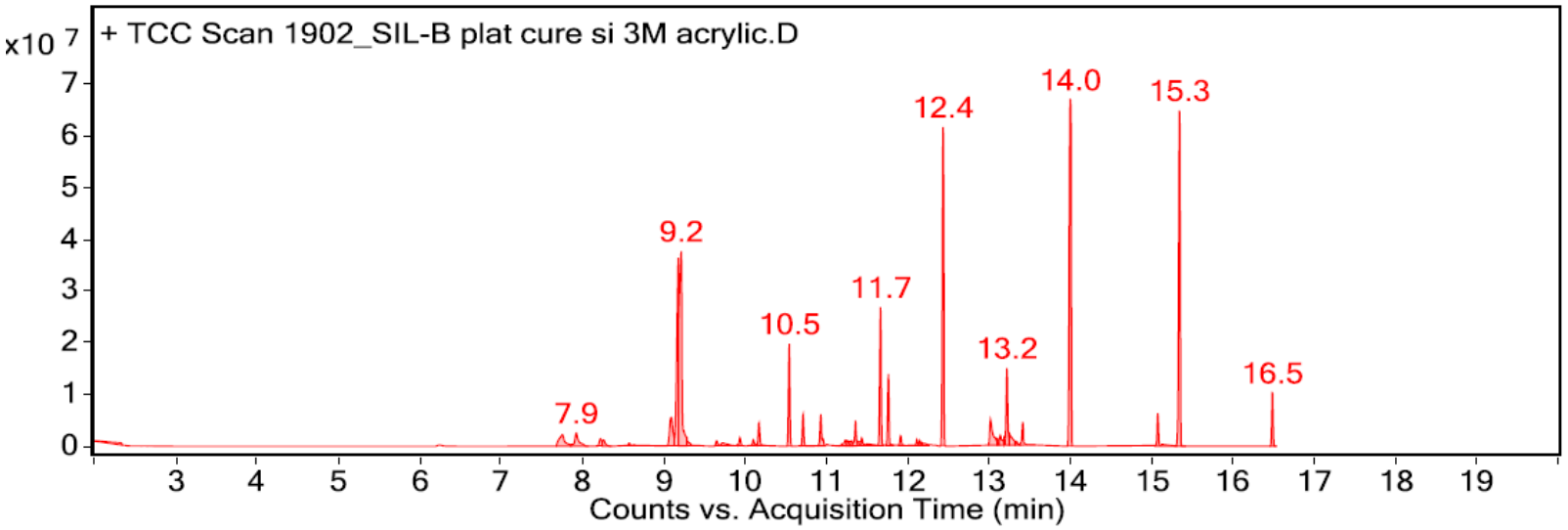
Sample: Netherland Rubber; Black Sil-B silicone foam with acrylic 3M pressure sensitive adhesive backing

Oddy test result: Temporary

Date GC-MS collected: 9/20/2017

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) ~13.0 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) ~13.2 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.100	91.7	C3H10OSi	90.1	2774528	1066-40-6	Silanol, trimethyl-
6.200	98.1	C8H10	106.1	1110587	1330-20-7	XYLENE
7.800	96.1	C4H10O2	90.1	11859904	110-63-4	1,4-Butanediol
7.900	98.6	C7H6O	106.0	7724530	100-52-7	Benzaldehyde
8.200	97.4	C6H6O	94.0	4316662	108-95-2	Phenol
8.300	92.3	C8H24O4Si4	296.1	1479776	556-67-2	Cyclotetrasiloxane, octamethyl-
8.600	94.2	C10H22	142.2	1180181	124-18-5	Decane
9.100	95.8	C10H16	136.1	2197023	138-86-3	dl-Limonene
9.100	96.5	C8H18O	130.1	14796228	1000411-44-8	2-Ethyl-1-hexanol
9.200	83.7	C9H18O2	158.1	3644566	999083-12-4	Octyl ester of formic acid
9.200	97.4	C7H8O	108.1	107682992	100-51-6	Benzyl Alcohol
9.300	89.3	C8H18O	130.1	1479396	7212-53-5	5-Methyl-1-heptanol
9.700	99.3	C8H8O	120.1	1634936	98-86-2	Ethanone, 1-phenyl-
9.700	84.4	C8H18O	130.1	2329005	111-87-5	1-Octanol
9.900	91.9	C9H12O	136.1	2491740	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
10.100	97.0	C11H24	156.2	1740838	1120-21-4	Undecane
10.200	98.3	C9H18O	142.1	6025438	124-19-6	Nonanal
10.500	95.5	C10H30O5Si5	370.1	23607866	541-02-6	Cyclopentasiloxane, decamethyl-
10.700	96.9	C10H20O2	172.1	7096123	103-09-3	Acetic acid, 2-ethylhexyl ester
10.900	96.8	C12H36O4Si5	384.1	6669515	141-63-9	Pentasiloxane, dodecamethyl-
11.200	84.2	C8H18O3	162.1	1393234	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
11.400	94.0	C12H26	170.2	4566750	112-40-3	Dodecane
11.400	96.9	C10H20O	156.2	2252443	112-31-2	Decanal

11.700	95.9	C11H20O2	184.1	32279278	42928-87-0	4-(Prop-2-enoyloxy)octane
11.800	92.3	C11H22O2	186.2	16060968	999145-46-3	2-Ethyl-1-hexyl propionate
11.900	94.3	C10H16N2	164.1	2554989	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
12.100	80.3	C6H11NO	113.1	1447228	105-60-2	Caprolactam
12.200	85.1	C14H30O	214.2	1328877	19780-33-7	2-Ethyl-1-dodecanol
12.400	95.1	C12H36O6Si6	444.1	78417740	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.000	91.5	C12H24O3	216.2	14160658	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.100	87.0	C14H30	198.2	1192405	6418-41-3	Tridecane, 3-methyl-
13.200	94.1	C12H24O3	216.2	22375072	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.300	86.8	C14H28	196.2	1154960	1120-36-1	1-TETRADECENE
13.400	96.6	C14H30	198.2	3135117	629-59-4	Tetradecane
14.000	82.8	C14H42O7Si7	518.1	110767354	107-50-6	Cycloheptasiloxane, tetradecamethyl-
15.300	87.9	C16H48O8Si8	592.2	85560606	556-68-3	Cyclooctasiloxane, hexadecamethyl-
16.500	85.1	C18H54O9Si9	666.2	11540657	556-71-8	OCTADECAMETHYLCYCLONONASILOXANE