

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

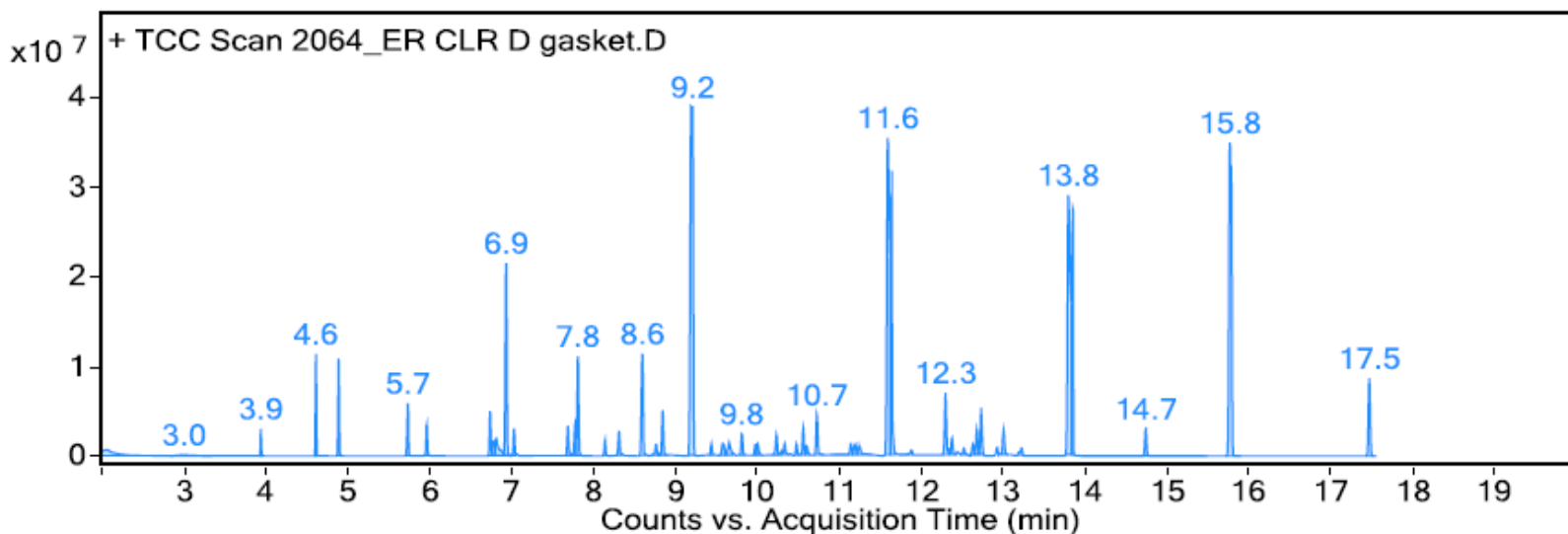
Sample: Elastostar Rubber transparent silicone D-shaped gasket

Oddy test result: Unsuitable

Date GC-MS collected: 3/20/2018

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) 5.7 min: methoxy-phenyl oxime (2) 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	90.0	C3H10OSi	90.1	8728378	1066-40-6	Silanol, trimethyl-
3.900	93.7	C2H8O2Si	92.0	2052791	1066-42-8	Silanediol, dimethyl-
4.900	94.1	C6H18O3Si3	222.1	10195734	541-05-9	Cyclotrisiloxane, hexamethyl-
5.700	85.3	C8H9NO2	151.1	6743840	1000222-86-6	Oxime-, methoxy-phenyl-
6.000	96.9	C6H14O2	118.1	4029191	111-76-2	Ethanol, 2-butoxy-
6.800	88.9	C7H6O	106.0	1335787	100-52-7	Benzaldehyde
6.900	97.1	C8H24O4Si4	296.1	26474651	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	94.3	C7H14O3	146.1	3479531	763-69-9	Propanoic acid, 3-ethoxy-, ethyl ester
7.700	97.4	C8H18O	130.1	4482494	104-76-7	1-Hexanol, 2-ethyl-
7.800	96.9	C10H16	136.1	4466456	138-86-3	dl-Limonene
7.800	95.5	C7H8O	108.1	8283527	100-51-6	Benzyl Alcohol
8.100	88.7	C6H18O3Si3	222.1	2105208	541-05-9	Cyclotrisiloxane, hexamethyl-
8.300	90.7	C8H8O	120.1	3585689	98-86-2	Ethanone, 1-phenyl-
8.600	91.9	C9H12O	136.1	13550310	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.800	89.8	C11H24	156.2	1785689	1120-21-4	Undecane
8.800	97.6	C9H18O	142.1	6417437	124-19-6	Nonanal
9.200	94.4	C10H30O5Si5	370.1	77191949	541-02-6	Cyclopentasiloxane, decamethyl-
9.200	88.3	C8H24O4Si4	296.1	18746601	556-67-2	Cyclotetrasiloxane, octamethyl-
9.400	95.8	C10H20O2	172.1	1597318	103-09-3	Acetic acid, 2-ethylhexyl ester
9.700	97.1	C12H36O4Si5	384.1	1724569	141-63-9	Pentasiloxane, dodecamethyl-
9.700	80.7	C10H18O	154.1	1019094	491-07-6	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, cis-
9.800	87.3	C9H18O4	190.1	3457619	1000367-08-6	1-(1-Methoxypropan-2-yloxy)propan-2-yl acetate

10.000	94.2	C10H20O	156.2	1271286	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./-.)-
10.300	93.6	C10H20O	156.2	2034783	112-31-2	Decanal
10.500	89.4	C12H36O4Si5	384.1	1736086	141-63-9	Pentasiloxane, dodecamethyl-
10.600	93.1	C11H20O2	184.1	1305412	54774-91-3	2-Propenoic acid, 6-methylheptyl ester
11.100	83.6	C7H4Cl2O	174.0	1278150	874-42-0	Benzaldehyde, 2,4-dichloro-
11.200	94.0	C12H24O4Si4	344.1	1735054	1000415-93-2	1,3,5,7-Tetramethyl-1,3,5,7-tetravinylcyclotetrasiloxane
11.200	86.7	C18H38O	270.3	1206767	1000406-38-3	Decyl octyl ether
11.600	95.6	C12H36O6Si6	444.1	101436604	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	81.6	C2H7N	45.1	1595474	124-40-3	Methanamine, N-methyl-
11.700	93.0	C13H28	184.2	3184926	629-50-5	Tridecane
11.900	88.5	C17H36O	256.3	1138075	1000406-39-1	Decyl heptyl ether
12.400	88.2	C12H24O3	216.2	2971919	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	91.4	C12H24O3	216.2	4212750	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.700	94.1	C14H42O5Si6	458.2	4648758	107-52-8	Hexasiloxane, tetradecamethyl-
13.000	95.0	C14H30	198.2	4231125	629-59-4	Tetradecane
13.800	82.5	C14H42O7Si7	518.1	89057722	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.700	88.3	C16H48O6Si7	532.2	4473241	541-01-5	Heptasiloxane, hexadecamethyl-
15.800	88.7	C16H48O8Si8	592.2	80068142	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.500	84.9	C18H54O9Si9	666.2	12813662	556-71-8	Cyclononasiloxane, octadecamethyl-