

**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

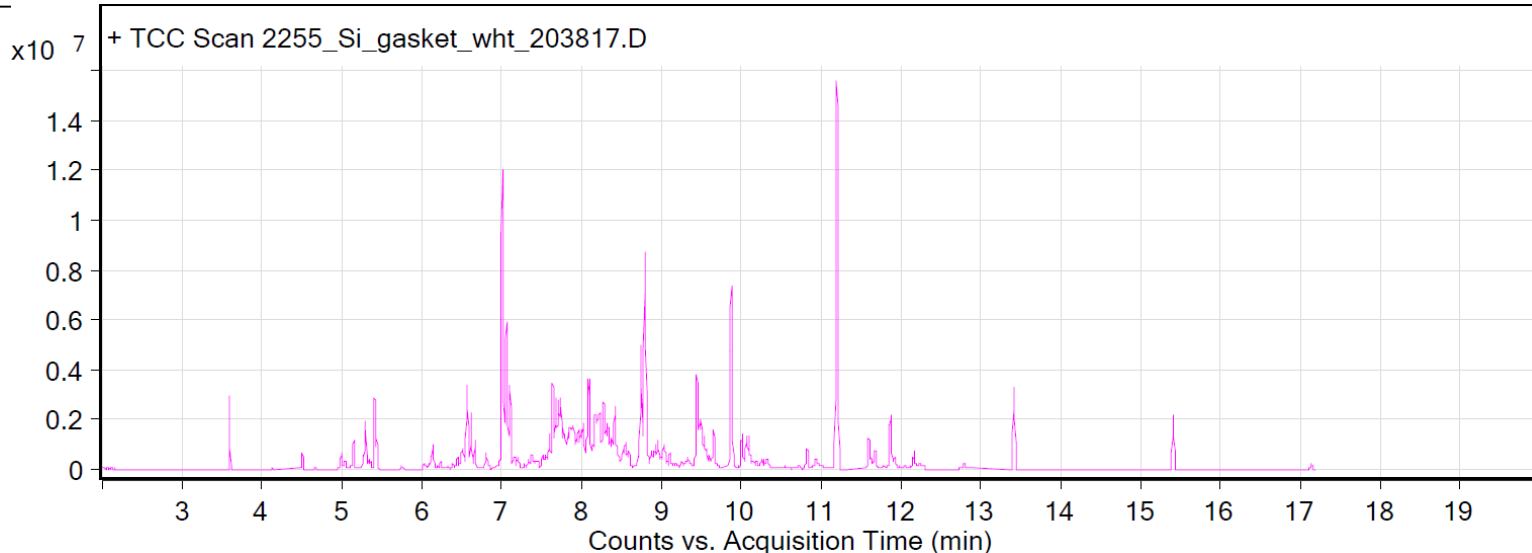
Sample: Technical Rubber SRL: expanded white silicone tubular gasket, 411/PLT

Oddy test result: temporary

Date collected: 8/17/2018

Technique used: SPME 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 at 60°C for 20 minutes; fiber exposure at 60°C for 20 minutes; sample injected into 220°C inlet and cryo-trapped for 2 min at -15°C; GC ramped from 35°C to 250 °C at 10°C/min. Data analyzed in Masshunter Qualitative Analysis. Deconvoluted data with > 85% match with a NIST 17.0 or Wiley 9 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 5.3 min: methoxyphenyl oxime; (2) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 11.9 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
1.38	86.35	1389507	Carbon dioxide	Co2
3.6	93.65	2002091	Silanediol, dimethyl-	C2H8O2Si
4.5	92.52	925163	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
4.99	88.91	705367	1-Methoxy-2-propyl ester of acetic acid	C6H12O3
5.04	86.85	399009	Benzene, 1,3-dimethyl-	C8H10
5.15	90.23	1256524	Butyl isobutyl ether	C8H18O
5.27	85.1	542553	Oxime-, methoxy-phenyl-	C8H9NO2
5.29	95.33	2349990	2-Propenoic acid, butyl ester	C7H12O2
5.34	96.61	322196	Nonane	C9H20
5.41	90	3065196	Ethanol, 2-butoxy-	C6H14O2
6.13	93.67	1367978	Benzaldehyde	C7H6O
6.45	85.08	521637	5-Hepten-2-one, 6-methyl-	C8H14O
6.56	94.75	4300055	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.57	93.99	670604	unidentified C3-benzene	C9H12
6.62	96.06	1607931	Decane	C10H22
6.67	95.09	766207	Octanal	C8H16O
6.81	89.8	852804	3-Carene	C10H16
7	92.81	1267428	Benzene, methyl(1-methylethyl)-	C10H14
7.01	95.21	10243185	1-Hexanol, 2-ethyl-	C8H18O
7.06	96.75	6050866	dl-Limonene	C10H16
7.52	91.44	908629	Dodecane, 2,6,11-trimethyl-	C15H32
7.99	92.69	830291	Benzoic acid, methyl ester	C8H8O2
8.02	93.65	4370214	Undecane	C11H24
8.09	96.06	6074139	Nonanal	C9H18O
8.32	87.71	2236749	1,1,1,2-tetrafluoro-2-tridecene	C13H22F4
8.42	92.64	3143216	Undecane, 4,7-dimethyl-	C13H28
8.5	90.81	1098844	Undecane, 2,8-dimethyl-	C13H28
8.75	96.38	5156680	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.8	94.4	11402150	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.11	89.21	880430	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, [1S-(1.alpha.,2.alpha.,5.beta.)]-	C10H20O

9.33	91.72	706927	1-Dodecanol	C12H26O
9.44	93.62	3165072	Dodecane	C12H26
9.54	95.04	1238075	Decanal	C10H20O
9.66	92.63	2546587	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-	C10H20O
9.87	94.53	11643874	2-Ethylhexyl acrylate	C11H20O2
10	91.23	1897601	2-Ethyl-1-hexyl propionate	C11H22O2
10.11	85.74	856592	2-Propenoic acid, octyl ester	C11H20O2
10.82	93.97	1320230	Tridecane	C13H28
11.2	95.86	16537790	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.59	91.44	2125118	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.86	92.54	3591224	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	C12H24O3
11.92	85.82	495577	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-	C13H20O2
12.15	95.09	764521	Tetradecane	C14H30
12.79	85.54	366299	Cyclopentane, nonyl-	C14H28
15.41	90.11	3567571	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8