

**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

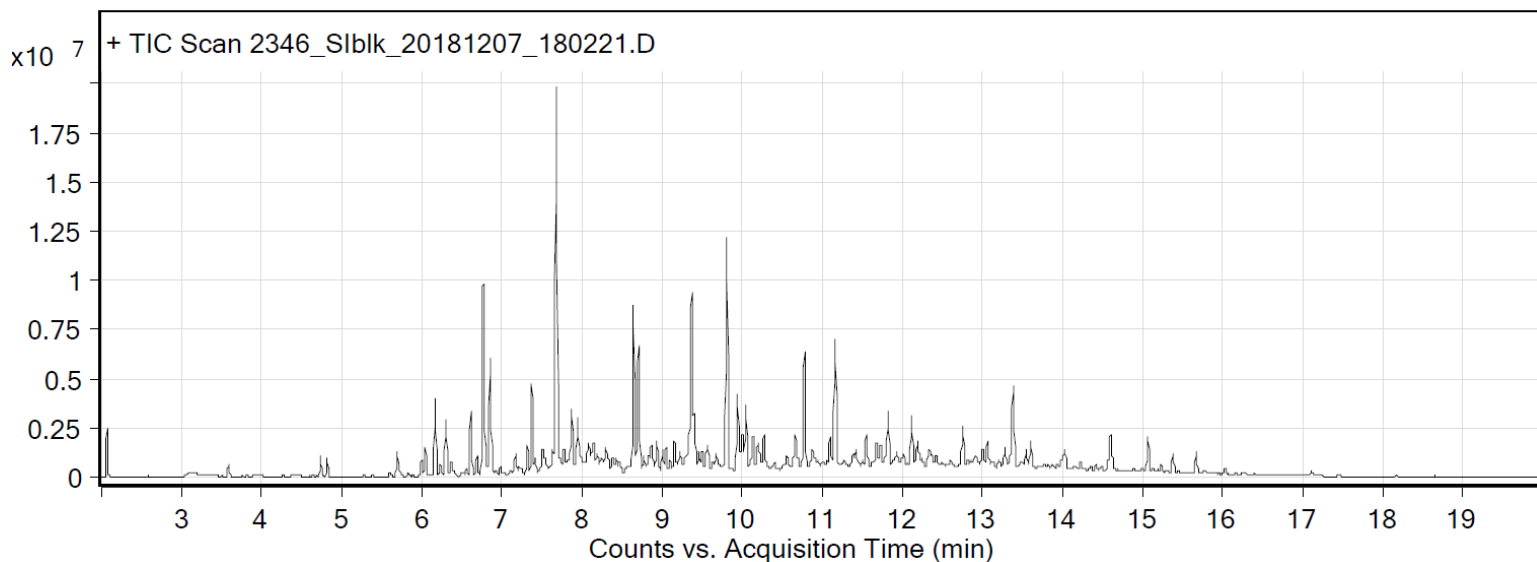
Sample: Stockwell Elastomerics: Norseal sponge silicone rubber, R10470Silicone Sheet of black foamed silicone 0.032 or 1/32 inch thick

Oddly test result: Temporary

Date collected: 12/5/2018

Technique used: SPME with a PDMS/Carbon WR 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) 11.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 11.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



#### Compound Table

RT	Score (Lib)	Area	Name	Formula
1.73	90.56	620051	Benzene, methyl-	C7H8
2.07	93.66	2108826	Silanediol, dimethyl-	C2H8O2Si
3.12	90.64	1943881	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.59	92.41	809190	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.93	96.64	807757	unidentified C2-benzene	C8H10
4.82	96.79	1338775	Ethanol, 2-butoxy-	C6H14O2
5.69	93.32	2077429	Benzaldehyde	C7H6O
6.04	97.73	2070550	.alpha.-Methylstyrene	C9H10
6.16	94.97	5802842	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
6.22	95.02	665662	Benzene, 1,2,3-trimethyl-	C9H12
6.29	95.67	3154885	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.31	96.8	1375693	Decane	C10H22
6.37	88.98	766369	Ethanol, 2-(2-ethoxyethoxy)-	C6H14O3
6.55	92.37	608835	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.61	94.34	4753427	4-Cyanocyclohexene	C7H9N
6.77	96.84	15006468	1-Hexanol, 2-ethyl-	C8H18O
6.78	91.96	2238917	dl-Limonene	C10H16
6.85	95.85	7022922	Benzyl Alcohol	C7H8O
6.87	88.01	2660394	1-Hexanol, 5-methyl-2-(1-methylethyl)-	C10H22O
7.17	90.01	1877236	Nonane, 3-methyl-	C10H22
7.32	90.59	2322091	Dodecane, 2,6,11-trimethyl-	C15H32
7.37	98.03	6131041	Ethanone, 1-phenyl-	C8H8O
7.68	91.66	30761667	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O
7.77	87.08	1448811	Benzene, (1-methoxy-1-methylethyl)-	C10H14O
7.87	96.12	6082618	Undecane	C11H24
7.94	95.5	5047922	Nonanal	C9H18O
8.29	90.63	3494152	Undecane, 3,7-dimethyl-	C13H28
8.38	89.62	1553168	Undecane, 2,8-dimethyl-	C13H28
8.64	96.69	13118202	Acetic acid, 2-ethylhexyl ester	C10H20O2

8.71	93.49	9757086	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.77	88.42	1167973	Octane, 6-ethyl-2-methyl-	C11H24
8.93	93.46	2321878	Undecane, 3-methyl-	C12H26
9.37	93.68	15424991	Dodecane	C12H26
9.46	93.46	1389920	Decanal	C10H20O
9.67	93.16	982281	Ethanol, 2-phenoxy-	C8H10O2
9.81	95.96	17969008	2-Ethylhexyl acrylate	C11H20O2
9.94	90.52	6204086	2-Ethyl-1-hexyl propionate	C11H22O2
10.05	87.06	4805219	2-Propenoic acid, octyl ester	C11H20O2
10.13	86.07	2582607	2-Propenoic acid, octyl ester	C11H20O2
10.27	88.6	2939183	acrylic acid dodecanyl ester	C15H28O2
10.4	85.17	728089	Octane, 1,1'-oxybis-	C16H34O
10.66	94.46	3697176	1-Tridecene	C13H26
10.78	94.6	9200258	Tridecane	C13H28
11.16	96.04	9842457	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.17	87.68	1940691	Dodecane, 2,2,11,11-tetramethyl-	C16H34
11.55	88.38	2847720	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.67	88.74	2254105	Ethanol, 2-(2-butoxyethoxy)-, acetate	C10H20O4
11.73	90.68	2139256	Tridecane, 3-methyl-	C14H30
11.82	92.74	5409390	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.11	94.73	4432497	Tetradecane	C14H30
12.19	86.49	2690974	Tridecane, 6-propyl-	C16H34
12.76	88.28	3918433	1-Tetradecanol	C14H30O
12.91	87.82	1679885	Tetracosane	C24H50
13.28	93.94	1797012	1-Pentadecene	C15H30
13.48	86.69	1044787	Carbonic acid, 2-ethylhexyl undecyl ester	C20H40O3
13.54	91.39	1120100	Phenol, 2,4-bis(1,1-dimethylethyl)-	C14H22O
13.6	97.67	1772717	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
14.03	85.91	1425300	n-Nonylcyclohexane	C15H30
14.41	86.66	445681	Cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	C10H20
14.6	94.23	3273023	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
15.07	93.28	1997109	2,6-Bis(1,1-dimethylethyl)-4-(1-oxopropyl)phenol	C17H26O2
15.23	88.16	698512	Cyclohexadecane	C16H32
15.38	88.65	1594176	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8
16.02	92.88	516986	1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-	C18H20