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

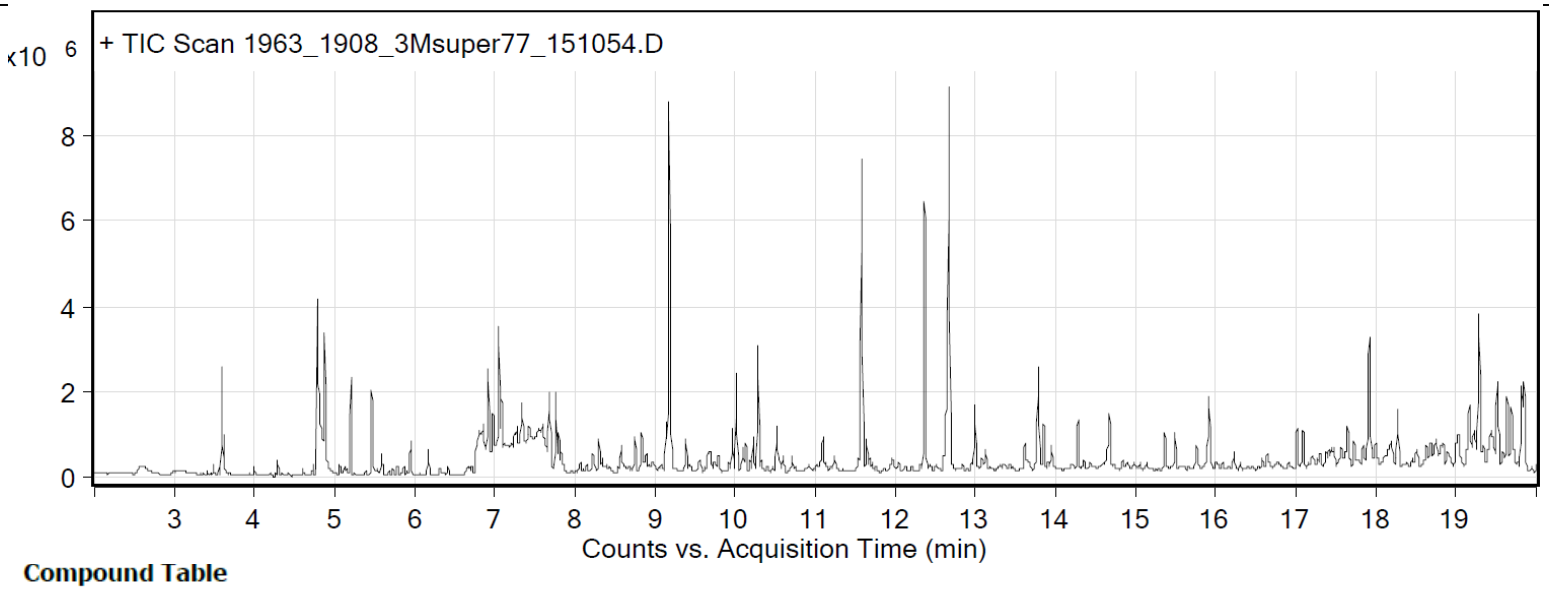
Alkynes – can become reactive when exposed to heat or UV light

Sample: 3M Super 77 spray adhesive

Oddy test result: temporary

Date collected: 6/26/2018

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) 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



Compound Table

RT	Score (Lib)	Area	Name	Formula
2.24	89.34	564922	Ethanamine, N-ethyl-	C4H11N
2.58	90.42	1776985	Cyclohexane	C6H12
3.01	90.16	777249	Triethylamine	C6H15N
3.48	92.83	272106	Formic acid	CH2O2
3.56	93.14	147663	Silanol, trimethyl-	C3H10OSi
3.6	97.2	2248452	Acetic acid	C2H4O2
3.61	92.19	761963	Ethanamine, N-ethyl-	C4H11N
3.99	95.7	189444	Triethylamine	C6H15N
4.29	91.68	391311	1,2-Propanediol	C3H8O2
4.78	95.26	9714141	Morpholine	C4H9NO
4.88	92.59	2071147	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.2	95.65	2153038	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
5.46	96.79	2230548	1,3-Butanediol, (S)-	C4H10O2
5.48	91.74	141493	Ethylbenzene	C8H10
5.53	86.67	224085	PENTANOIC ACID	C5H10O2
5.58	97.15	658682	unidentified C2-benzene	C8H10
5.78	90.05	223348	Cyclohexanol	C6H12O
5.86	96.64	226714	unidentified C2-benzene	C8H10
5.95	91.81	786035	Ethanol, 2-butoxy-	C6H14O2
6.8	96.06	553479	Benzaldehyde	C7H6O
6.86	87.97	2907027	Hexanoic acid	C6H12O2
6.91	85.6	625333	Phenol	C6H6O
6.92	95.88	1816399	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.05	95.21	3295744	6-Methyl-5-hepten-2-one	C8H14O
7.08	94.85	1615816	Bicyclo[2.2.1]heptane, 2,2,3-trimethyl-	C10H18
7.28	90.81	558022	Decane	C10H22
7.34	97.85	1549637	Octanal	C8H16O
7.67	96.27	1794890	1-Hexanol, 2-ethyl-	C8H18O
7.69	93.85	940668	Benzene, methyl(1-methylethyl)-	C10H14
7.76	97.7	2251925	dl-Limonene	C10H16

7.79	89.09	1099288	Benzyl Alcohol	C7H8O
8.22	87.96	484465	Octane, 2,6-dimethyl-	C10H22
8.39	88.85	346026	Decane, 2,3,6-trimethyl-	C13H28
8.75	90	1129377	Undecane	C11H24
8.84	95.86	1356530	Nonanal	C9H18O
8.89	91.37	672465	Hexanoic acid, 2-ethyl-	C8H16O2
9.14	90.69	1787049	N-Formylmorpholine	C5H9NO2
9.18	94.5	9758424	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.79	86.46	592095	Decanedioic acid, didecyl ester	C30H58O4
9.92	88.2	254396	endo-Borneol	C10H18O
9.96	97.75	1359279	Cyclohexanol, 5-methyl-2-(1-methylethyl)-	C10H20O
10.01	96.11	2891234	Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
10.09	87.19	769416	Morpholine, 4-acetyl-	C6H11NO2
10.13	95.88	773571	Azulene	C10H8
10.18	95.37	361408	Methyl salicylate	C8H8O3
10.22	91.55	1017088	Dodecane	C12H26
10.28	95.25	3984464	ENDO-ISOCAMPHONONE	C10H16O
10.52	92.07	1418848	Ethanol, 2-phenoxy-	C8H10O2
11.1	95.86	1547666	Nonanoic acid	C9H18O2
11.24	87.92	602225	Decyl octyl ether	C18H38O
11.58	95.93	9436411	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.64	93.85	947580	Tridecane	C13H28
11.71	97.26	277212	Naphthalene, 2-methyl-	C11H10
11.93	95.81	140484	Naphthalene, 1-methyl-	C11H10
12.36	90.03	8600806	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
12.67	93.79	12757643	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.73	89.4	158835	Hexasiloxane, tetradecamethyl-	C14H42O5Si6
12.99	95.05	2097407	Tetradecane	C14H30
13.08	86.63	371625	2,4,7,9-Tetramethyl-5-decyne-4,7-diol	C14H26O2
13.13	97.18	721931	Dodecanal	C12H24O
13.85	90.24	1441041	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	C14H20O2
13.95	95.65	802774	1-Dodecanol	C12H26O
14.21	89.14	187427	Acenaphthylene, 1,2-dihydro-	C12H10
14.28	94.48	1526116	pentadecane	C15H32
14.73	86.53	166039	Heptasiloxane, hexadecamethyl-	C16H48O6Si7
15.49	94.3	1102087	Hexadecane	C16H34
15.76	89.52	720010	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8
16.22	91.15	544788	Octane, 1,1'-oxybis-	C16H34O
16.64	93.49	628344	Heptadecane	C17H36
17.84	85.97	684357	.alpha.-Phellandrene, dimer	C20H32
19.28	96.62	5614021	(1S,4aS,4bS,7S,8aS,10aS)-7-Isopropyl-1,4a-dimethyltetradecahydrophenanthrene	C19H34
19.69	88.03	2620060	(1S,4aS,4bS,7S,8aS,10aS)-7-Isopropyl-1,4a-dimethyltetradecahydrophenanthrene	C19H34
20.09	90.44	912994	4b,8-Dimethyl-2-isopropylphenanthrene, 4b,5,6,7,8,8a,9,10-octahydro-	C19H28