

**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

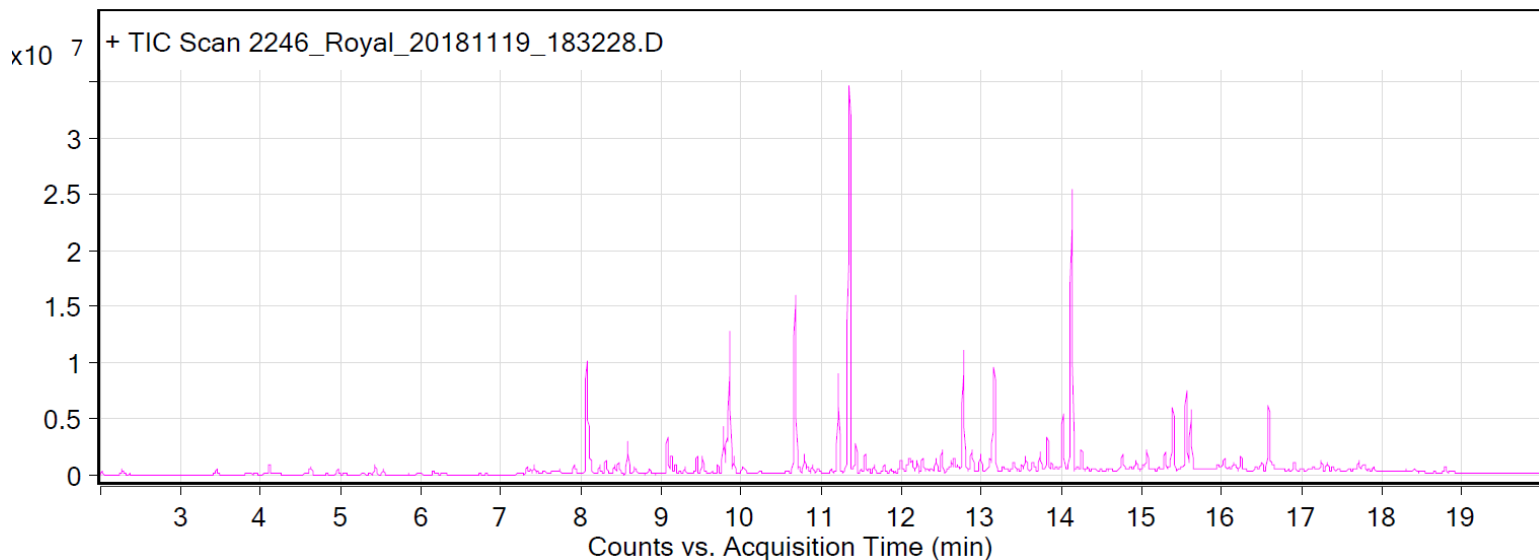
Sample: Royal Long Lasting Insecticidal Net

Oddy test result: Temporary

Date collected:

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) 13.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 13.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



#### Compound Table

RT	Score (Lib)	Area	Name	Formula
0.17	94	7576541	Oxygen	O2
0.49	94	1134177	Oxygen	O2
0.52	87.44	1094474	Air	O2
1.27	96.85	1930355	2-Propanol	C3H8O
1.45	94.77	787467	Silanol, trimethyl-	C3H10OSi
1.55	98.22	946217	Acetic acid	C2H4O2
4.1	93.66	1505007	Octane	C8H18
4.62	92.51	1119650	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
4.96	95.76	744410	2,4-Dimethyl-1-heptene	C9H18
5.43	96.34	1304701	Octane, 4-methyl-	C9H20
5.53	98.06	706437	XYLENE	C8H10
7.36	88.4	840515	Nonane, 4-methyl-	C10H22
7.41	94.29	1169752	Nonane, 2-methyl-	C10H22
7.91	95.96	1191606	1-Decene	C10H20
8.07	97.21	14775191	Decane	C10H22
8.1	96.04	5692249	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
8.13	97.92	1316539	Octanal	C8H16O
8.24	91.69	1260981	Nonane, 2,6-dimethyl-	C11H24
8.31	92.38	2203214	3-Ethyl-3-methylheptane	C10H22
8.42	93.4	1394837	Nonane, 2,5-dimethyl-	C11H24
8.47	87.7	1517053	Octane, 3-ethyl-	C10H22
8.66	97.38	747855	Benzyl Alcohol	C7H8O
8.85	90.81	758577	Decane, 4-methylene-	C11H22
9.08	93.33	5476620	Undecane, 4,7-dimethyl-	C13H28
9.13	95.32	2341416	Decane, 4-methyl-	C11H24
9.18	93.12	1516096	Undecane, 4,7-dimethyl-	C13H28
9.29	91.08	814737	1-Octanol	C8H18O
9.45	88.01	2353656	1-Dodecene	C12H24
9.52	90.01	2518093	1-Dodecene	C12H24
9.71	96.77	805912	Benzoic acid, methyl ester	C8H8O2
9.78	97.65	6315054	Undecane	C11H24

9.82	88.83	3685626	Dodecane	C12H26
9.86	98.01	20178104	Nonanal	C9H18O
9.91	92.55	2251949	Undecane, 4,7-dimethyl-	C13H28
10.67	95.69	24709800	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
10.72	92.56	894231	2,3-Dimethyldecane	C12H26
10.79	94.47	2744621	Undecane, 2-methyl-	C12H26
10.89	93.31	1179878	Undecane, 3-methyl-	C12H26
11.21	97.35	14017586	1-Dodecene	C12H24
11.35	96.5	69645754	Dodecane	C12H26
11.43	97.97	3977910	Decanal	C10H20O
11.55	95.32	2441626	Undecane, 4,6-dimethyl-	C13H28
11.66	93.06	974105	Dodecane, 4-methyl-	C13H28
11.79	94.38	1043045	2-Ethylhexyl acrylate	C11H20O2
11.99	90.56	1733162	2,6-Dimethyldecane	C12H26
12.2	93.8	1453321	Dodecane, 4-methyl-	C13H28
12.26	92.12	2351099	Tridecane, 5-methyl-	C14H30
12.5	91.47	3016082	Dodecane, 4,6-dimethyl-	C14H30
12.62	88.07	1554511	Decane, 6-ethyl-2-methyl-	C13H28
12.66	93.82	2126106	1-Tridecene	C13H26
12.77	95.55	17628242	Tridecane	C13H28
12.99	90.33	2823368	2-Isopropyl-5-methyl-1-heptanol	C11H24O
13.14	89.64	3161615	Dodecane, 2,6,10-trimethyl-	C15H32
13.16	96.04	14315121	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
13.27	85.88	1046188	Dodecane, 2,6,11-trimethyl-	C15H32
13.5	87.49	724524	Tridecane, 5-methyl-	C14H30
13.55	87.17	2335280	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
13.64	87.8	1528914	Tridecane, 2-methyl-	C14H30
13.73	92.01	3288525	Tridecane, 3-methyl-	C14H30
13.82	93.93	5018208	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
13.88	93.73	934937	2-Propenoic acid, 1,7,7-	C13H20O2

			trimethylbicyclo[2.2.1]hept-2-yl ester, exo-	
13.93	88.16	742538	1-Dodecene, 2-ethyl-	C14H28
14.02	97.24	8870645	1-Tetradecene	C14H28
14.13	95.93	44389303	Tetradecane	C14H30
14.25	96.65	3036605	Dodecanal	C12H24O
14.76	90.35	2919610	Cyclotetradecane	C14H28
14.93	91.52	1941396	Tetradecane, 2-methyl-	C15H32
15.29	95.05	2939996	1-Pentadecene	C15H30
15.56	92.94	9090970	Phenol, 2,4-bis(1,1-dimethylethyl)-	C14H22O
15.61	97.18	7229721	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
16.15	86.89	1447342	Pentadecane, 2-methyl-	C16H34
16.24	93.19	2019601	Pentadecane, 3-methyl-	C16H34
16.5	95.98	1314762	Cetene	C16H32
16.58	92.32	10525860	Hexadecane	C16H34
16.9	96.74	1411138	Dodecanoic acid, 1-methylethyl ester	C15H30O2
17.24	92.47	1651013	Cyclohexadecane	C16H32
17.32	89.79	1467640	Octyl tetradecyl ether	C22H46O
17.71	95.22	1614484	Heptadecane	C17H36
18.79	91.6	816273	Octadecane	C18H38