

**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

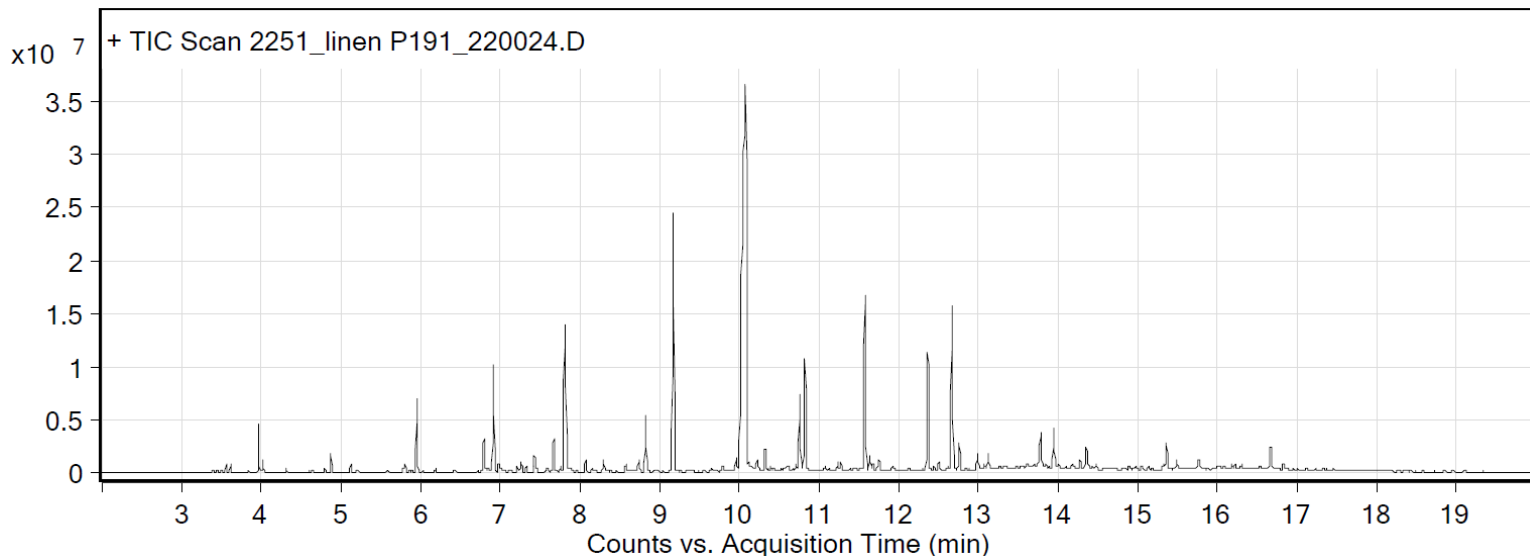
Sample: Libeco: P191 Flax-0024 Belgian Linen

Oddy test result: Unsuitable

Date collected: 7/23/2018

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) 5.8 min: methoxyphenyl oxime; (2) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



RT	Score (Lib)	Area	Name	Formula
3.96	93.68	3129737	Silanediol, dimethyl-	C2H8O2Si
4.88	92.5	1366304	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.8	85.48	1380903	Oxime-, methoxy-phenyl-	C8H9NO2
5.95	96.98	7106722	Ethanol, 2-butoxy-	C6H14O2
6.79	97.76	3573591	Benzaldehyde	C7H6O
6.91	96.21	9988422	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.43	97.86	1835201	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.67	97.47	3701697	1-Hexanol, 2-ethyl-	C8H18O
7.81	97.3	21607589	2-Pyrrolidinone, 1-methyl-	C5H9NO
7.82	95.77	3795117	Benzyl Alcohol	C7H8O
8.07	92.33	1424360	Undecane, 4,7-dimethyl-	C13H28
8.74	92.74	1454817	Undecane, 4,7-dimethyl-	C13H28
8.82	96.88	6357313	Nonanal	C9H18O
9.17	96.06	29490332	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.96	96.33	1829541	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./.-.)-	C10H20O
10.08	95.06	123431709	Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
10.22	91.5	1521771	Dodecane	C12H26
10.32	94.31	2881571	Decanal	C10H20O
10.76	87.66	8962222	2-Propanol, 1,1'-oxybis-	C6H14O3
10.82	88.74	13570122	2-Propanol, 1-(2-butoxy-1-methylethoxy)-	C10H22O3
11.58	96.04	21250692	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.64	94.06	2044336	Tridecane	C13H28
12.36	89.99	14997804	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
12.67	93.73	21884774	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.76	96.42	3270546	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-	C13H20O2

12.99	93.69	2050899	Tetradecane	C14H30
13.12	97.35	1854255	Dodecanal	C12H24O
13.94	97.11	5227638	1-Dodecanol	C12H26O
14.35	86.58	2321727	Phenol, 2,4-bis(1,1-dimethylethyl)-	C14H22O
16.67	91.39	3020858	Methanone, (1-hydroxycyclohexyl)phenyl-	C13H16O2