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

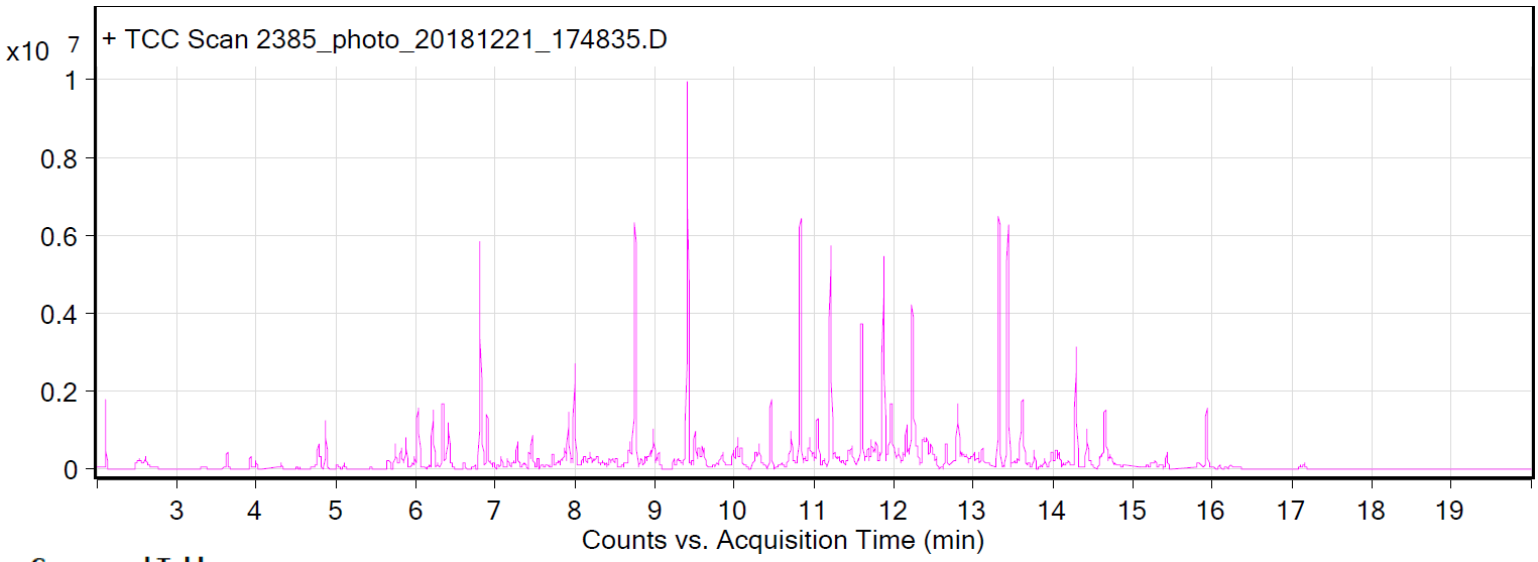
Sample: Talas; Photomount board

Oddy test result: temporary

Date collected: 12/21/2018

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) 4.8 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
1.51	98.43	682080	Acetic acid	C2H4O2
2.1	93.65	1567143	Silanediol, dimethyl-	C2H8O2Si
2.53	90.32	1650743	Hexanal	C6H12O
2.61	87.56	181347	(S)-(+)-1,2-Propanediol	C3H8O2
3.63	92.44	676121	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.92	96.48	455524	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
3.99	85.35	224481	2-Propanol, 1-(2-propenyloxy)-	C6H12O2
4.31	94	257817	1-Hexanol	C6H14O
4.78	85.78	704332	Oxime-, methoxy-phenyl-_	C8H9NO2
4.8	92.12	797169	Heptanal	C7H14O
4.87	96.87	1398809	Ethanol, 2-butoxy-	C6H14O2
5.02	88.02	192742	2(5H)-furanone	C4H4O2
5.1	95.79	179089	2-Methyl-2,4-pentanediol	C6H14O2
5.44	90.78	128429	2-Propanol, 1-butoxy-	C7H16O2
5.67	94.2	261809	2-Heptenal, (E)-	C7H12O
5.74	98.13	960567	N-benzylidene-dimethylammonium chloride	C9H12ClN
5.87	93.76	1430866	1-Heptanol	C7H16O
5.99	90.53	384924	Hexanoic acid	C6H12O2
6.16	85.9	116072	6-Methyl-5-hepten-2-one	C8H14O
6.21	94.95	2319938	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
6.24	89.92	243015	Furan, 2-pentyl-	C9H14O
6.27	94.71	174638	Benzene, 1,2,3-trimethyl-	C9H12
6.34	96.02	2841953	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.38	90.36	130877	O-Ethyl-1,3-dioxolanium	C5H11O2
6.41	97.14	1563301	Octanal	C8H16O
6.44	85.43	281137	O-Ethyl-1,3-dioxolanium	C5H11O2
6.6	96.92	281518	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.81	97.17	5239673	1-Hexanol, 2-ethyl-	C8H18O
6.83	92.45	852112	dl-Limonene	C10H16

6.9	96.79	1020702	Benzyl Alcohol	C7H8O
6.98	89.02	169902	3-Octen-2-one	C8H14O
7.07	87.85	414778	Hexane, 1-nitro-	C6H13NO2
7.28	95.24	544163	2-Octenal, (E)-	C8H14O
7.36	91.93	196175	Dodecane, 2,6,11-trimethyl-	C15H32
7.43	97.72	505829	Ethanone, 1-phenyl-	C8H8O
7.46	96.87	1110090	1-Octanol	C8H18O
7.54	88.92	282250	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
7.72	87.15	360841	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O
7.87	94.13	502867	Benzoic acid, methyl ester	C8H8O2
7.92	97.43	2040711	Undecane	C11H24
7.99	98.45	4002211	Nonanal	C9H18O
8.69	95.52	919668	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.72	85.79	539473	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one	C16H11NO2S
8.75	95.26	10480753	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.83	91.59	350492	trans-2-Nonenal	C9H16O
8.98	94.39	663741	Undecane, 2,3-dimethyl-	C13H28
9.02	93.99	244013	Benzoic acid, ethyl ester	C9H10O2
9.05	95.98	514329	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(.+/-.)-	C10H20O
9.24	87.54	307367	Naphthalene	C10H8
9.41	96.1	11446255	Dodecane	C12H26
9.51	97.71	990985	Decanal	C10H20O
9.85	91.4	520587	2-Propenoic acid, 6-methylheptyl ester	C11H20O2
10.31	89.47	889564	2-Decenal, (E)-	C10H18O
10.45	94.16	2791361	n-Propyl benzoate	C10H12O2
10.71	96	1593127	1-Tridecene	C13H26
10.83	95.5	10289406	Tridecane	C13H28
11.04	85.27	1015440	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
11.21	96.05	10219892	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.31	85.4	358746	Heptadecane, 7-methyl-	C18H38
11.6	89.48	6106671	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.77	91.05	938805	Tridecane, 3-methyl-	C14H30
11.87	93.58	9074472	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
11.96	96.73	925119	1,1'-Biphenyl	C12H10
12.06	95.04	669720	1-Tetradecene	C14H28
12.16	95.26	1687408	Tetradecane	C14H30
12.23	91.64	6115449	1,1'-Biphenyl, 2-methyl-	C13H12
12.26	87.63	1073971	Benzene, 1,1'-oxybis-	C12H10O
12.54	87.94	217820	2,2'-Dimethylbiphenyl	C14H14
12.66	90.9	987824	Diphenylmethane	C13H12
12.81	90.37	1683635	Cyclotetradecane	C14H28
12.96	85.75	525562	Tetradecane, 4-methyl-	C15H32
13.32	94.46	10561618	1,1'-Biphenyl, 4-methyl-	C13H12
13.6	93.8	1700482	1,1'-biphenyl, 2,6-dimethyl-	C14H14
13.62	90.37	1252745	Heptane, 2,2,4,6,6-pentamethyl-	C12H26
13.77	93.94	659272	Benzene, 1,1'-(1,2-ethanediyl)bis-	C14H14
13.84	89.75	184813	Benzene, 1-methyl-4-(phenylmethyl)-	C14H14
13.89	94.88	387570	Benzene, 1-methyl-2-(phenylmethyl)-	C14H14
14.08	88.51	524240	n-Nonylcyclohexane	C15H30
14.29	86.26	4947434	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID	C13H16O3
14.43	86.71	1497751	1-METHYL-2-(PROPENYLOXY)-ETHYL ESTER OF BENZOIC ACID	C13H16O3
14.59	95.43	425374	4,4'-Dimethylbiphenyl	C14H14
14.65	94.65	2491452	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
14.71	95.08	213855	4,4'-Dimethylbiphenyl	C14H14
15.42	88.41	732344	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8
15.8	90.94	176306	Hexadecane, 2,6,10-trimethyl-	C19H40
15.93	94.22	2469968	Benzoic acid, 2-ethylhexyl ester	C15H22O2
17.11	87.86	133556	Isopropyl myristate	C17H34O2