

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

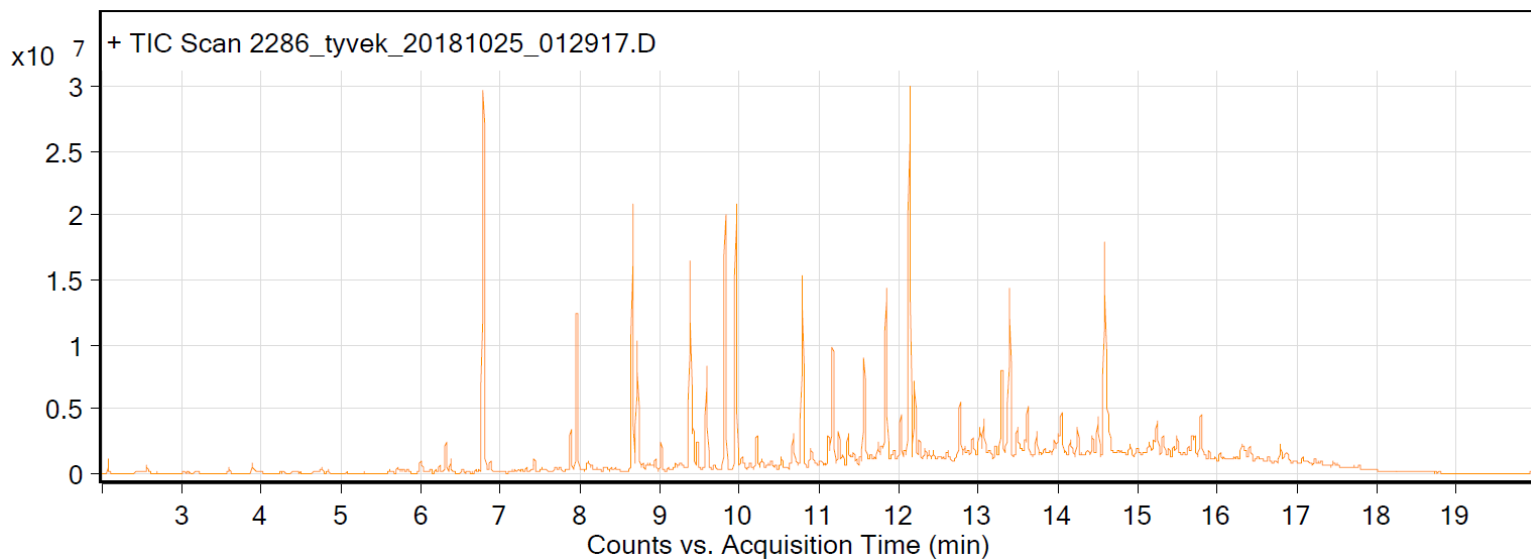
Sample: Gaylord Archival: Tyvek® Envelopes with 2" Gusset & 4" Flap (50-Pack), #3970

Oddy test result: Temporary

Date collected: 10/23/2018

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) 11.6 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
1.53	98.04	6323027	Acetic acid	C2H4O2
2.07	93.7	949476	Silanediol, dimethyl-	C2H8O2Si
2.56	94.11	658856	1,2-Propanediol	C3H8O2
3.6	92.54	579505	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.88	96.17	985335	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
3.92	96.33	1105374	Benzene, 1,4-dimethyl-	C8H10
6.24	94.98	828513	unidentified C3-benzene	C9H12
6.31	96.32	1791274	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.32	96.29	2283413	Decane	C10H22
6.37	97.01	1364109	Octanal	C8H16O
6.79	96.26	47486321	1-Hexanol, 2-ethyl-	C8H18O
6.8	94.41	7208358	dl-Limonene	C10H16
6.87	89.3	971739	Benzyl alcohol	C7H8O
7.43	92.84	1309528	1-Octanol	C8H18O
7.88	97.17	4842451	Undecane	C11H24
7.96	97.84	18778672	Nonanal	C9H18O
8.11	95.02	705862	Benzeneethanol	C8H10O
8.66	96.68	32582605	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.72	94.9	14582075	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.75	86.67	1291704	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, cis-	C10H18O
8.95	88.92	1523666	Undecane, 2,3-dimethyl-	C13H28
9.02	97.82	3276760	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./-./-)	C10H20O
9.26	90.26	1143854	1-Dodecene	C12H24
9.38	95.44	26627022	Dodecane	C12H26
9.47	96.2	3217531	Decanal	C10H20O
9.59	94.69	12594565	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-	C10H20O

9.82	95.38	30369182	2-Ethylhexyl acrylate	C11H20O2
9.96	91.57	31010957	2-Ethyl-1-hexyl propionate	C11H22O2
10.4	90.06	1041287	1-Decanol	C10H22O
10.52	92.19	1600463	Dodecane, 4,6-dimethyl-	C14H30
10.68	95.88	4912553	1-Tridecene	C13H26
10.79	95.01	24157527	Tridecane	C13H28
11.12	88.75	3744427	n-Butyric acid 2-ethylhexyl ester	C12H24O2
11.17	92.59	14533208	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.25	85.44	3941829	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-	C12H16
11.3	87.82	949015	Benzene, 3-cyclohexen-1-yl-	C12H14
11.51	87.39	955185	Tridecane, 5-methyl-	C14H30
11.56	91.02	14744565	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.65	89.45	1805176	Dodecane, 3-methyl-	C13H28
11.74	90.22	3490079	Tridecane, 3-methyl-	C14H30
11.78	85.91	1524836	3-Phenyl-1-propanol, acetate	C11H14O2
11.84	93.26	23846423	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.02	96.1	7173905	1-Tetradecene	C14H28
12.14	94.86	52358875	Tetradecane	C14H30
12.2	94.18	8656911	1,1'-Biphenyl, 2-methyl-	C13H12
12.26	95.09	2961347	Dodecanal	C12H24O
12.77	89.48	9517430	1-Tetradecanol	C14H30O
12.93	91.05	4703569	Hexadecane, 2,6,11,15-tetramethyl-	C20H42
13.28	92.08	1783410	BENZENE, 1,1'-METHYLENEBIS-	C13H12
13.3	95.77	11751949	1-Pentadecene	C15H30
13.49	92.52	6419153	bis(2-Ethylhexyl) ether	C16H34O
13.62	95.08	5032583	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
13.73	94.15	2633783	Benzene, 1,1'-(1,2-ethanediy)bis-	C14H14
14.04	89.05	5648602	n-Nonylcyclohexane	C15H30
14.15	88.9	3946517	Pentadecane, 2-methyl-	C16H34
14.24	88.38	4040029	Pentadecane, 3-methyl-	C16H34
14.43	85.15	3030949	Cyclopentane, 1,2-dimethyl-3-(1-methylethyl)-	C10H20
14.5	96.24	6661524	Cetene	C16H32
14.59	88.92	34059190	Hexadecane	C16H34
14.82	85.54	933538	(+)-2-Octylvinyl carbonate	C11H20O3
14.9	90.05	2792367	Dodecanoic acid, 1-methylethyl ester	C15H30O2
15.24	90.04	5632272	Cyclopentane, nonyl-	C14H28
15.32	92.21	3908717	Octane, 1,1'-oxybis-	C16H34O
15.64	93.25	2188431	1-Heptadecene	C17H34
15.71	92.67	3146613	Heptadecane	C17H36
15.78	89.98	3051864	Sulfurous acid, 2-ethylhexyl tridecyl ester	C21H44O3S
16.04	88.11	988150	1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-	C18H20
16.79	91.88	2328690	Eicosane	C20H42