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

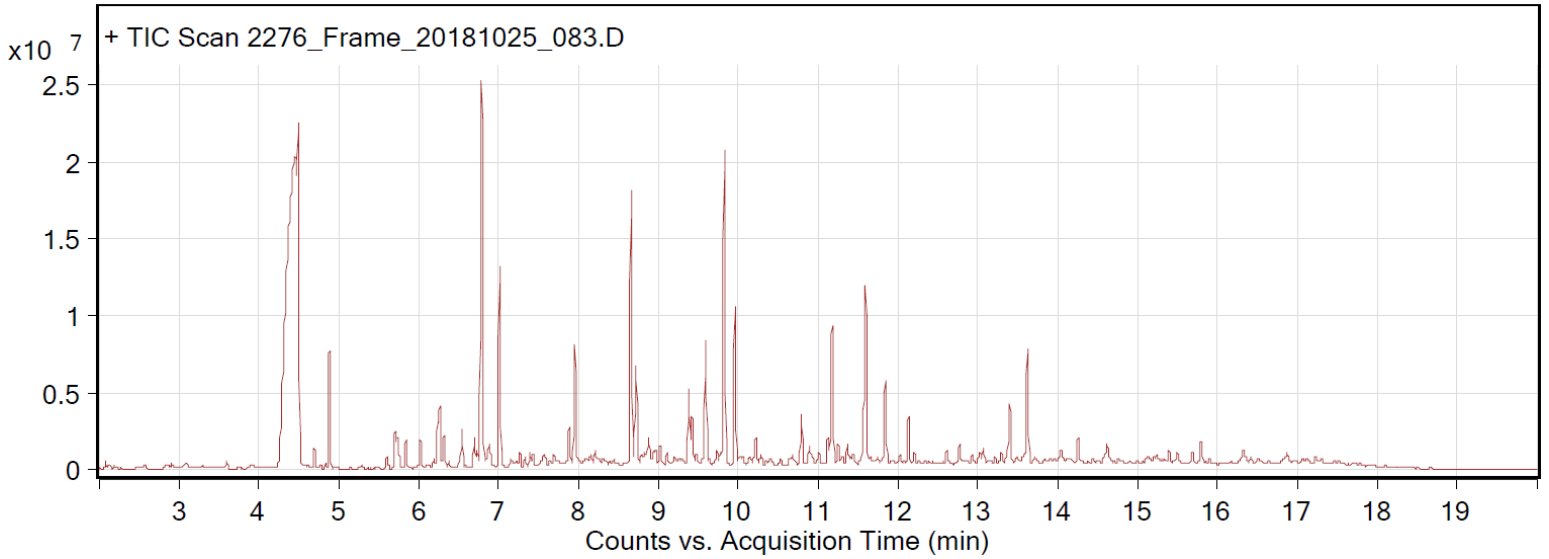
Halogenated compounds – can become reactive with exposure to heat and UV light

Nitrogen-containing, not amine – can react with other off-gassed chemicals

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

Sample: Dick Blick: Framer's Tape II Clear, 23028-1002
Oddy test result: Temporary
Date collected: 10/24/2018
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) 11.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
1.5	97.72	2058358	Acetic acid	C2H4O2
1.72	93.14	1493851	Benzene, methyl-	C7H8
3.9	85.7	1460699	Benzene, 1,3-dimethyl-	C8H10
4.69	94.56	1637393	2-Propenoic acid, butyl ester	C7H12O2
4.88	96.05	9941997	Propanoic acid, butyl ester	C7H14O2
5.7	96.79	3633823	Benzaldehyde	C7H6O
5.73	91.46	3078368	unidentified C3-benzene	C9H12
5.84	95.12	2334235	unidentified C3-benzene	C9H12
6.24	95.37	4175397	unidentified C3-benzene	C9H12
6.26	96.82	5426724	Butanoic acid, butyl ester	C8H16O2
6.31	96.02	1824333	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.32	95.42	1723404	Decane	C10H22
6.54	88.81	3241219	N-HEXYL-CIS-CROTONATE	C10H18O2
6.7	89.5	2849155	unidentified C3-benzene	C9H12
6.73	87.97	1455254	Benzene, methyl(1-methylethyl)-	C10H14
6.79	96.17	38149686	1-Hexanol, 2-ethyl-	C8H18O
6.8	94.32	7049253	dl-Limonene	C10H16
6.87	87.05	1235774	Benzyl alcohol	C7H8O
6.89	90.67	1720664	Octyl ester of formic acid	C9H18O2
7.01	94.95	17875691	2-Butenoic acid, butyl ester	C8H14O2
7.27	85.55	1258873	p-Mentha-1,5,8-triene	C10H14
7.39	92.6	1201154	Ethanone, 1-phenyl-	C8H8O
7.43	88.87	1029301	1-Octanol, 2-methyl-	C9H20O
7.56	93.87	1047276	Benzene, 1-ethyl-2,3-dimethyl-	C10H14
7.88	89.57	4361199	Undecane	C11H24
7.95	85.43	12462309	Propionic acid, 3-butoxy-	C7H14O3
8.21	86.77	1506803	1,1,1,2-tetrafluoro-2-tridecene	C13H22F4
8.3	88.91	993847	Undecane, 4,7-dimethyl-	C13H28
8.66	96.62	27809839	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.72	93.04	9071262	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.95	87.89	1385396	Undecane, 3-methyl-	C12H26

9.02	85.08	1828553	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.beta.)-	C10H20O
9.11	89.18	1175326	Acetic acid, octyl ester	C10H20O2
9.38	95.97	7111607	Dodecane	C12H26
9.42	88.08	5248504	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-	C10H20O
9.59	95	12982104	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-	C10H20O
9.73	93.12	1439734	5-Chloro-2-methyl-3(2H)-isothiazolone	C4H4ClNOS
9.77	98.45	1002254	1,3,5,7-Tetraazatricyclo[3.3.1.1(3,7)]decane	C6H12N4
9.82	95.97	31825253	2-Ethylhexyl acrylate	C11H20O2
9.95	91.56	15198918	2-Ethyl-1-hexyl propionate	C11H22O2
10.68	94.99	1389659	1-Tridecene	C13H26
10.79	95	5155837	Tridecane	C13H28
11.01	88.16	1532560	1-Octanol, 2-butyl-	C12H26O
11.17	94	14439195	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.25	85.28	2156442	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-	C12H16
11.37	85.2	1968559	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-	C12H16
11.84	90.77	8750232	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.03	94.8	1111268	1-Tetradecene	C14H28
12.13	94.06	4605133	Tetradecane	C14H30
12.77	90.09	2395043	1-Tetradecanol	C14H30O
13.07	95.01	1562104	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	C14H20O2
13.3	88.02	1026732	1-Pentadecene	C15H30
13.49	89.17	999050	bis(2-Ethylhexyl) ether	C16H34O
13.62	97.72	10290898	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
14.04	85.02	1281492	n-Nonylcyclohexane	C15H30
14.25	88.77	2014540	Ionol 2	C16H26O
15.39	86.46	1203835	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8