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

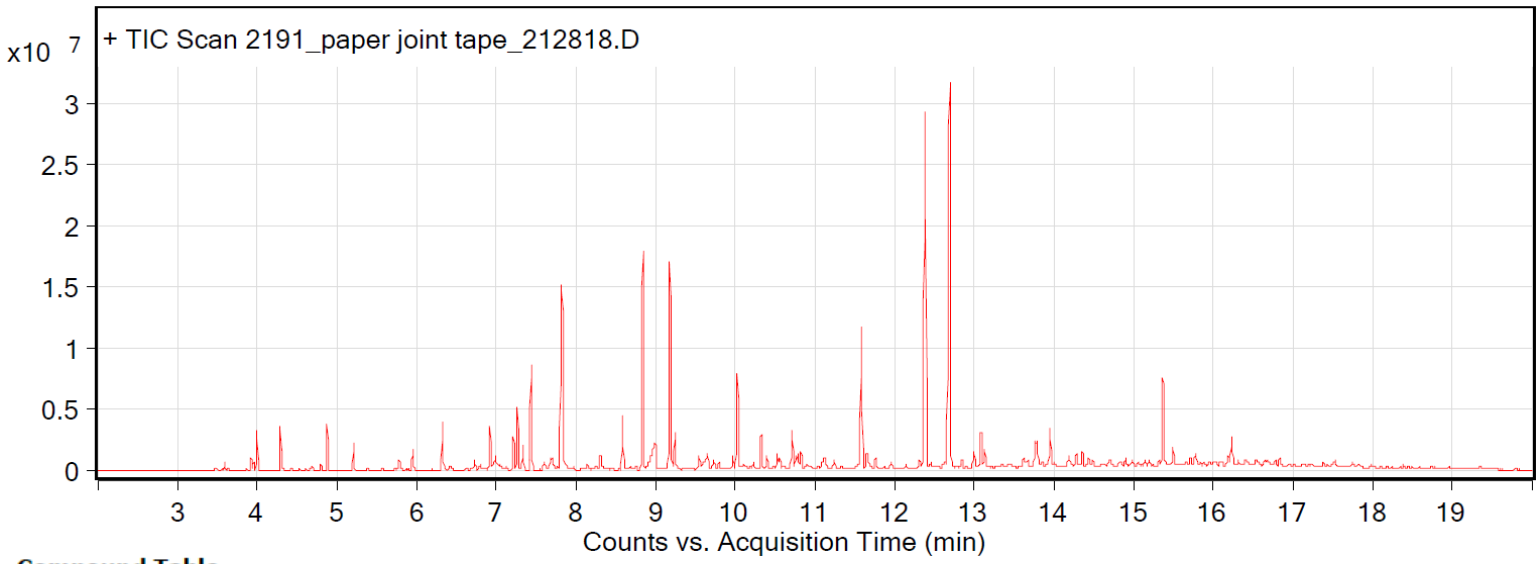
Halogenated compounds – can become reactive with exposure to heat and UV light

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

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

Sample: Paper joint tape
Oddy test result: Temporary
Date collected: 6/29/2018
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-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
3.59	98	605781	Acetic acid	C2H4O2
3.92	86.84	756202	2-Propanol, 1-methoxy-	C4H10O2
4	95.76	2624136	Triethylamine	C6H15N
4.29	94.48	3562392	1,2-Propanediol	C3H8O2
4.88	92.46	2684670	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.21	95.63	2056433	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
5.78	85.49	1427290	Oxime-, methoxy-phenyl-_	C8H9NO2
5.95	91.66	1774641	Ethanol, 2-butoxy-	C6H14O2
6.32	95.3	4288841	Ethanol, 2-(2-methoxyethoxy)-	C5H12O3
6.92	96.13	3512571	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.02	90.25	732730	Phenol	C6H6O
7.21	98.87	2932867	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.26	91.02	6181679	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.33	97.79	2311775	Octanal	C8H16O
7.44	98.41	10580605	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.68	89.03	2030491	1-Hexanol, 2-ethyl-	C8H18O
7.71	99.26	657756	Butanedioic acid, dimethyl ester	C6H10O4
7.82	96.56	26657309	2-Pyrrolidinone, 1-methyl-	C5H9NO
7.83	92.68	3509853	Benzyl Alcohol	C7H8O
8.84	97.53	22566672	Nonanal	C9H18O
8.99	94.77	7716217	Hexanoic acid, 2-ethyl-	C8H16O2
9.18	95.81	19714751	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.24	97.49	3692463	Pentanedioic acid, dimethyl ester	C7H12O4
9.54	93.69	1327365	1,3-Pentanediol, 2,2,4-trimethyl-	C8H18O2
9.65	91.69	3799468	Benzoic acid	C7H6O2
9.73	94.24	1103037	Octanoic Acid	C8H16O2
9.79	86.46	745156	1-Nonanol	C9H20O

9.97	96.72	1344117	Cyclohexanol, 5-methyl-2-(1-methylethyl)-	C10H20O
10.02	96.15	10290790	Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
10.52	92.96	1618556	Ethanol, 2-phenoxy-	C8H10O2
10.71	91.74	3863157	Benzothiazole	C7H5NS
10.76	87.6	1547061	2-Propanol, 1,1'-oxybis-	C6H14O3
10.79	90.67	1529266	Hexanedioic acid, dimethyl ester	C8H14O4
10.82	88.11	1665123	2-Propanol, 1-(2-butoxy-1-methylethoxy)-	C10H22O3
11.13	90.56	1492805	2-Decenal, (E)-	C10H18O
11.24	95.25	1107546	1-Decanol	C10H22O
11.58	95.98	14767044	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.64	93.97	1440064	Tridecane	C13H28
11.66	86.12	1233058	Formamide, N,N-dibutyl-	C9H19NO
11.76	94.13	1248196	Undecanal	C11H22O
12.38	87.63	46998348	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
12.69	93.26	55523948	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.99	96.06	2051626	Tetradecane	C14H30
13.08	96.19	4383792	2,4,7,9-Tetramethyl-5-decyne-4,7-diol	C14H26O2
13.13	97.52	1985451	Dodecanal	C12H24O
13.76	85.27	2724148	2,6-di(t-butyl)-4-hydroxy-4-methyl-2,5-cyclohexadien-1-one	C15H24O2
13.95	96.98	4310189	1-Dodecanol	C12H26O
14.18	92.93	1482775	1-Pentadecene	C15H30
14.28	93.19	1576399	pentadecane	C15H32
14.43	96.64	1147278	Tridecanal	C13H26O
14.9	86.77	966686	Sulfurous acid, hexyl tetradecyl ester	C20H42O3S
14.98	91.4	892266	n-Nonylcyclohexane	C15H30
15.14	92.87	660139	Pentadecane, 3-methyl-	C16H34
15.36	86.89	9325884	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
15.49	88.1	2167009	Dodecane, 2,6,10-trimethyl-	C15H32
15.71	93.2	1000719	Longiborneol	C15H26O
16.03	86.74	818734	Tridecane, 5-propyl-	C16H34
16.18	92.83	1327899	Cyclopentane, undecyl-	C16H32
16.23	95.21	3448793	Octane, 1,1'-oxybis-	C16H34O
16.39	86.77	724897	1-Tetradecanol	C14H30O
16.68	85.59	1164040	Pentadecane, 2,6,10,14-tetramethyl-	C19H40
16.78	90.16	775891	Benzoic acid, 2-ethylhexyl ester	C15H22O2
16.83	85.79	949618	Heptane, 2,2,4,6,6-pentamethyl-	C12H26