

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

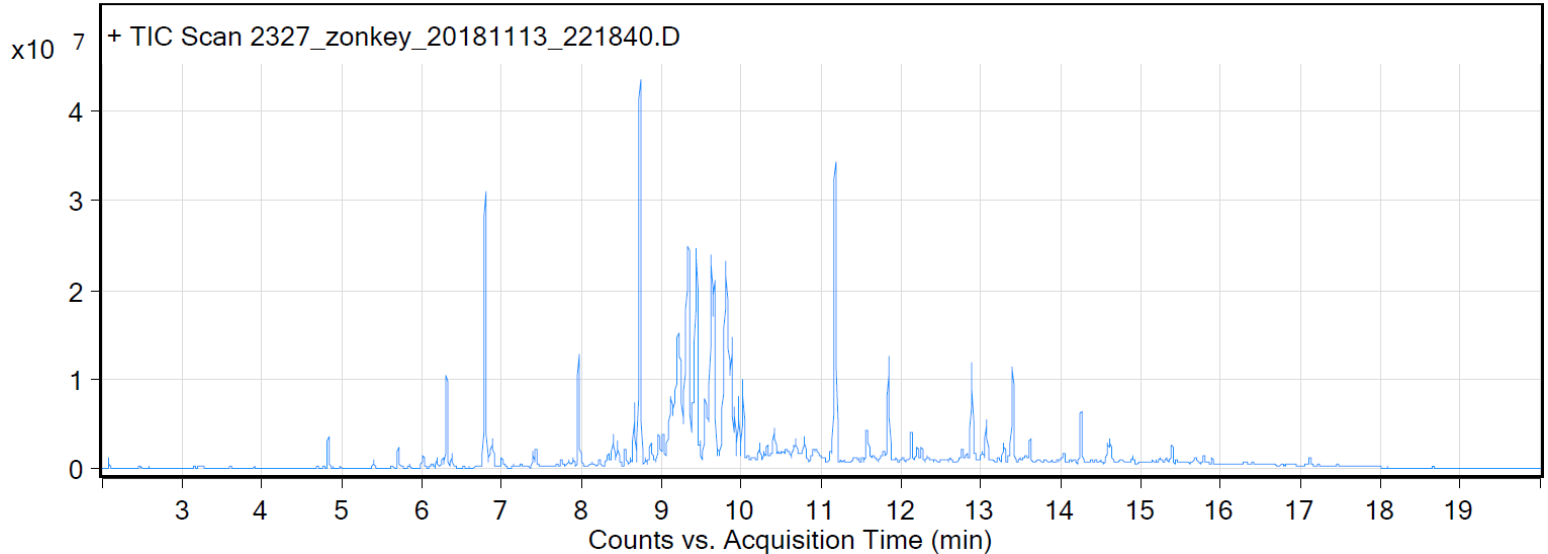
Sample: Siena USA: Rubber Cork Hybrid; Zonkey flooring tiles

Oddy test result: Unsuitable

Date collected: 11/13/2018

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	98.41	1350973	Acetic acid	C2H4O2
2.08	90.88	1015101	Silanediol, dimethyl-	C2H8O2Si
4.83	96.72	4297072	Ethanol, 2-butoxy-	C6H14O2
5.4	96.16	1350556	2-Propanol, 1-butoxy-	C7H16O2
5.71	97.81	3459633	Benzaldehyde	C7H6O
6.02	90.43	1825836	Phenol	C6H6O
6.19	87.83	1579942	1-Heptanol, 6-methyl-	C8H18O
6.31	95.82	14317813	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.37	97.6	2227794	Octanal	C8H16O
6.8	88.55	59525281	1-Hexanol, 2-ethyl-	C8H18O
6.88	92.84	2530259	Benzyl Alcohol	C7H8O
6.89	88.54	3303503	(S)-3-Ethyl-4-methylpentanol	C8H18O
7	95.23	1715723	(S)-(+)-5-Methyl-1-heptanol	C8H18O
7.39	88.5	2384488	Ethanone, 1-phenyl-	C8H8O
7.43	95.65	2894594	1-Octanol	C8H18O
7.96	97.11	19316748	Nonanal	C9H18O
8.21	85.74	1092067	1-Nonanol	C9H20O
8.39	93.79	7184836	1-Nonanol	C9H20O
8.45	94.98	4140206	Pentanedioic acid, dimethyl ester	C7H12O4
8.54	88.84	3086412	(S)-(+)-6-Methyl-1-octanol	C9H20O
8.66	96.74	10483430	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.73	96.52	86602259	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.8	92.15	1127682	2-Nonenal, (E)-	C9H16O
8.87	89.11	5484170	Cyclopropane, 1-butyl-1-methyl-2-propyl-	C11H22
8.96	95.23	7933427	1-Nonanol	C9H20O
9.02	91.34	6785533	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, [1S-(1.alpha.,2.alpha.,5.beta.)]-	C10H20O
9.19	88.01	1972080	(1R,7SR,8RS)-1,4,7,8-Tetramethyl-2-oxatricyclo[6.2.1.0(3,7)]undec-3-en-11-one	C14H20O2
9.44	87.01	62240024	Cyclopropane, 1-(2-methylbutyl)-1-(1-methylpropyl)-	C12H24

9.96	89.34	10841736	2-Ethyl-1-hexyl propionate	C11H22O2
10.02	89.7	14669153	Cyclopentane, (2-methylbutyl)-	C10H20
10.41	94.73	8256510	1-Decanol	C10H22O
10.68	91.78	6028188	1-Undecanol	C11H24O
10.79	91.18	5130509	Tridecane	C13H28
11.18	96.39	63929500	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.84	93.94	19933274	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.13	95.46	5149096	Tetradecane	C14H30
12.26	97.36	2466223	Dodecanal	C12H24O
12.77	85.19	2825596	Heptyl tetradecyl ether	C21H44O
12.83	85.57	1335644	5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-	C13H22O
12.89	95.82	16394244	1,2-Benzenedicarboxylic acid, dimethyl ester	C10H10O4
12.92	93.61	1910243	3-Ethyl-2,6,10-trimethylundecane	C16H34
13.28	91.91	2025648	1,1'-Biphenyl, 4-methyl-	C13H12
13.29	86.76	1868960	n-Heptadecanol-1	C17H36O
13.62	97.77	3689177	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
14.58	89.8	2705498	1,2-Benzenedicarboxylic acid, diethyl ester	C12H14O4
14.61	93.43	5230647	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
14.9	92.65	1403276	Dodecanoic acid, 1-methylethyl ester	C15H30O2
15.32	91.45	1110804	Octane, 1,1'-oxybis-	C16H34O
15.39	87.74	3415543	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8