

**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

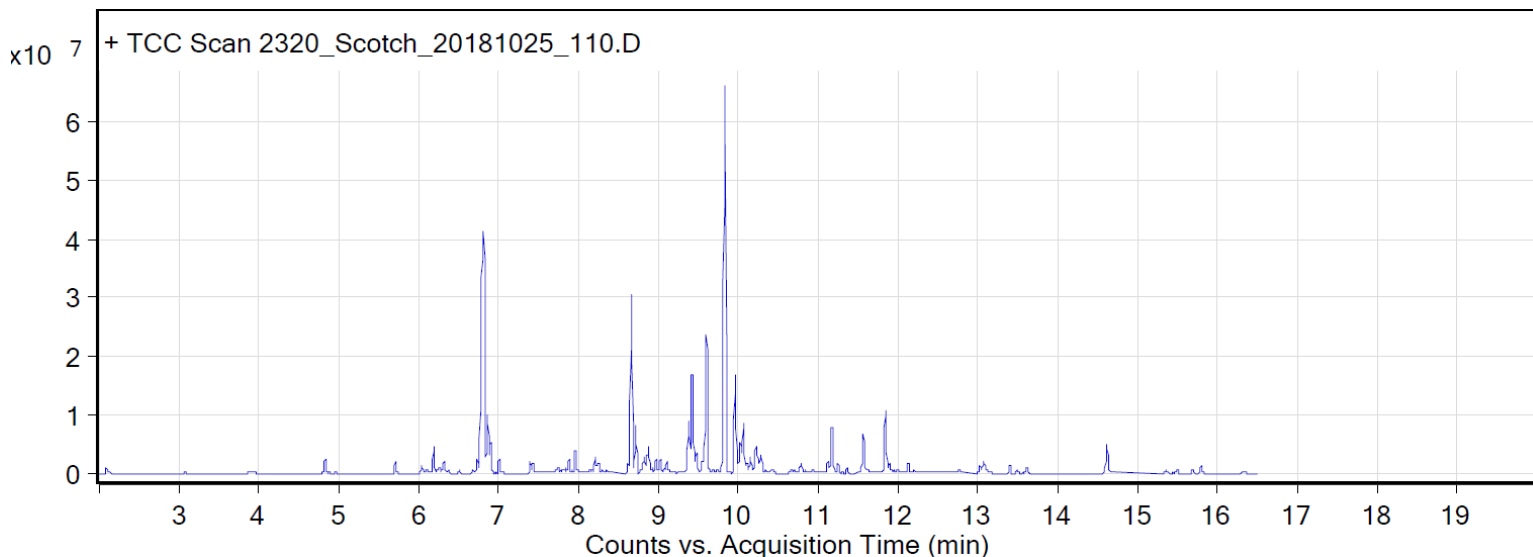
Sample: 3M Scotch Preservation Double Sided Tape 889

Oddy test result: temporary

Date collected: 10/25/2018

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) 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
1.52	97.21	2978205	Acetic acid	C2H4O2
1.69	93.5	1884215	Benzene, methyl-	C7H8
2.09	93.7	971858	Silanediol, dimethyl-	C2H8O2Si
2.13	94.44	772309	Propanoic acid	C3H6O2
3.91	91.1	2188728	Benzene, 1,4-dimethyl-	C8H10
4.4	89.99	948328	Benzene, 1,4-dimethyl-	C8H10
4.83	96.93	3365464	Ethanol, 2-butoxy-	C6H14O2
4.97	92.73	823421	2(5H)-Furanone	C4H4O2
5.71	94.68	3202839	Benzaldehyde	C7H6O
6.04	92.96	1737115	Phenol	C6H6O
6.19	92.19	4088514	1-Heptanol, 6-methyl-	C8H18O
6.24	92.3	1108701	Benzene, 1,3,5-trimethyl-	C9H12
6.31	96	1377358	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.32	95.94	1133944	Decane	C10H22
6.37	97.54	1047762	Octanal	C8H16O
6.51	94.98	998338	.DELTA.3-Carene	C10H16
6.73	91.49	3234194	Benzene, methyl(1-methylethyl)-	C10H14
6.86	86.41	4392092	2,3,4,5-Tetrahydropyridazine	C4H8N2
7.01	95.64	4123058	(S)-(+)-5-Methyl-1-heptanol	C8H18O
7.43	94.84	2342810	1-Octanol	C8H18O
7.88	94.58	2367079	Undecane	C11H24
7.96	97.58	6786868	Nonanal	C9H18O
8.21	89.39	4790426	1-Heptanol, 6-methyl-	C8H18O
8.66	96.69	52912771	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.72	94.07	10353136	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
8.88	86.53	8257431	Acetic acid, octyl ester	C10H20O2
9.11	90.67	3768670	Acetic acid, octyl ester	C10H20O2
9.42	89	20753108	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-	C10H20O
9.48	89.66	1998647	Decanal	C10H20O

9.6	95.48	41820744	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-	C10H20O
9.83	95.73	69684454	2-Ethylhexyl acrylate	C11H20O2
9.96	91.46	29538592	2-Ethyl-1-hexyl propionate	C11H22O2
10.06	89.42	6966222	2-Propenoic acid, octyl ester	C11H20O2
10.22	87.28	5896761	2,3-Diethyl-2,3-dimethylsuccinonitrile	C10H16N2
10.27	85.47	1083079	Carvenone	C10H16O
10.28	87.23	3855590	(S)-(+)-5-Methyl-1-heptanol	C8H18O
10.79	93.38	3002500	Tridecane	C13H28
11.12	92.55	3394367	n-Butyric acid 2-ethylhexyl ester	C12H24O2
11.17	95.22	14407110	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.25	86.14	1856721	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-	C12H16
11.56	90.28	12467424	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.84	93.04	18797894	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
11.89	93.4	1821541	2-Propenoic acid, 1,7,7-trimethylbicyclo[2.2.1]hept-2-yl ester, exo-	C13H20O2
11.98	94.79	1359783	Isobornyl propionate	C13H22O2
12.12	94.48	2668461	Tetradecane	C14H30
12.77	85.53	1019946	1-Tetradecanol	C14H30O
13.49	92.01	869744	bis(2-Ethylhexyl) ether	C16H34O
13.62	96.54	1653937	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
14.62	90.25	9720924	PENTAN-1,3-DIOLDIISOBUTYRATE, 2,2,4-TRIMETHYL-	C16H30O4
15.35	87.29	1127600	2,5-Cyclohexadiene-1,4-dione, 2,5-bis(1,1-dimethylpropyl)-	C16H24O2