

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

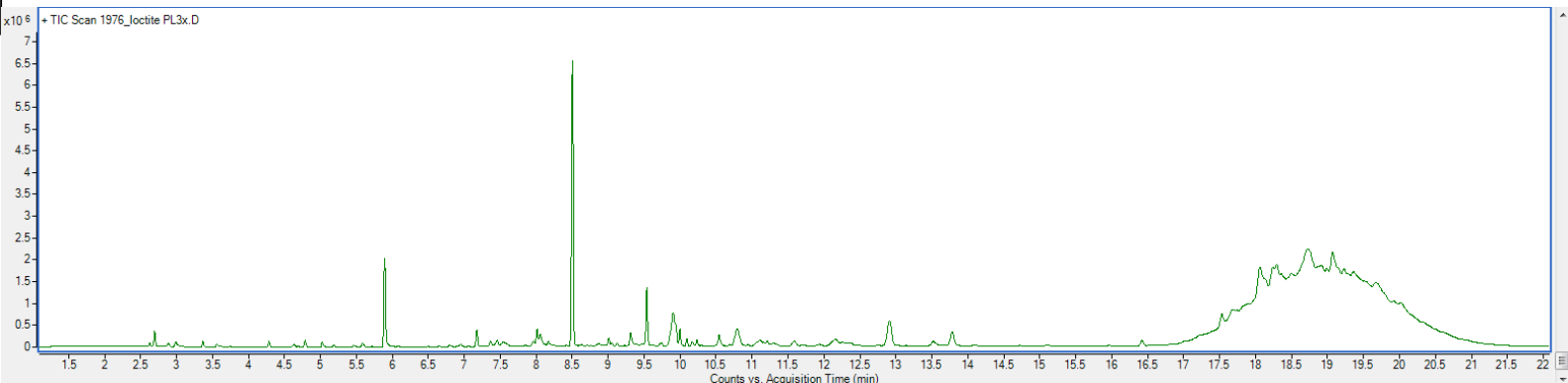
Sample: Loctite PL3X premium construction adhesive

Oddy test result: Permanent

Date collected: 12/23/2017

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 crotrapped for 2 min at -15°C; GC ramped from 40°C to 225 °C at 10°C/min. Data analyzed in masshunter Qualitative. Samples > 80% match with a NIST library are reported.

VOCs not highlighted are because they were also observed in blanks: (2) 13.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (3) 13.7 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.697	88.8	C3H6O	58.0	408494	107-25-5	Ethene, methoxy-
2.990	92.2	C4H8O	72.1	200071	123-72-8	Butanal
3.561	93.7	C2H8O2Si	92.0	121529	1066-42-8	Silanediol, dimethyl-
4.288	95.0	C7H8	92.1	170034	108-88-3	Benzene, methyl-
4.788	94.9	C6H18O3Si3	222.1	201240	541-05-9	Cyclotrisiloxane, hexamethyl-
5.027	92.1	C6H10O	98.1	186742	623-36-9	2-Pentenal, 2-methyl-
5.584	95.9	C8H10	106.1	170474	106-42-3	Benzene, 1,4-dimethyl-
5.893	99.3	C8H8	104.1	3253464	100-42-5	Styrene
6.958	95.5	C7H6O	106.0	123776	100-52-7	Benzaldehyde
7.176	95.6	C8H24O4Si4	296.1	487914	556-67-2	Cyclotetrasiloxane, octamethyl-
7.365	89.6	C8H18O	130.1	266455	26952-21-6	Isooctanol
7.458	83.7	C9H10	118.1	214731	611-15-4	Benzene, 1-ethenyl-2-methyl-
7.581	96.3	C8H8	104.1	301854	100-42-5	Styrene
7.963	84.3	C8H18O	130.1	283777	26952-21-6	Isooctanol
8.010	91.6	C10H16	136.1	560099	138-86-3	Limonene
8.057	86.1	C8H18O	130.1	889035	111-87-5	1-Octanol
8.168	91.9	C8H18O	130.1	322771	57803-73-3	(S)-(+)-5-Methyl-1-heptanol
8.506	96.4	C7H12O4	160.1	10269637	105-53-3	Diethyl malonate
9.009	95.6	C8H8O2	136.1	264157	93-58-3	Benzoic acid, methyl ester
9.312	89.3	C8H18O	130.1	622091	1653-40-3	1-Heptanol, 6-methyl-
9.540	89.0	C10H30O5Si5	370.1	1685079	541-02-6	Cyclopentasiloxane, decamethyl-
9.726	80.8	C10H20O2	172.1	167704	1000368-74-9	Acetic acid, 2-propylpentyl ester
9.906	94.2	C7H12O4	160.1	3056872	105-53-3	Propanedioic acid, diethyl ester
9.998	86.8	C10H20O2	172.1	602550	112-14-1	Acetic acid, octyl ester
10.094	87.3	C10H20O2	172.1	242170	103-09-3	Acetic acid, 2-ethylhexyl ester
10.165	86.5	C11H22O2	186.2	172185	143-13-5	Acetic acid, nonyl ester
10.542	87.2	C8H18O	130.1	592659	26952-21-6	Isooctanol
10.797	86.3	C10H30O5Si5	370.1	1386566	541-02-6	Cyclopentasiloxane, decamethyl-
11.114	85.6	C8H18O	130.1	703025	111-87-5	1-Octanol
11.212	85.9	C9H18O2	158.1	296449	999083-12-4	Octyl ester of formic acid
11.299	83.1	C8H17Cl	148.1	246774	628-61-5	Octane, 2-chloro-
11.584	87.4	C16H32	224.3	402656	35507-09-6	7-Hexadecene, (Z)-
12.163	84.5	C11H20O2	184.1	946161	2499-59-4	2-Propenoic acid, octyl ester

12.915	88.4	C12H36O6Si6	444.1	1978161	540-97-6	Cyclohexasiloxane, dodecamethyl-
13.521	91.4	C12H24O3	216.2	550090	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.785	92.5	C12H24O3	216.2	1160951	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
17.531	88.5	C16H26	218.2	922960	2435-85-0	Pyrene, hexadecahydro-
18.070	84.7	C13H28	184.2	2780398	31081-17-1	Nonane, 2-methyl-5-propyl-
18.714	85.1	C19H40	268.3	10346790	629-92-5	Nonadecane
19.072	80.4	C19H40	268.3	11373129	629-92-5	Nonadecane
19.676	84.0	C16H34	226.3	1238385	544-76-3	Hexadecane
19.934	81.9	C8H11NO3	169.1	1356131	999105-58-4	1,4-Dimethyl-2-oxa-5-azabicyclo[2.2.2]octan-3,6-dione
20.026	83.4	C16H34	226.3	503566	544-76-3	Hexadecane