

**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

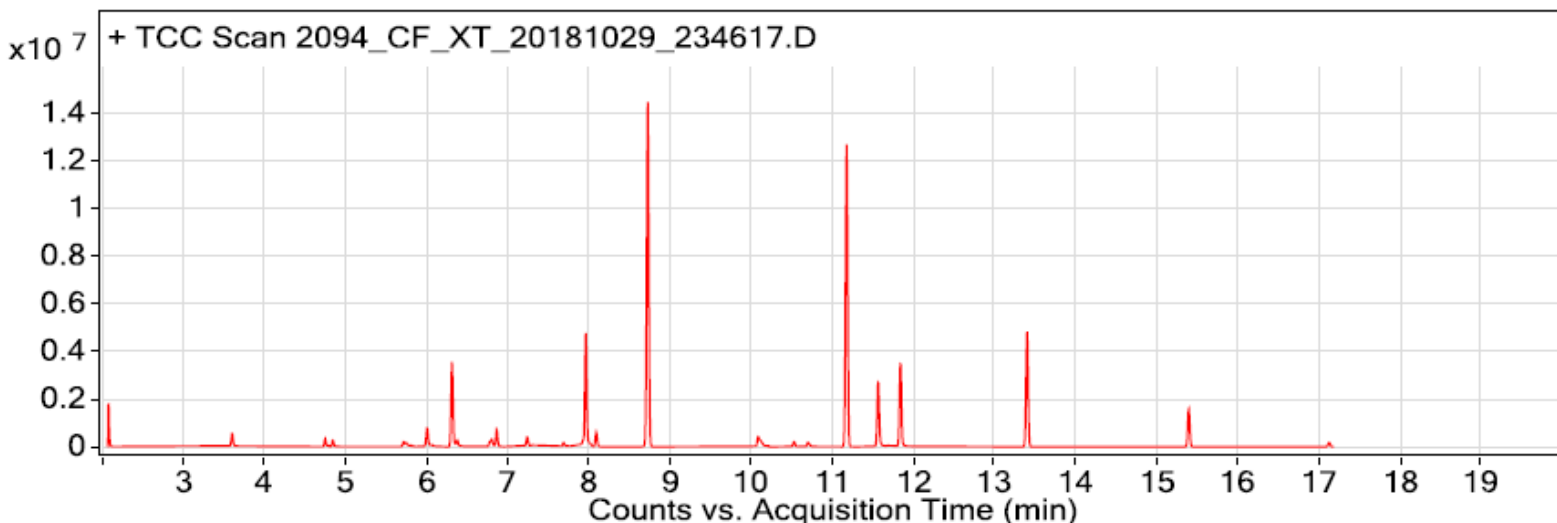
Sample: Eastman Chemical; Colorfabb XT clear 3D printing filament

Oddy test result: Permanent

Date collected: 10/29/2018

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 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: (1) 4.75 min: methoxy-phenyl-oxime; (2) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (3) 11.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.080	93.7	C2H8O2Si	92.0	1743049	1066-42-8	Silenediol, dimethyl-
3.600	93.3	C6H18O3Si3	222.1	981311	541-05-9	Cyclotrisiloxane, hexamethyl-
4.750	83.0	C8H9NO2	151.1	467240	1000222-86-6	Oxime-, methoxy-phenyl-
4.850	96.7	C6H14O2	118.1	391830	111-76-2	Ethanol, 2-butoxy-
5.720	90.0	C7H6O	106.0	338728	100-52-7	Benzaldehyde
6.310	95.9	C8H24O4Si4	296.1	5901479	556-67-2	Cyclotetrasiloxane, octamethyl-
6.380	97.0	C8H16O	128.1	361665	124-13-0	Octanal
6.780	94.4	C8H18O	130.1	337098	104-76-7	1-Hexanol, 2-ethyl-
6.810	95.5	C10H16	136.1	369352	138-86-3	dl-Limonene
6.870	96.7	C7H8O	108.1	568542	100-51-6	Benzyl Alcohol
7.240	92.1	C11H24	156.2	639719	17302-23-7	Nonane, 4,5-dimethyl-
7.690	80.9	C10H16	136.1	269960	2153-66-4	Santolina triene
7.960	97.8	C9H18O	142.1	7713557	124-19-6	Nonanal
8.730	95.4	C10H30O5Si5	370.1	26298799	541-02-6	Cyclopentasiloxane, decamethyl-
10.090	95.0	C6H11NO	113.1	902567	105-60-2	Caprolactam
10.530	91.9	C15H32	212.3	319673	31295-56-4	Dodecane, 2,6,11-trimethyl-
11.180	96.2	C12H36O6Si6	444.1	23230454	540-97-6	Cyclododecylsiloxane, dodecamethyl-
11.570	90.2	C12H24O3	216.2	4798821	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.840	93.7	C12H24O3	216.2	6036290	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.400	80.8	C14H42O7Si7	518.1	8737847	107-50-6	Cyclododecylsiloxane, tetradecamethyl-
15.400	89.7	C16H48O8Si8	592.2	2896664	556-68-3	Cyclotetrasiloxane, hexadecamethyl-
17.130	84.6	C18H54O9Si9	666.2	346331	556-71-8	Cyclononasiloxane, octadecamethyl-