

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

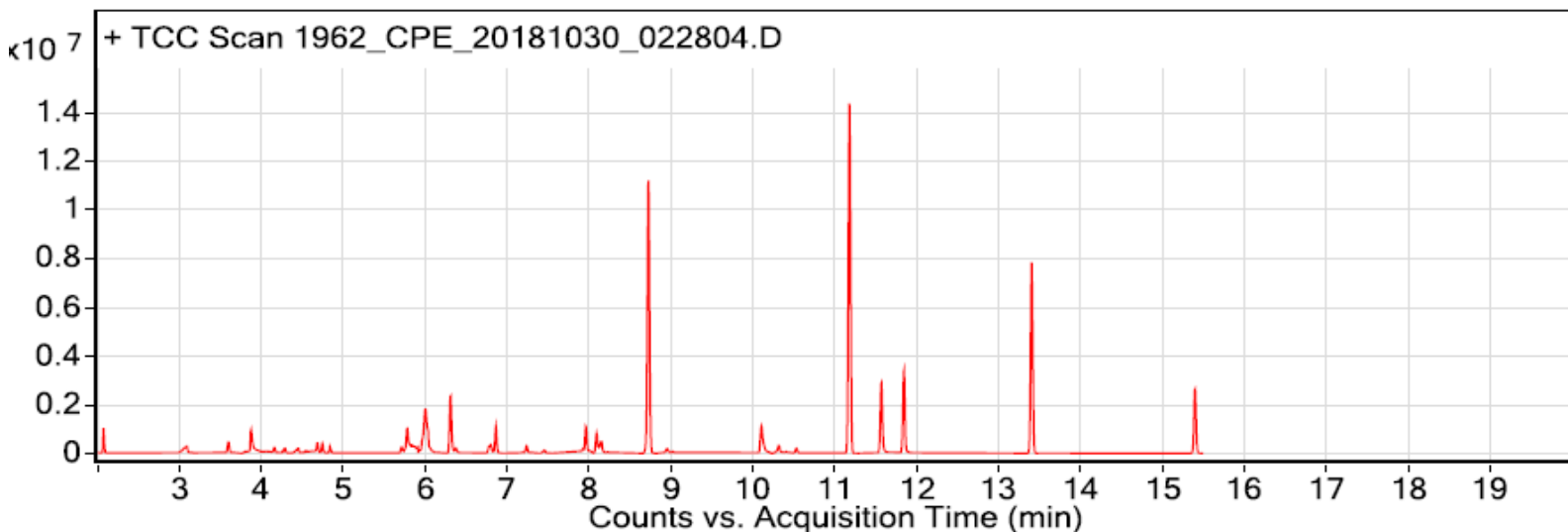
Sample: Ultimaker copolyester plus (CPE) 3D printed filament

Oddy test result: Permanent

Date collected: 10/30/2018

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
1.270	92.9	CH2O2	46.0	443458	64-18-6	Formic acid
2.070	93.7	C2H8O2Si	92.0	1035439	1066-42-8	Silanediol, dimethyl-
3.070	86.1	C4H8O2	88.1	496746	107-92-6	Butanoic acid
3.600	91.7	C6H18O3Si3	222.1	851675	541-05-9	Cyclotrisiloxane, hexamethyl-
3.880	95.6	C6H12O2	116.1	1373735	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
4.160	95.1	C8H12	108.1	484037	7086-15-9	Cyclopentadiene, 2,5,5-trimethyl-
4.450	91.9	C5H10O2	102.1	509242	109-52-4	Pentanoic acid
4.690	88.1	C9H18	126.1	935690	53941-19-8	2-Hexene, 3,4,4-trimethyl-
4.750	85.1	C8H9NO2	151.1	487029	1000222-86-6	Oxime-, methoxy-phenyl-
4.840	95.4	C6H14O2	118.1	280918	111-76-2	Ethanol, 2-butoxy-
5.710	91.2	C7H6O	106.0	449396	100-52-7	Benzaldehyde
6.030	81.1	C6H12O2	116.1	2376715	142-62-1	Hexanoic acid
6.310	96.2	C8H24O4Si4	296.1	4109533	556-67-2	Cyclotetrasiloxane, octamethyl-
6.380	90.0	C8H16O	128.1	264856	124-13-0	Octanal
6.780	94.8	C8H18O	130.1	404802	104-76-7	1-Hexanol, 2-ethyl-
6.800	95.7	C10H16	136.1	408125	138-86-3	dl-Limonene
6.860	95.9	C7H8O	108.1	820634	100-51-6	Benzyl Alcohol
7.240	90.9	C11H24	156.2	467875	17302-23-7	Nonane, 4,5-dimethyl-
7.960	97.1	C9H18O	142.1	1807509	124-19-6	Nonanal
8.150	94.3	C8H16O2	144.1	1077272	149-57-5	Hexanoic acid, 2-ethyl-
8.700	87.4	C16H11NO2S	281.1	324970	70453-75-7	2-methoxy[1]benzothieno[2,3-c]quinolin-6(5H)-one
8.730	95.9	C10H30O5Si5	370.1	20672959	541-02-6	Cyclopentasiloxane, decamethyl-
8.950	86.6	C8H16O2	144.1	343784	124-07-2	Octanoic acid
10.100	95.0	C6H11NO	113.1	2110632	105-60-2	Caprolactam
10.320	95.9	C9H18O2	158.1	579750	112-05-0	Nonanoic acid
10.530	91.0	C14H30	198.2	297631	61141-72-8	Dodecane, 4,6-dimethyl-
11.180	96.2	C12H36O6Si6	444.1	26233419	540-97-6	Cyclohexasiloxane, dodecamethyl-

11.570	90.1	C12H24O3	216.2	5153701	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.850	93.8	C12H24O3	216.2	5900057	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.400	81.3	C14H42O7Si7	518.1	14034674	107-50-6	Cycloheptasiloxane, tetradecamethyl-
15.400	89.7	C16H48O8Si8	592.2	4838300	556-68-3	Cyclooctasiloxane, hexadecamethyl-