

**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

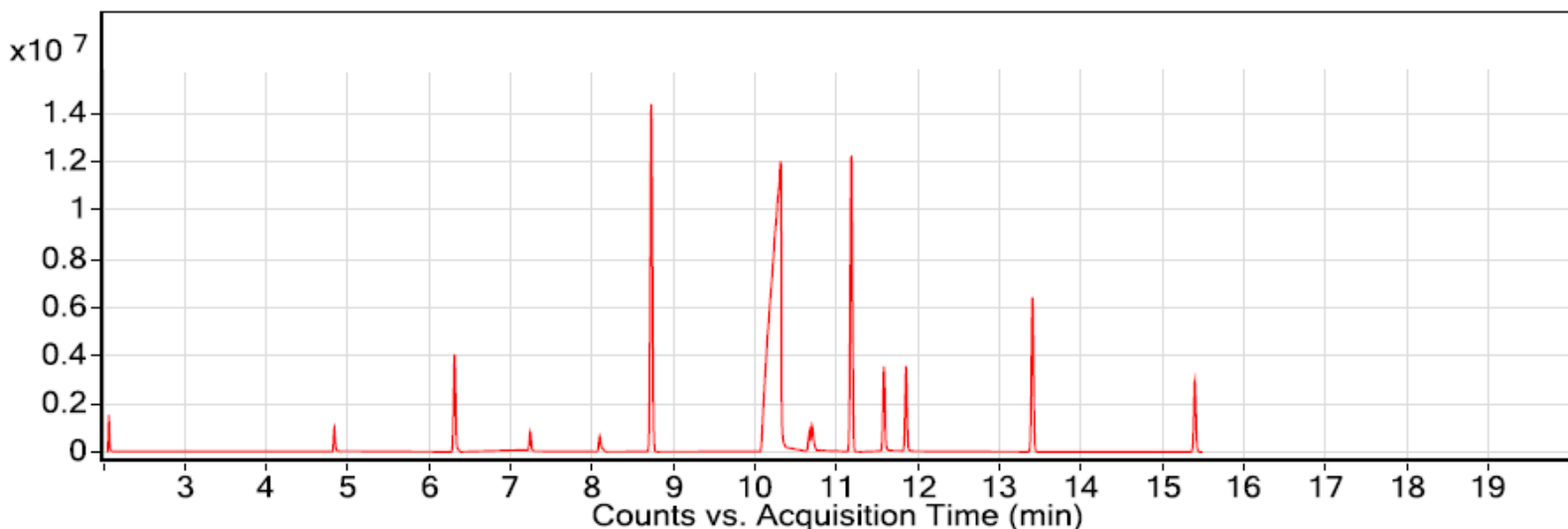
Sample: Ultimaker extruded nylon 3D printing material with platform adhesive

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 > 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-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 11.8 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester nonanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.070	93.7	C2H8O2Si	92.0	1396451	1066-42-8	Silanediol, dimethyl-
4.830	96.8	C6H14O2	118.1	1351701	111-76-2	Ethanol, 2-butoxy-
6.310	96.0	C8H24O4Si4	296.1	7011610	556-67-2	Cyclotetrasiloxane, octamethyl-
7.240	92.5	C13H28	184.2	1252133	17301-32-5	Undecane, 4,7-dimethyl-
8.730	95.6	C10H30O5Si5	370.1	26854994	541-02-6	Cyclopentasiloxane, decamethyl-
10.310	95.3	C6H11NO	113.1	101466982	105-60-2	Caprolactam
10.660	89.0	C10H16O	152.1	1173371	4884-24-6	[1,1'-Bicyclopentyl]-2-one
10.700	92.4	C8H15NO	141.1	1967954	3470-98-2	2-Pyrrolidinone, 1-butyl-
11.180	96.2	C12H36O6Si6	444.1	23211480	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.580	90.1	C12H24O3	216.2	5913024	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.850	93.4	C12H24O3	216.2	5672912	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
13.400	81.2	C14H42O7Si7	518.1	11841275	107-50-6	Cycloheptasiloxane, tetradecamethyl-
15.400	89.2	C16H48O8Si8	592.2	5324964	556-68-3	Cyclooctasiloxane, hexadecamethyl-