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

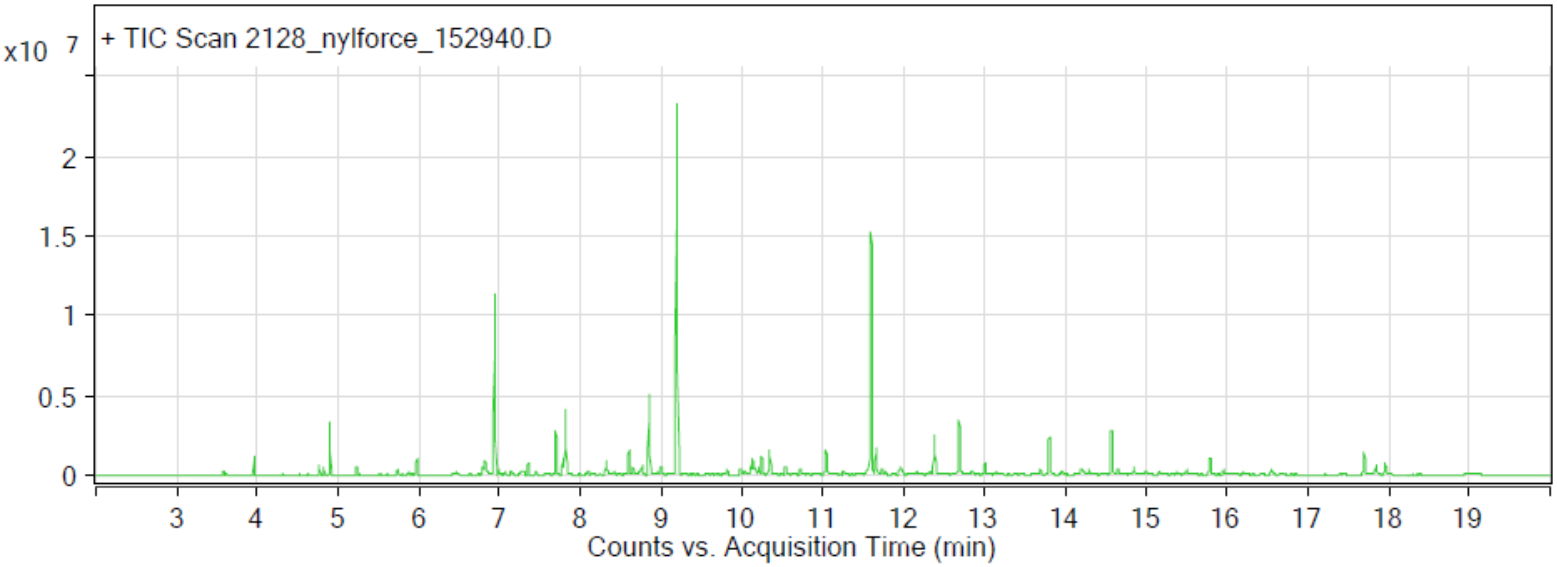
Sample: Nylforce 3D printed glass-nylon filament

Oddy test result: Temporary

Date collected: 04/18/2018

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 Analysis. 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) 5.7 min: methoxyphenyl oxime; (2) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (3) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Compound Table

RT	Score (Lib)	Area	Name	Formula
3.96	93.69	892672	Silanediol, dimethyl-	C2H8O2Si
4.76	95.34	560765	Cyclopentanone	C5H8O
4.82	97.44	427345	Hexanal	C6H12O
4.9	92.46	2481935	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.23	95.79	564198	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
5.73	85.78	278445	Oxime-, methoxy-phenyl-_	C8H9NO2
5.97	91.59	1039727	Ethanol, 2-butoxy-	C6H14O2
6.82	98.06	881405	Benzaldehyde	C7H6O
6.84	90.14	290162	1-Heptanol	C7H16O
6.94	96.23	10998298	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.35	97.61	847863	Octanal	C8H16O
7.45	97.7	329740	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.69	96.84	3131645	1-Hexanol, 2-ethyl-	C8H18O
7.78	91.86	1169267	dl-Limonene	C10H16
7.81	96.45	4838244	Benzyl Alcohol	C7H8O
8.6	86.29	1685667	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O
8.64	94.99	715592	1-Undecene	C11H22
8.77	92.74	864676	Undecane	C11H24
8.85	97.66	6368652	Nonanal	C9H18O
8.99	87.67	598085	Benzeneethanol	C8H10O
9.19	95.58	27774102	Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.98	97.86	549353	Menthol	C10H20O
10.12	91.76	1324171	1-Dodecene	C12H24
10.15	96.19	1069770	Azulene	C10H8
10.2	95.96	569926	Methyl salicylate	C8H8O3

10.24	93.3	1376853	Dodecane	C12H26
10.34	97.89	1951089	Decanal	C10H20O
10.53	92.95	597340	Ethanol, 2-phenoxy-	C8H10O2
10.73	89.63	481942	Benzothiazole	C7H5NS
11.04	94.93	2404878	Caprolactam	C6H11NO
11.6	95.93	18921561	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.66	95.11	2160971	Tridecane	C13H28
11.73	95.47	428700	Naphthalene, 2-methyl-	C11H10
11.95	86.51	340475	Naphthalene, 1-methyl-	C11H10
11.96	85.13	493529	Cyclododecene, (E)-	C12H22
12.38	90.78	3189660	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
12.68	93.89	4648219	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
13.01	94.99	1076431	Tetradecane	C14H30
13.14	95.33	286485	Dodecanal	C12H24O
13.69	90.97	529985	Cyclopentane, nonyl-	C14H28
13.96	88	304468	1-Dodecanol	C12H26O
14.2	93.45	460664	Cetene	C16H32
14.29	91.64	428739	Pentadecane	C15H32
14.57	96.66	4019857	Cyclododecanone	C12H22O
14.65	86.33	407305	Dibenzofuran	C12H8O
14.85	93.96	655475	Oxacyclotridecan-2-one	C12H22O2
15	94.41	288507	n-Nonylcyclohexane	C15H30
15.51	91.12	397845	Hexadecane	C16H34
15.79	95.77	1372422	Dodecanoic acid, 1-methylethyl ester	C15H30O2
15.96	97.55	460720	Methanone, diphenyl-	C13H10O
17.7	95.86	2159613	Azacyclotridecan-2-one	C12H23NO
17.84	97.87	906728	2-Ethylhexyl salicylate	C15H22O3
19.12	91.22	677965	Diphenyl sulfone	C12H10O2S
21.1	96.15	329005	Pyrene	C16H10