

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

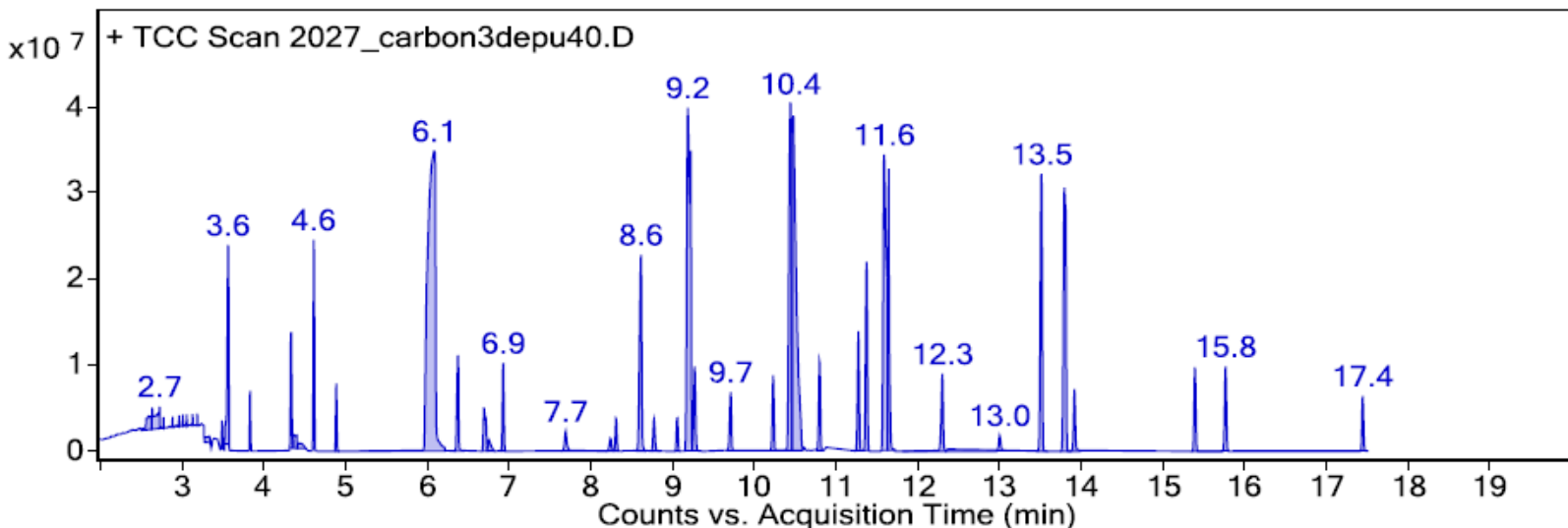
Sample: 3D printed elastomeric polyurethane, EPU40, black; by Carbon 3D

Oddy test result: Temporary

Date GC-MS collected: 03/09/2018

Technique used: SPME Arrow 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 sample at 60°C for 20 minutes; fiber exposure to sample at 60°C for 20 minutes; fiber injected into 220°C inlet and cryotrapped 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) ~6.0 min: methoxy-phenyl oxime



Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.800	90.9	C ₄ H ₁₁ N	73.1	9799504	75-64-9	2-Propanamine, 2-methyl-
1.900	87.9	C ₁₀ H ₁₉ N ₃ O ₄	245.1	16891681	999304-65-6	2-Amino-2-methyl-N-(4'-nitrooxycyclohexyl)-1-(13C)-propionylamide
2.400	85.0	C ₁₁ H ₁₃ NO ₅	239.1	15631050	999288-50-6	1,1-Dimethoxy-3-(4-nitrophenyl)propan-2-one
2.700	83.5	C ₁₁ H ₁₃ NO ₅	239.1	3746254	999288-50-6	1,1-Dimethoxy-3-(4-nitrophenyl)propan-2-one
3.300	80.9	C ₁₁ H ₁₃ NO ₅	239.1	13686884	999288-50-6	1,1-Dimethoxy-3-(4-nitrophenyl)propan-2-one
3.500	92.3	C ₄ H ₁₁ N	73.1	2445717	75-64-9	2-Propanamine, 2-methyl-
3.600	89.5	C ₃ H ₁₀ OSi	90.1	39285928	1066-40-6	Silanol, trimethyl-
3.800	95.8	C ₆ H ₁₃ N	99.1	4474077	7020-80-6	N-Ethylidene t-butylamine
4.300	80.0	C ₅ H ₁₂ OSi	116.1	16772186	3292-88-4	2,2-Dimethyl-1-oxa-2-silacyclopentane
4.400	82.6	C ₅ H ₁₂ OSi	116.1	6958941	3292-88-4	2,2-Dimethyl-1-oxa-2-silacyclopentane
4.900	93.3	C ₆ H ₁₈ O ₃ Si ₃	222.1	6760673	541-05-9	Cyclotrisiloxane, hexamethyl-
6.000	83.0	C ₈ H ₉ NO ₂	151.1	2478219	1000222-86-6	Oxime-, methoxy-phenyl-
6.400	94.9	C ₅ H ₁₂ O ₃	120.1	15056646	111-77-3	Ethanol, 2-(2-methoxyethoxy)-
6.900	96.5	C ₈ H ₂₄ O ₄ Si ₄	296.1	12285438	556-67-2	Cyclotetrasiloxane, octamethyl-
8.200	91.0	C ₁₀ H ₂₀ N ₂	168.2	2370915	30834-74-3	2-Propanamine, N,N'-1,2-ethanediylidenebis[2-methyl-
8.300	99.3	C ₈ H ₈ O	120.1	4816880	98-86-2	Ethanone, 1-phenyl-
8.600	91.0	C ₉ H ₁₂ O	136.1	41851701	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-

9.100	87.9	C6H18O3Si3	222.1	5146113	541-05-9	Cyclotrisiloxane, hexamethyl-
9.200	94.1	C10H30O5Si5	370.1	108860663	541-02-6	Cyclopentasiloxane, decamethyl-
9.300	89.2	C8H24O4Si4	296.1	12334578	556-67-2	Cyclotetrasiloxane, octamethyl-
10.200	95.5	C12H26	170.2	11374046	112-40-3	Dodecane
10.400	86.8	C10H19NO2	185.1	222118154	3775-90-4	2-(tert-Butylamino)ethyl methacrylate
10.500	93.5	C7H8O2	124.1	5936017	90-05-1	Phenol, 2-methoxy-
10.800	97.7	C8H14O4	174.1	14063576	627-93-0	Hexanedioic acid, dimethyl ester
11.300	92.7	C9H16O4	188.1	18571343	45103-58-0	Diethylene glycol monomethyl ether methacrylate
11.400	92.0	C8H24O4Si4	296.1	32999187	556-67-2	Cyclotetrasiloxane, octamethyl-
11.600	95.9	C12H36O6Si6	444.1	114033624	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.700	95.0	C13H28	184.2	10968151	629-50-5	Tridecane
12.300	80.9	C9H19NO	157.1	13842682	64845-12-1	Azacyclohexan-3-ol, 1-tert-butyl-
13.000	95.1	C14H30	198.2	2858274	629-59-4	Tetradecane
13.500	85.7	C10H30O5Si5	370.1	52698863	541-02-6	Cyclopentasiloxane, decamethyl-
13.800	82.6	C14H42O7Si7	518.1	66198752	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.900	93.5	C14H22O2	222.2	9617237	7534-94-3	iso-Bornyl methacrylate
15.400	82.2	C12H36O6Si6	444.1	13910161	540-97-6	Cyclohexasiloxane, dodecamethyl-
15.800	88.8	C16H48O8Si8	592.2	14313613	556-68-3	Cyclooctasiloxane, hexadecamethyl-
17.400	95.0	C16H30O2	254.2	8325352	999331-99-6	Methacrylic acid, dodecyl ester