

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

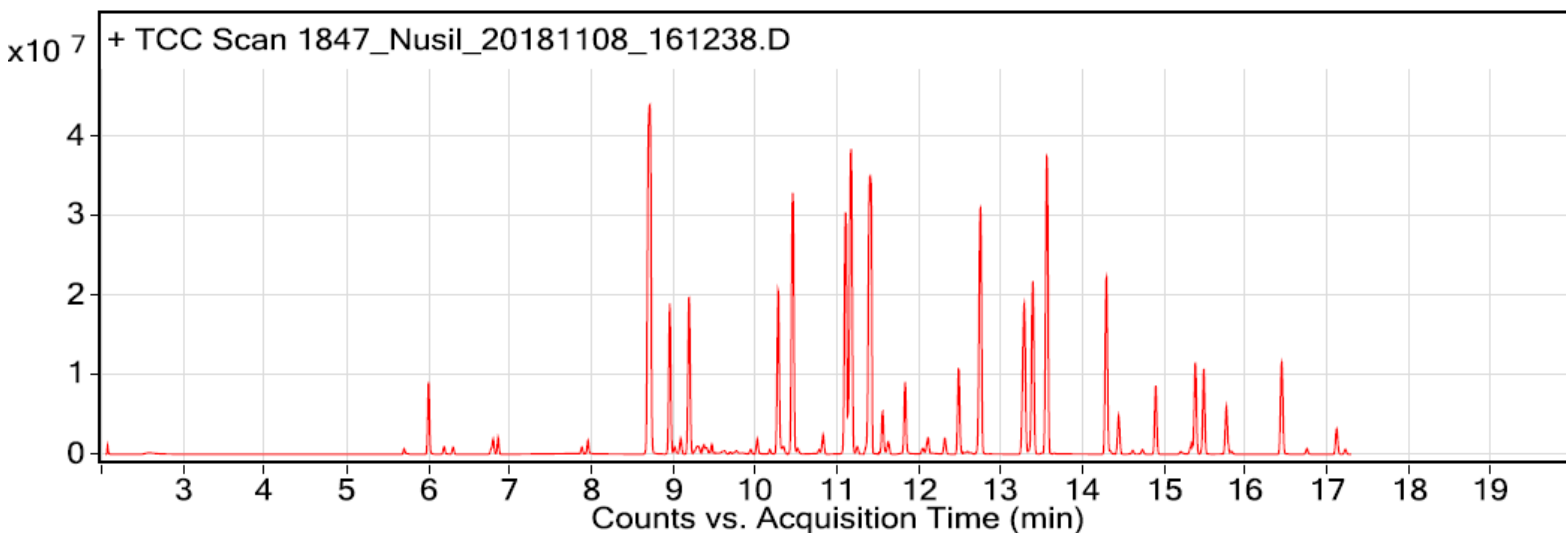
Sample: Nusil R2141

Oddy test result: Permanent

Date collected: 11/08/2018

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 17.0 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 propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.080	93.7	C2H8O2Si	92.0	925220	1066-42-8	Silanediol, dimethyl-
5.710	96.1	C7H6O	106.0	1173051	100-52-7	Benzaldehyde
6.300	95.8	C8H24O4Si4	296.1	1466696	556-67-2	Cyclotetrasiloxane, octamethyl-
6.770	94.7	C8H18O	130.1	1227289	104-76-7	1-Hexanol, 2-ethyl-
6.800	95.9	C10H16	136.1	2574220	138-86-3	dl-Limonene
6.860	96.6	C7H8O	108.1	1541697	100-51-6	Benzyl Alcohol
7.880	96.8	C11H24	156.2	1354138	1120-21-4	Undecane
7.950	95.9	C9H18O	142.1	2539727	124-19-6	Nonanal
8.730	87.4	C10H30O5Si5	370.1	8772767	541-02-6	Cyclopentasiloxane, decamethyl-
9.020	97.2	C10H20O	156.2	992589	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(+/-)-
9.090	94.1	C10H30O5Si5	370.1	3465991	541-02-6	Cyclopentasiloxane, decamethyl-
9.190	97.1	C12H36O4Si5	384.1	36484053	141-63-9	Pentasiloxane, dodecamethyl-
9.310	83.0	C18H32F2O2	318.2	1461753	999503-92-3	Ethyl (E)-2',2'-difluorohexadec-13-enoate
9.370	90.0	C12H26	170.2	1893943	112-40-3	Dodecane
9.410	82.7	C9H18	126.1	974731	3073-66-3	Cyclohexane, 1,1,3-trimethyl-
9.470	97.3	C10H20O	156.2	1155257	112-31-2	Decanal
9.620	84.1	C12H22O2	198.2	1087872	688-84-6	2-Ethylhexyl methacrylate
9.770	81.2	C11H24O	172.2	1095002	112-42-5	1-Undecanol
9.950	91.4	C11H22O2	186.2	873034	999145-46-3	2-Ethyl-1-hexyl propionate
10.030	97.5	C12H36O4Si5	384.1	3238104	141-63-9	Pentasiloxane, dodecamethyl-
10.180	95.4	C12H26O2	202.2	897312	5921-80-2	Butane, 1,1-dibutoxy-
10.280	84.8	C10H30O5Si5	370.1	37868572	541-02-6	Cyclopentasiloxane, decamethyl-
10.460	82.1	C13H36O4Si4	368.2	66474426	87867-97-8	3-Butoxy-1,1,1,5,5,5-hexamethyl-3-(trimethylsiloxy)trisiloxane
10.520	90.4	C15H32	212.3	887625	31295-56-4	Dodecane, 2,6,11-trimethyl-
10.780	83.8	C13H28	184.2	836998	62238-11-3	Decane, 2,3,5-trimethyl-
10.830	96.1	C12H36O6Si6	444.1	4073767	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.150	88.3	C23H48	324.4	1633427	638-67-5	Tricosane
11.170	96.1	C12H36O6Si6	444.1	59376863	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.360	90.5	C12H36O6Si6	444.1	1004294	540-97-6	Cyclohexasiloxane, dodecamethyl-

11.560	90.1	C12H24O3	216.2	9207274	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.630	95.3	C14H42O5Si6	458.2	2075934	107-52-8	Hexasiloxane, tetradecamethyl-
11.840	93.7	C12H24O3	216.2	15308853	74367-34-3	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester
12.120	94.3	C14H30	198.2	2128719	629-59-4	Tetradecane
12.320	94.5	C14H42O5Si6	458.2	3700874	107-52-8	Hexasiloxane, tetradecamethyl-
13.350	82.3	C13H28	184.2	810485	629-50-5	Tridecane
13.400	82.1	C14H42O7Si7	518.1	44357008	107-50-6	Cycloheptasiloxane, tetradecamethyl-
14.450	80.8	C16H48O8Si8	592.2	9061181	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.390	88.4	C16H48O8Si8	592.2	21881958	556-68-3	Cyclooctasiloxane, hexadecamethyl-
15.760	83.0	C18H52O7Si7	576.2	11452076	71579-69-6	3-Isopropoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris(trimethylsiloxy)tetrasiloxane
17.110	84.9	C18H54O9Si9	666.2	6136744	556-71-8	Cyclononasiloxane, octadecamethyl-