

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

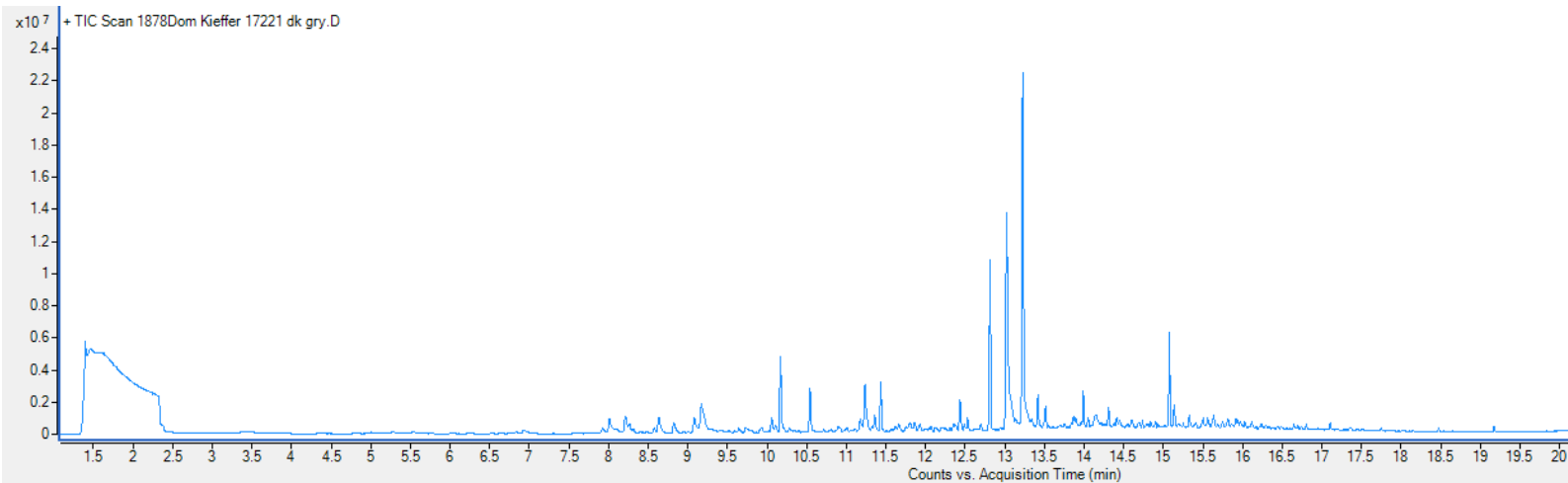
Sample: Dominique Kieffer fabric; 17221; dark gray

Oddy test result: Temporary

Date collected: 09/21/2017

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) 13.0 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 13.2 min: 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
2.707	83.5	C11H13NO5	239.1	1413631	999288-50-6	1,1-Dimethoxy-3-(4-nitrophenyl)propan-2-one
3.415	96.1	C2H8O2Si	92.0	739469	1066-42-8	Silanediol, dimethyl-
5.279	94.0	C6H18O3Si3	222.1	600621	541-05-9	Cyclotrisiloxane, hexamethyl-
6.930	96.3	C6H14O2	118.1	821831	111-76-2	Ethanol, 2-butoxy-
7.924	98.3	C7H6O	106.0	1099766	100-52-7	Benzaldehyde
8.011	98.5	C4H10O3	106.1	2958903	111-46-6	Ethanol, 2,2'-oxybis-
8.215	99.2	C6H6O	94.0	2427622	108-95-2	Phenol
8.265	92.3	C8H24O4Si4	296.1	649385	556-67-2	Cyclotetrasiloxane, octamethyl-
8.640	89.9	C6H14O3	134.1	1215565	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
8.823	95.1	C7H16O3	148.1	1323710	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
9.084	83.0	C10H16	136.1	2403641	5989-54-8	l-Limonene
9.172	97.4	C7H8O	108.1	5250578	100-51-6	Benzyl Alcohol
10.057	97.0	C8H8O2	136.1	1306361	93-58-3	Benzoic acid, methyl ester
10.105	89.3	C11H24	156.2	715201	1120-21-4	Undecane
10.170	98.2	C9H18O	142.1	6236750	124-19-6	Nonanal
10.542	93.3	C10H30O5Si5	370.1	2702332	541-02-6	Cyclopentasiloxane, decamethyl-
11.173	96.4	C10H20O	156.2	1815924	15356-70-4	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./-.)-
11.233	96.5	C8H18O3	162.1	4907062	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
11.437	98.5	C10H20O	156.2	3412739	112-31-2	Decanal
11.625	92.8	C8H10O2	138.1	597580	122-99-6	Ethanol, 2-phenoxy-
12.431	94.4	C12H36O6Si6	444.1	1799239	540-97-6	Cyclohexasiloxane, dodecamethyl-
12.446	96.4	C13H28	184.2	784342	629-50-5	Tridecane
12.533	92.5	C11H22O	170.2	886510	112-44-7	Undecanal
12.814	94.3	C7H12O5	176.1	10673796	1000428-18-0	1,3-Diacetin
13.020	91.0	C12H24O3	216.2	28299961	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.227	94.2	C12H24O3	216.2	31991712	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.417	96.1	C14H30	198.2	2164276	629-59-4	Tetradecane
13.513	96.1	C12H24O	184.2	1551763	112-54-9	Dodecanal

14.048	81.6	C14H20O2	220.1	718123	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
14.141	91.7	C12H26O	186.2	2744454	112-53-8	1-Dodecanol
14.306	94.6	C15H32	212.3	1290780	629-62-9	Pentadecane
14.413	96.1	C13H26O	198.2	745847	10486-19-8	Tridecanal
15.076	80.3	C16H30O4	286.2	5642435	74381-40-1	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
15.135	95.3	C16H34	226.3	1691648	544-76-3	Hexadecane
15.325	93.0	C15H30O2	242.2	742481	10233-13-3	Dodecanoic acid, 1-methylethyl ester
15.940	87.8	C19H40	268.3	826527	55000-52-7	Hexadecane, 2,6,10-trimethyl-