

**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

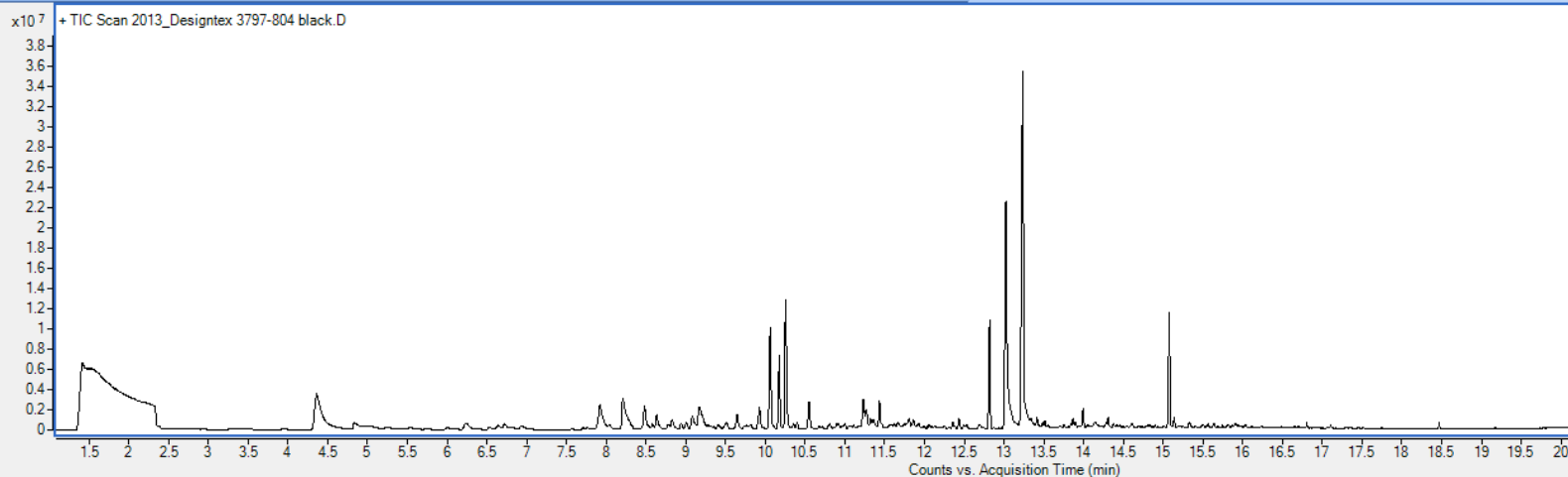
Sample: Designtex 3797-804 fabric; black

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



#### Library results

RT	Score	Formula	MW	Area	CAS #	Name
1.449	92.3	CH6N2O2	78.0	29856828	1111-78-0	Carbamic acid, monoammonium salt
4.362	98.0	C7H8	92.1	22100982	108-88-3	Benzene, methyl-
4.830	98.8	C3H7NO	73.1	4512455	68-12-2	Formamide, N,N-dimethyl-
5.041	95.6	C2Cl4	163.9	615309	127-18-4	Tetrachloroethylene
5.534	97.6	C5H4O2	96.0	1127456	98-01-1	Furfural
6.002	92.6	C7H4ClF3	180.0	592900	98-56-6	Benzene, 1-chloro-4-(trifluoromethyl)-
6.245	92.6	C8H10	106.1	2095943	95-47-6	o-Xylene
6.518	88.5	C4H9NO	87.1	1115147	127-19-5	N,N-Dimethylacetamide
6.648	93.1	C8H10	106.1	953376	95-47-6	o-Xylene
6.723	92.4	C6H10O	98.1	1424147	108-94-1	Cyclohexanone
6.829	92.6	C7H14O	114.1	712130	111-71-7	Heptanal
6.930	91.3	C6H14O2	118.1	1308104	111-76-2	Ethanol, 2-butoxy-
7.924	98.5	C7H6O	106.0	8331210	100-52-7	Benzaldehyde
8.042	88.6	C9H12	120.1	939420	0-00-0	unidentified C3-benzene
8.214	99.2	C6H6O	94.0	9885010	108-95-2	Phenol
8.481	96.0	C9H12	120.1	4758231	526-73-8	Benzene, 1,2,3-trimethyl-
8.581	86.8	C7H16O3	148.1	831696	34590-94-8	Dipropylene glycol monomethyl ether
8.825	95.5	C7H16O3	148.1	1644532	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
8.841	84.3	C6H4Cl2	146.0	768281	106-46-7	Benzene, 1,4-dichloro-
8.941	93.9	C9H12	120.1	1169117	526-73-8	Benzene, 1,2,3-trimethyl-
9.171	95.3	C7H8O	108.1	6775862	100-51-6	Benzyl Alcohol
9.405	83.5	C10H14	134.1	720274	135-98-8	Benzene, (1-methylpropyl)-
9.498	83.9	C10H14	134.1	654388	488-23-3	Benzene, 1,2,3,4-tetramethyl-
9.515	91.4	C8H14O	126.1	811402	2548-87-0	2-Octenal, (E)-
9.645	97.9	C8H8O	120.1	2691212	98-86-2	Ethanone, 1-phenyl-
9.733	85.8	C9H18O2	158.1	1050340	112-32-3	Formic acid, octyl ester
9.905	94.1	C10H14	134.1	722067	933-98-2	Benzene, 1-ethyl-2,3-dimethyl-
9.926	97.3	C8H16O3	160.1	2509384	112-07-2	2-Butoxyethyl acetate
10.060	97.0	C8H8O2	136.1	15496158	93-58-3	Benzoic acid, methyl ester
10.173	97.8	C9H18O	142.1	10105534	124-19-6	Nonanal

10.253	97.5	C6H11NO	113.1	18580561	2687-91-4	1-Ethyl-2-pyrrolidinone
10.352	94.3	C10H14	134.1	606874	488-23-3	Benzene, 1,2,3,4-tetramethyl-
10.400	94.8	C10H14	134.1	764132	488-23-3	Benzene, 1,2,3,4-tetramethyl-
10.542	93.1	C10H30O5Si5	370.1	1362564	541-02-6	Cyclopentasiloxane, decamethyl-
10.551	97.3	C7H12O4	160.1	2499157	1119-40-0	Pentanedioic acid, dimethyl ester
10.811	85.8	C10H14	134.1	578315	141-93-5	Benzene, 1,3-diethyl-
11.233	94.8	C8H18O3	162.1	4845182	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
11.273	90.6	C10H8	128.1	1526065	275-51-4	Azulene
11.326	90.9	C8H8O3	152.0	892827	119-36-8	Methyl salicylate
11.359	84.7	C10H22O	158.2	1585083	2051-33-4	1-Hexanol, 5-methyl-2-(1-methylethyl)-
11.437	96.3	C10H20O	156.2	3518529	112-31-2	Decanal
11.621	91.0	C8H10O2	138.1	660869	122-99-6	Ethanol, 2-phenoxy-
11.809	81.3	C8H14O4	174.1	1334058	627-93-0	Hexanedioic acid, dimethyl ester
11.865	87.1	C11H20O2	184.1	787483	2499-59-4	2-Propenoic acid, octyl ester
12.353	95.4	C7H7ClO	142.0	686551	615-74-7	Phenol, 2-chloro-5-methyl-
12.432	93.9	C12H36O6Si6	444.1	916094	540-97-6	Cyclohexasiloxane, dodecamethyl-
12.818	94.4	C7H12O5	176.1	10770609	1000428-18-0	1,3-Diacetin
13.023	90.5	C12H24O3	216.2	41281617	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
13.236	94.6	C12H24O3	216.2	56892753	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.417	95.9	C14H30	198.2	1292069	629-59-4	Tetradecane
13.514	96.6	C12H24O	184.2	801241	112-54-9	Dodecanal
13.873	81.4	C13H22O	194.2	929562	3796-70-1	5,9-Undecadien-2-one, 6,10-dimethyl-, (E)-
14.143	85.2	C12H26O	186.2	1591480	112-53-8	1-Dodecanol
14.307	94.6	C15H32	212.3	989610	629-62-9	Pentadecane
15.135	95.6	C16H34	226.3	1150429	544-76-3	Hexadecane
15.633	80.6	C9H20O	144.2	577727	999057-74-5	Methyl octyl ether
15.913	89.6	C13H28	184.2	569581	17453-94-0	Undecane, 5-ethyl-