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

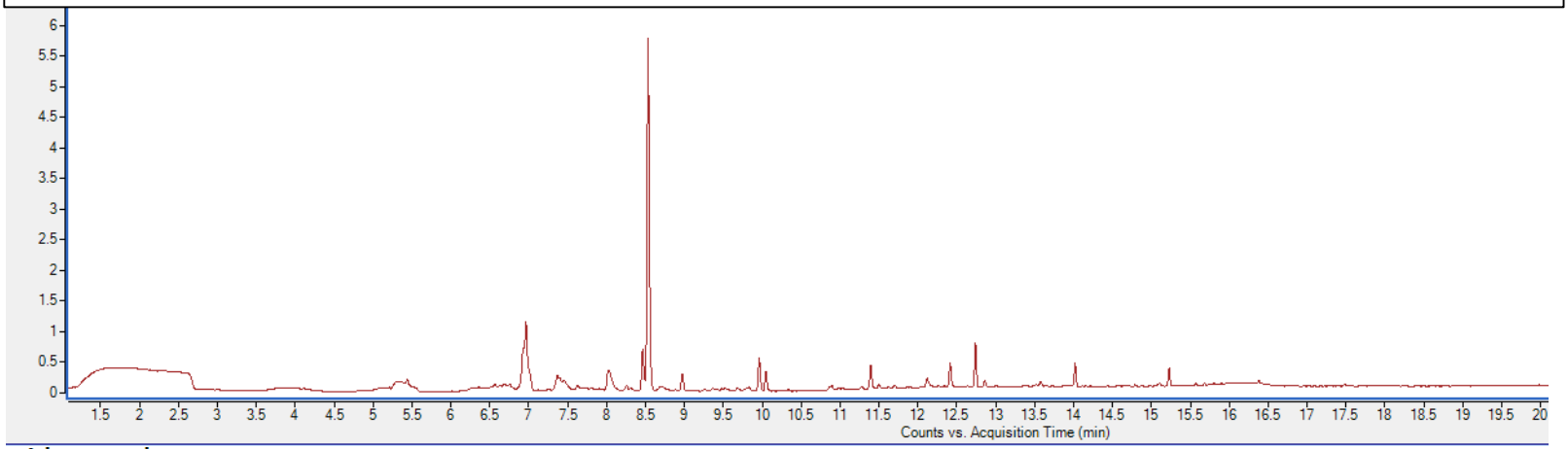
Sample: Benchmark 35-111 sueded polyethylene fabric; creme; no adhesive backing

Oddy test result: Permanent

Date collected: 12/04/2017

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) 12.1 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 12.2, 12.4 min: 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
4.111	94.8	C6H12O	100.1	158250	66-25-1	Hexanal
4.268	82.8	C13H21NO	207.2	121010	999199-46-0	12-AZABICYCLO(9.2.1)TETRADECA-1(14)-ENE-13-ONE
5.209	84.2	C7H14O	114.1	174338	106-35-4	3-Heptanone
5.325	87.3	C7H14O	114.1	1106274	111-71-7	Heptanal
5.439	95.4	C7H14O	114.1	873340	111-71-7	Heptanal
6.357	99.0	C7H6O	106.0	419081	100-52-7	Benzaldehyde
6.757	89.0	C8H16O	128.1	343983	111-13-7	2-Octanone
6.926	90.0	C7H16	100.1	584846	142-82-5	Heptane
6.965	98.6	C8H16O	128.1	4154503	124-13-0	Octanal
7.364	96.3	C8H18O	130.1	1007494	1000411-44-8	2-Ethyl-1-hexanol
7.400	81.4	C10H16	136.1	225719	138-86-3	dl-Limonene
7.459	91.9	C7H8O	108.1	517877	100-51-6	Benzyl alcohol
7.623	97.3	C5H9NO	99.1	301980	872-50-4	2-Pyrrolidinone, 1-methyl-
8.019	94.6	C10H22O	158.2	1218799	112-30-1	1-Decanol
8.261	91.1	C9H12O	136.1	155345	617-94-7	Benzenemethanol, .alpha.,.alpha.-dimethyl-
8.461	98.7	C11H24	156.2	1279600	1120-21-4	Undecane
8.532	98.5	C9H18O	142.1	11444520	124-19-6	Nonanal
8.689	87.2	C8H10O	122.1	200836	60-12-8	Phenylethyl Alcohol
8.970	92.2	C10H30O5Si5	370.1	452443	541-02-6	Cyclopentasiloxane, decamethyl-
9.684	94.6	C10H20O	156.2	118494	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
9.960	97.0	C12H26	170.2	991291	112-40-3	Dodecane
10.046	98.2	C10H20O	156.2	622259	112-31-2	Decanal
10.894	89.5	C9H18O2	158.1	160401	112-05-0	Nonanoic acid
11.391	92.8	C13H28	184.2	631646	629-50-5	Tridecane
11.494	95.3	C11H22O	170.2	133312	112-44-7	Undecanal
12.119	92.4	C12H24O3	216.2	443227	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.412	93.4	C12H24O3	216.2	745259	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.741	95.6	C14H30	198.2	1103926	629-59-4	Tetradecane
12.862	97.6	C12H24O	184.2	190630	112-54-9	Dodecanal
14.018	95.8	C15H32	212.3	597327	629-62-9	pentadecane
15.228	95.8	C20H42	282.3	448213	112-95-8	Eicosane
16.063	84.9	C24H38O4	390.3	233662	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
16.380	92.3	C35H72	492.6	141611	630-07-9	Pentatriacontane