

**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

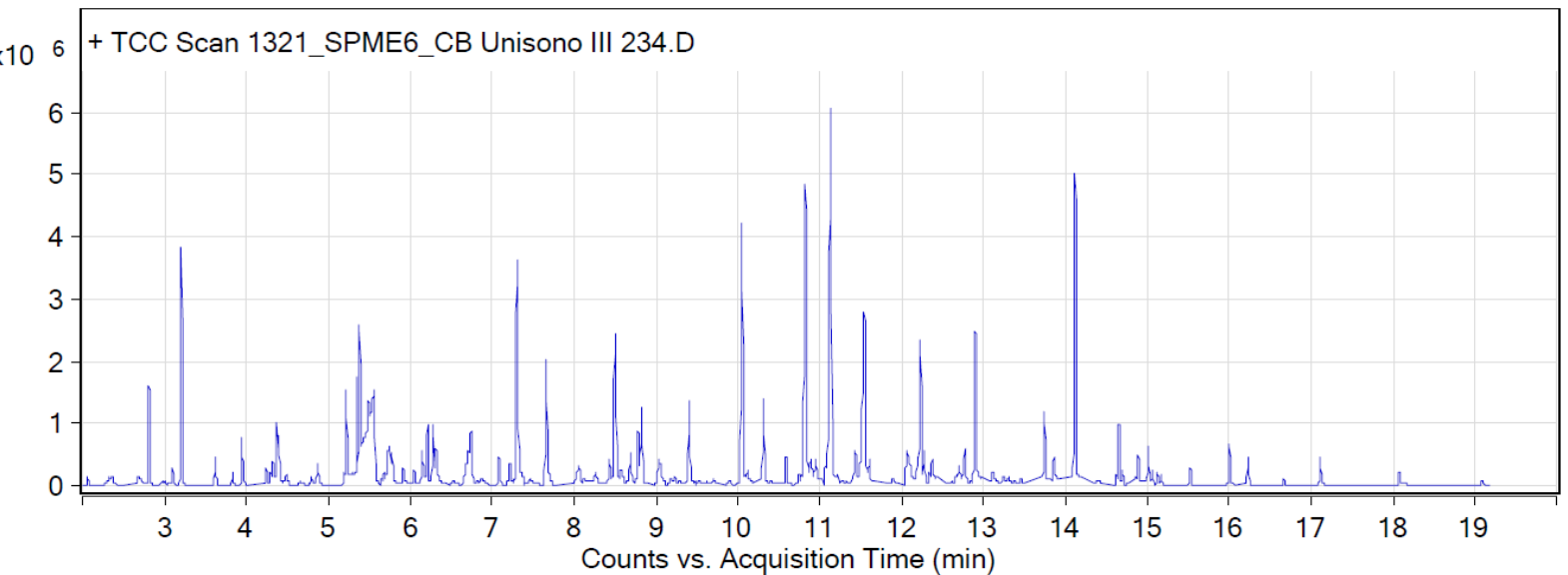
Sample: Creation Baumann Unisono III 234 - unwashed cotton fabric swatch

Oddy test score: Temporary

Date collected: 06/01/2016

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) 10.8 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 11.1 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



RT	Mass	Name	DB Formula
1.53		2-Propanone	C3H6O
1.9		Furan, tetrahydro-	C4H8O
1.93		Acetic acid	C2H4O2
2.67		(S)-(+)-1,2-Propanediol	C3H8O2
2.81		Benzene, methyl-	C7H8
3.2		Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.83		Benzene, ethyl-	C8H10
3.94		XYLENE	C8H10
4.24		unidentified C2-benzene	C8H10
4.29		Undecane	C11H24
4.39		Ethanol, 2-butoxy-	C6H14O2
4.78		Ethanol, 2-(2-methoxyethoxy)-	C5H12O3
5.22		Benzaldehyde	C7H6O
5.38		Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
5.42		Phenol	C6H6O
5.56		Ethanol, 2,2'-oxybis-	C4H10O3
5.65		(R)-2-(2'-hydroxyethoxy)-2-hydroxymethyl-1,4-dioxane	C7H14O5
5.68		Benzene, 1,2,3-trimethyl-	C9H12
5.72		Decane	C10H22
5.74		Ethanol, 2-(2-ethoxyethoxy)-	C6H14O3
5.78		Octanal	C8H16O
5.91		dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
6.14		1-Hexanol, 2-ethyl-	C8H18O
6.21		dl-Limonene	C10H16
6.28		Benzyl Alcohol	C7H8O
6.76		benzophenone	C8H8O
7.3		NONANAL	C9H18O

7.71	Pentanedioic acid, dimethyl ester	C7H12O4
8.06	1,3-Pentanediol, 2,2,4-trimethyl-	C8H18O2
8.43	Cyclohexanol, 5-methyl-2-(1-methylethyl)-	C10H20O
8.5	Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
8.78	Decanal	C10H20O
8.82	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
9.01	Ethanol, 2-phenoxy-	C8H10O2
9.4	Hexanoic acid, 2-ethyl-, 2-methylpropyl ester	C12H24O2
10.82	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
10.95	Undecane, 2,9-dimethyl-	C13H28
11.14	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	C12H24O3
11.43	Dodecane, 2,6,11-trimethyl-	C15H32
11.54	2,4,7,9-Tetramethyl-5-decyne-4,7-diol	C14H26O2
12.07	1,2-Benzenedicarboxylic acid, dimethyl ester	C10H10O4
12.27	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-	C14H20O2
12.37	Cyclohexadecane	C16H32
12.7	Hexadecane, 2,6,10,14-tetramethyl-	C20H42