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

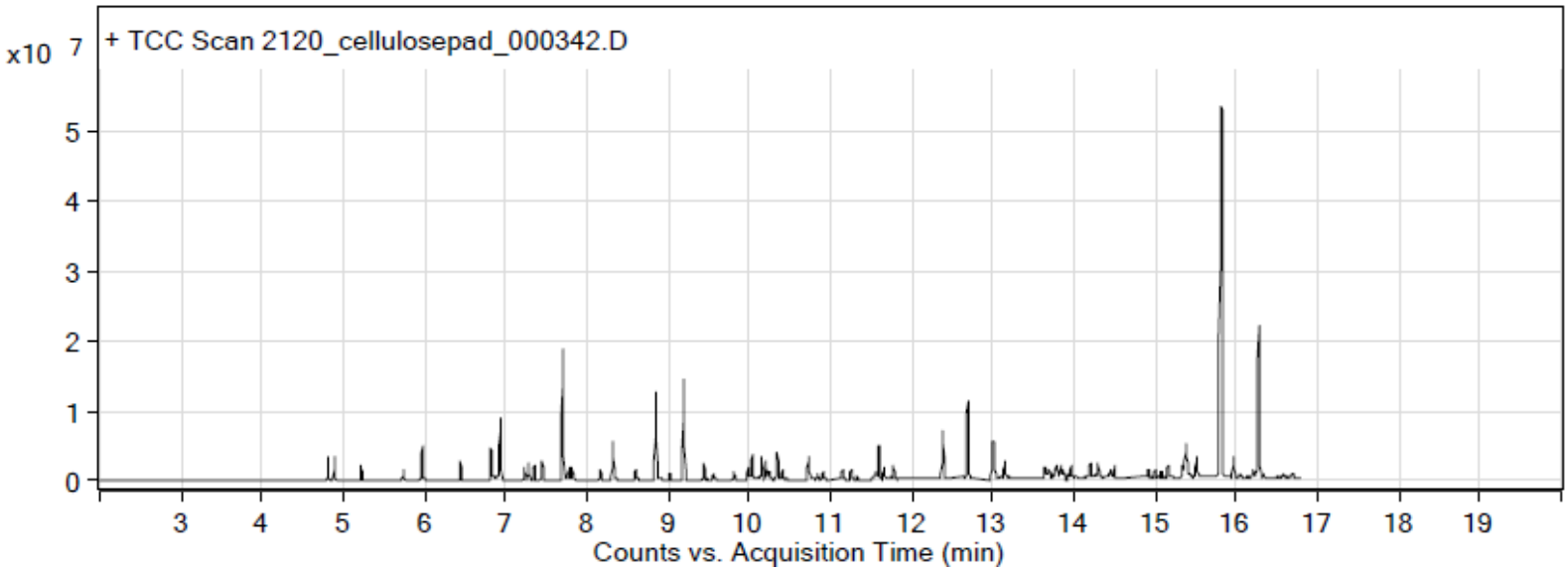
Alkynes – can become reactive when exposed to heat or UV light

Sample: Cellulose kraft paper wadding; Catalog # S-656

Date collected: 04/19/2018

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) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



RT	Mass	Name	DB Formula
4.81		Hexanal	C6H12O
4.89		Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
5.97		Ethanol, 2-butoxy-	C6H14O2
6.44		2-Propanol, 1-butoxy-	C7H16O2
6.82		Benzaldehyde	C7H6O
6.94		Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
7.23		dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.28		dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.35		Octanal	C8H16O
7.45		dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN	C7H16O3
7.7		1-Hexanol, 2-ethyl-	C8H18O
7.78		dl-Limonene	C10H16
7.82		Benzyl Alcohol	C7H8O
8.85		Nonanal	C9H18O
9.02		Phosphoric acid, triethyl ester	C6H15O4P
9.19		Cyclopentasiloxane, decamethyl-	C10H30O5Si5
9.44		Acetic acid, 2-ethylhexyl ester	C10H20O2
9.56		1,3-Pentanediol, 2,2,4-trimethyl-	C8H18O2
9.81		1-Nonanol	C9H20O
9.98		Cyclohexanol, 5-methyl-2-(1-methylethyl)-	C10H20O
10.03		Ethanol, 2-(2-butoxyethoxy)-	C8H18O3
10.15		Azulene	C10H8
10.2		Methyl salicylate	C8H8O3
10.34		Decanal	C10H20O
10.73		Benzothiazole	C7H5NS
10.91		1-Phenoxypropan-2-ol	C9H12O2
11.26		1-Decanol	C10H22O
11.6		Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6

11.66		Tridecane	C13H28
11.77		Undecanal	C11H22O
12.69		Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
13		Benzaldehyde, 3-hydroxy-4-methoxy-	C8H8O3
13.01		Tetradecane	C14H30
13.15		Dodecanal	C12H24O
13.96		1-Dodecanol	C12H26O
14.2		Cetene	C16H32
14.29		pentadecane	C15H32
14.44		Tridecanal	C13H26O
15.16		Pentadecane, 3-methyl-	C16H34
15.82		Dodecanoic acid, 1-methylethyl ester	C15H30O2
15.96		Methanone, diphenyl-	C13H10O