

**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

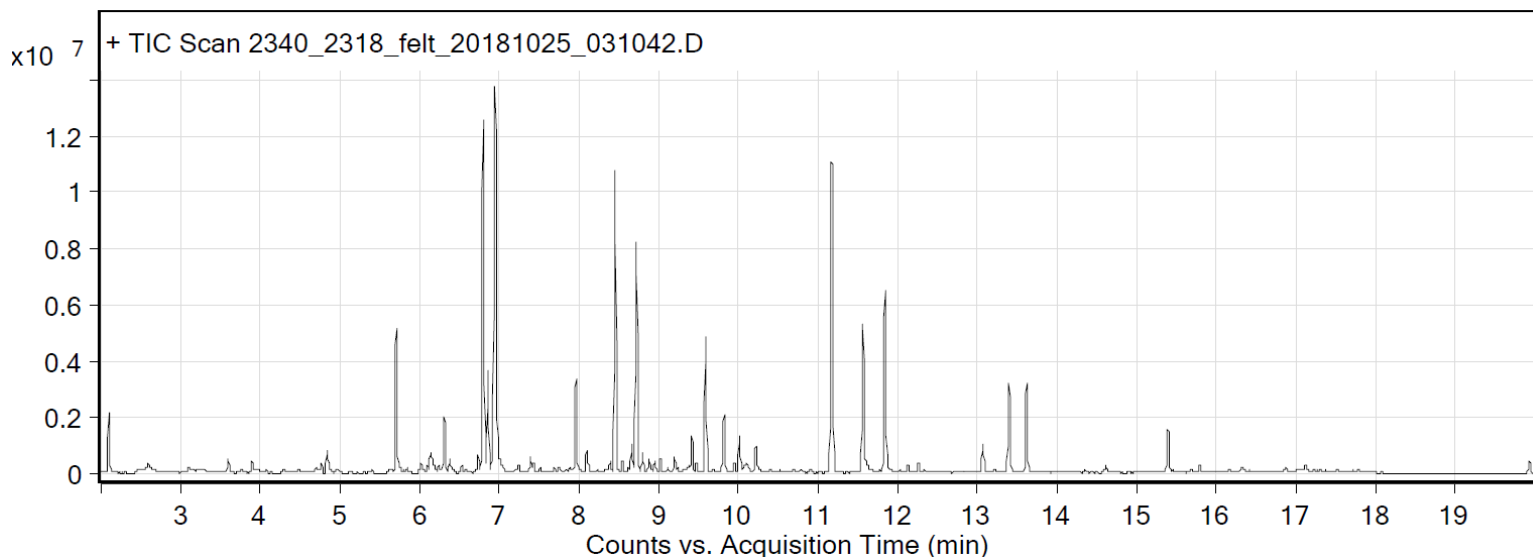
Sample: Sutherland Felt Company: 1/4" Stif-Felt, PE-F-59230-48 no adhesive

Oddy test result: Temporary

Date collected: 10/23/2018

Technique used: SPME with a PDMS/Carbon WR 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 cryo-trapped for 2 min at -15°C; GC ramped from 35°C to 250 °C at 10°C/min. Data analyzed in Masshunter Qualitative Analysis. Deconvoluted data with > 85% match with a NIST 17.0 or Wiley 9 library are reported.

VOCs not highlighted are because they were also observed in blanks: (1) 11.5 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 11.8 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



**Compound Table**

RT	Score (Lib)	Area	Name	Formula
1.49	97.76	608199	Acetic acid	C2H4O2
1.73	94.68	2937220	Benzene, methyl-	C7H8
2.1	93.68	2402064	Silanediol, dimethyl-	C2H8O2Si
3.1	95.44	436573	Formamide, N,N-dimethyl-	C3H7NO
3.6	92.63	738416	Cyclotrisiloxane, hexamethyl-	C6H18O3Si3
3.89	96.19	572305	2-Pentanone, 4-hydroxy-4-methyl-	C6H12O2
4.77	92.77	805698	Heptanal	C7H14O
4.84	96.79	951357	Ethanol, 2-butoxy-	C6H14O2
5.7	97.94	7060573	Benzaldehyde	C7H6O
6.09	87.28	430305	3-Pentenoic acid, 4-methyl-	C6H10O2
6.24	95.22	333429	Benzene, 1,3,5-trimethyl-	C9H12
6.31	96.38	2664478	Cyclotetrasiloxane, octamethyl-	C8H24O4Si4
6.38	94.96	714913	Octanal	C8H16O
6.53	96.82	388396	Benzene, 1,4-dichloro-	C6H4Cl2
6.73	93.62	893677	Benzene, methyl(1-methylethyl)-	C10H14
6.8	95.19	19976898	1-Hexanol, 2-ethyl-	C8H18O
6.86	99.54	4921847	Butanedioic acid, dimethyl ester	C6H10O4
6.92	94.99	1636349	Benzyl Alcohol	C7H8O
6.95	97.46	27643381	2-Pyrrolidinone, 1-methyl-	C5H9NO
7.39	97.58	767747	Ethanone, 1-phenyl-	C8H8O
7.43	96.31	437437	1-Octanol	C8H18O
7.69	88.42	292616	Benzenemethanol, .alpha.,.alpha.-dimethyl-	C9H12O
7.96	97.98	4876614	Nonanal	C9H18O
8.11	90.24	379158	Benzeneethanol	C8H10O
8.39	90.22	680028	1-Nonanol	C9H20O
8.45	97.37	15218822	Pentanedioic acid, dimethyl ester	C7H12O4
8.54	95.4	530838	(S)-(+)-6-Methyl-1-octanol	C9H20O
8.66	95.86	1481432	Acetic acid, 2-ethylhexyl ester	C10H20O2
8.72	94.26	12260770	Cyclopentasiloxane, decamethyl-	C10H30O5Si5

8.8	95.39	1001468	2-Nonenal, (E)-	C9H16O
8.88	96.3	661364	Acetic acid, phenylmethyl ester	C9H10O2
8.95	96.82	644878	1-Nonanol	C9H20O
9.02	95.89	739081	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-(./-.)-	C10H20O
9.2	93.26	712287	Azulene	C10H8
9.35	96.28	280352	Methyl salicylate	C8H8O3
9.42	95.52	1953745	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-	C10H20O
9.47	95.05	527990	Decanal	C10H20O
9.59	95.42	7201352	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-	C10H20O
9.82	95.76	2901568	2-Ethylhexyl acrylate	C11H20O2
9.95	91.54	485896	2-Ethyl-1-hexyl propionate	C11H22O2
10.01	97.65	2055318	Hexanedioic acid, dimethyl ester	C8H14O4
10.09	86.64	470450	2H-Azepin-2-one, hexahydro-	C6H11NO
10.22	93.68	1657157	2,3-Diethyl-2,3-dimethylsuccinonitrile	C10H16N2
11.17	95.88	17979484	Cyclohexasiloxane, dodecamethyl-	C12H36O6Si6
11.56	91.57	9189538	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	C12H24O3
11.84	92.97	10314340	Propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	C12H24O3
12.13	93.94	302375	Tetradecane	C14H30
12.26	97.84	495736	Dodecanal	C12H24O
13.62	96.68	4066162	Phenol, 2,6-bis(1,1-dimethylethyl)-4-methyl-	C15H24O
14.61	86.82	430521	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester	C16H30O4
15.39	90.61	2446745	Cyclooctasiloxane, hexadecamethyl-	C16H48O8Si8