

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

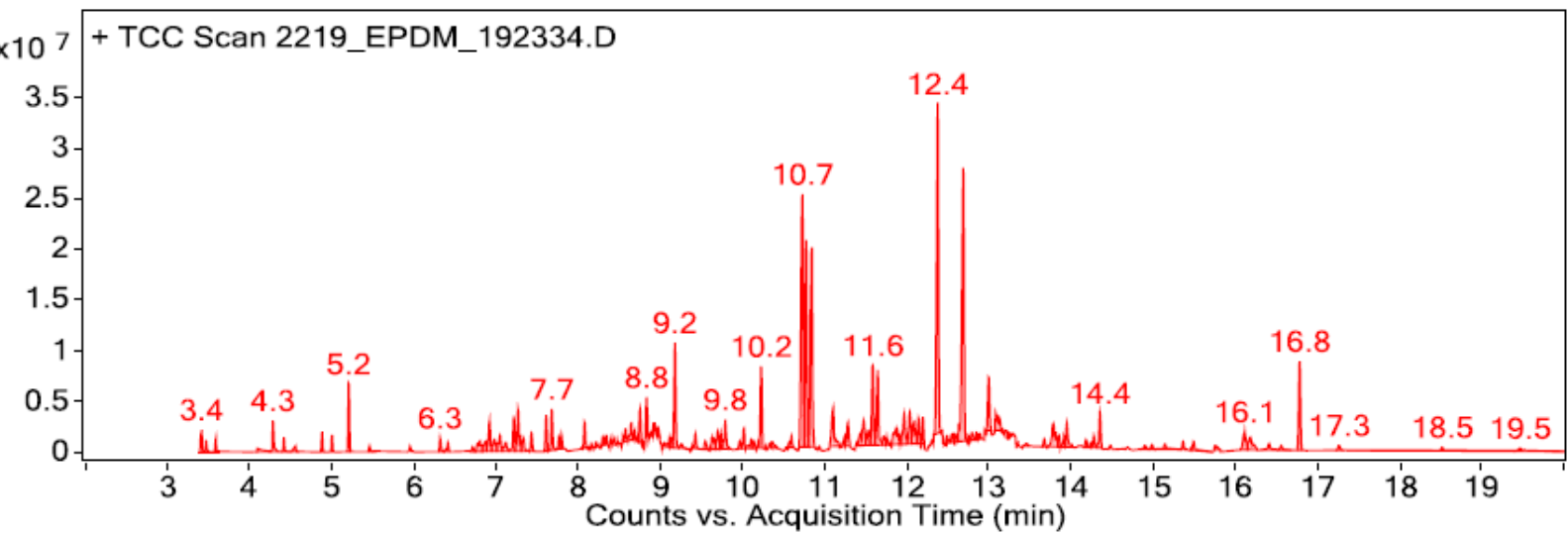
Sample: Jacobs and Thompson EPDM neoprene foam tape gasket

Oddy test result: Temporary

Date collected: 06/29/2018

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 library are reported.

VOCs not highlighted are because they were also observed in blanks: : (1) 12.4 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxyl-1-methylethyl) propyl ester propanoic acid; (2) 12.7 min: 2-methyl-, 3-hydroxyl-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
3.400	92.8	CHNO	43.0	2538418	75-13-8	Hydrogen isocyanate
3.500	92.9	CH2O2	46.0	922503	64-18-6	Formic acid
3.600	98.5	C2H4O2	60.0	1139105	64-19-7	Acetic acid
4.100	85.9	CH3NO	45.0	1425837	75-12-7	Formamide
4.300	93.4	C3H8O2	76.1	3138890	57-55-6	1,2-Propanediol
4.600	89.4	C4H8O2	88.1	1084413	107-92-6	Butanoic acid
4.900	91.7	C6H18O3Si3	222.1	1761822	541-05-9	Cyclotrisiloxane, hexamethyl-
5.000	95.2	C9H20	128.2	1456884	2213-23-2	Heptane, 2,4-dimethyl-
5.200	93.0	C6H12O2	116.1	6885743	123-42-2	2-Pentanone, 4-hydroxy-4-methyl-
5.500	92.6	C9H20	128.2	626072	2216-34-4	Octane, 4-methyl-
6.000	91.7	C6H14O2	118.1	652500	111-76-2	Ethanol, 2-butoxy-
6.300	93.7	C5H12O3	120.1	1642306	111-77-3	Ethanol, 2-(2-methoxyethoxy)-
6.800	98.4	C7H6O	106.0	563473	100-52-7	Benzaldehyde
6.900	86.3	C6H12O2	116.1	2482991	142-62-1	Hexanoic acid
6.900	88.2	C8H24O4Si4	296.1	3595768	556-67-2	Cyclotetrasiloxane, octamethyl-
7.100	90.3	C6H10O4	146.1	1304518	111-55-7	1,2-Ethandiol, diacetate
7.200	98.3	C7H16O3	148.1	5011054	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	91.1	C7H16O3	148.1	10601684	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.300	89.9	C10H22	142.2	1595249	124-18-5	Decane
7.300	96.5	C8H16O	128.1	1770458	124-13-0	Octanal
7.400	99.6	C7H16O3	148.1	2532208	0-00-0	dipropylene glycol monomethyl ether isomer, STRUCTURE UNKNOWN
7.600	94.0	C7H9N	107.1	4468403	100-45-8	4-Cyanocyclohexene
7.700	97.4	C8H18O	130.1	4046053	104-76-7	1-Hexanol, 2-ethyl-
7.800	97.2	C10H16	136.1	1728783	138-86-3	dl-Limonene
8.100	93.1	C13H28	184.2	3932429	17301-32-5	Undecane, 4,7-dimethyl-
8.200	84.4	C13H28	184.2	966870	17301-32-5	Undecane, 4,7-dimethyl-
8.200	91.6	C15H32	212.3	1076126	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.300	83.7	C24H46O3	382.3	1155587	1000383-10-8	Carbonic acid, eicosyl prop-1-en-2-yl ester
8.400	89.2	C11H24O	172.2	1616063	91337-07-4	2-Isopropyl-5-methyl-1-heptanol

8.500	82.1	C14H30O	214.2	1078210	112-72-1	1-Tetradecanol
8.500	90.0	C11H24	156.2	1449761	17302-23-7	Nonane, 4,5-dimethyl-
8.600	84.1	C11H24	156.2	1414521	62016-18-6	Octane, 5-ethyl-2-methyl-
8.700	83.1	C13H28	184.2	969303	62108-23-0	Decane, 2,5,6-trimethyl-
8.800	94.9	C11H24	156.2	7278146	1120-21-4	Undecane
8.800	86.9	C9H18O	142.1	7267531	124-19-6	Nonanal
8.900	84.4	C12H26	170.2	2011732	17312-54-8	Decane, 3,7-dimethyl-
9.100	82.8	C11H24	156.2	1897274	17302-23-7	Nonane, 4,5-dimethyl-
9.200	95.5	C10H30O5Si5	370.1	13595481	541-02-6	Cyclopentasiloxane, decamethyl-
9.400	95.3	C10H20O2	172.1	1979487	103-09-3	Acetic acid, 2-ethylhexyl ester
9.500	80.4	C11H24	156.2	1503276	13151-34-3	Decane, 3-methyl-
9.600	88.3	C13H28	184.2	452438	62185-54-0	Nonane, 5-(1-methylpropyl)-
9.800	89.2	C17H36O	256.3	1267539	1000406-39-1	Decyl heptyl ether
10.000	95.0	C10H20O	156.2	1151527	1490-04-6	Cyclohexanol, 5-methyl-2-(1-methylethyl)-
10.000	95.5	C8H18O3	162.1	1695755	112-34-5	Ethanol, 2-(2-butoxyethoxy)-
10.100	93.7	C10H8	128.1	1014526	275-51-4	Azulene
10.200	94.7	C8H8O3	152.0	602168	119-36-8	Methyl salicylate
10.200	90.6	C12H26	170.2	10409187	112-40-3	Dodecane
10.300	94.5	C10H20O	156.2	911903	112-31-2	Decanal
10.400	90.6	C30H58O4	482.4	712287	2432-89-5	Decanedioic acid, didecyl ester
10.500	83.2	C8H10O2	138.1	572982	122-99-6	Ethanol, 2-phenoxy-
10.600	92.0	C11H20O2	184.1	1396691	103-11-7	2-Ethylhexyl acrylate
10.700	95.4	C7H5NS	135.0	41866844	95-16-9	Benzothiazole
10.800	86.7	C6H14O3	134.1	27903546	25265-71-8	2-Propanol, 1,1'-oxybis-
10.800	89.6	C10H22O3	190.2	34037695	29911-28-2	2-Propanol, 1-(2-butoxy-1-methylethoxy)-
10.900	85.2	C10H16N2	164.1	736437	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
11.100	92.1	C7H13NO	127.1	5759044	766-93-8	Formamide, N-cyclohexyl-
11.300	89.4	C14H30	198.2	2131007	61141-72-8	Dodecane, 4,6-dimethyl-
11.500	83.1	C16H34	226.3	938904	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
11.500	87.8	C10H14O	150.1	655955	0-00-0	1-(Hydroxyphenyl)-2-methylpropane
11.500	92.3	C13H28O	200.2	1477526	112-70-9	1-Tridecanol
11.600	95.9	C12H36O6Si6	444.1	11060894	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	94.0	C13H28	184.2	8275404	629-50-5	Tridecane
11.800	88.7	C30H58O4	482.4	1330194	2432-89-5	Decanedioic acid, didecyl ester
11.900	81.6	C13H28O	200.2	2373148	7289-40-9	Ether, heptyl hexyl
11.900	87.1	C16H34	226.3	1778874	544-76-3	Hexadecane
12.000	95.2	C16H34	226.3	2912008	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.100	84.1	C12H16	160.1	2970272	13065-07-1	Naphthalene, 1,2,3,4-tetrahydro-2,7-dimethyl-
12.200	87.8	C12H16	160.1	4915535	1076-69-3	5,6,7,8,9,10-Hexahydrobenzocyclooctene
12.400	88.4	C12H24O3	216.2	33650185	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.400	86.3	C20H42	282.3	1136565	638-36-8	Hexadecane, 2,6,10,14-tetramethyl-
12.500	90.2	C16H34	226.3	3503851	4390-04-9	Nonane, 2,2,4,4,6,8,8-heptamethyl-
12.700	93.4	C12H24O3	216.2	44395552	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
12.800	83.9	C12H26S	202.2	4408609	999185-34-2	dihexylsulfide
12.900	86.1	C14H28	196.2	1027880	295-17-0	Cyclotetradecane
12.900	80.6	C17H33NS	283.2	1861389	0-00-0	n-Cetyl thiocyanate
13.000	94.2	C14H30	198.2	7765116	629-59-4	Tetradecane
13.100	80.6	C14H26O2	226.2	621355	126-86-3	2,4,7,9-Tetramethyl-5-decyne-4,7-diol
13.100	82.5	C14H28O	212.2	1274733	124-25-4	Tetradecanal
13.200	83.1	C33H68	464.5	2216511	630-05-7	Tritriacontane
13.700	89.1	C14H28	196.2	1435241	2882-98-6	Cyclopentane, nonyl-
13.800	80.3	C14H42O7Si7	518.1	2448465	107-50-6	Cycloheptasiloxane, tetradecamethyl-
13.800	84.9	C23H48	324.4	650385	638-67-5	Tricosane
13.900	87.6	C14H20O2	220.1	1082257	719-22-2	2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-
13.900	94.8	C12H26O	186.2	2222175	112-53-8	1-Dodecanol
14.200	82.7	C15H30	210.2	1122311	13360-61-7	1-Pentadecene
14.300	91.3	C15H32	212.3	1802301	629-62-9	Pentadecane
14.500	84.8	C16H34	226.3	611178	59222-86-5	Tetradecane, 2,2-dimethyl-
15.000	82.7	C15H30	210.2	682655	2883-02-5	n-Nonylcyclohexane
15.500	90.7	C16H34	226.3	1197899	544-76-3	Hexadecane
15.800	88.5	C16H48O8Si8	592.2	655933	556-68-3	Cyclooctasiloxane, hexadecamethyl-
16.100	80.7	C10H19N	153.2	2509578	1197-52-0	Cyclohexanamine, N-butylidene-
16.800	94.9	C15H22O2	234.2	12629347	5444-75-7	Benzoic acid, 2-ethylhexyl ester