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

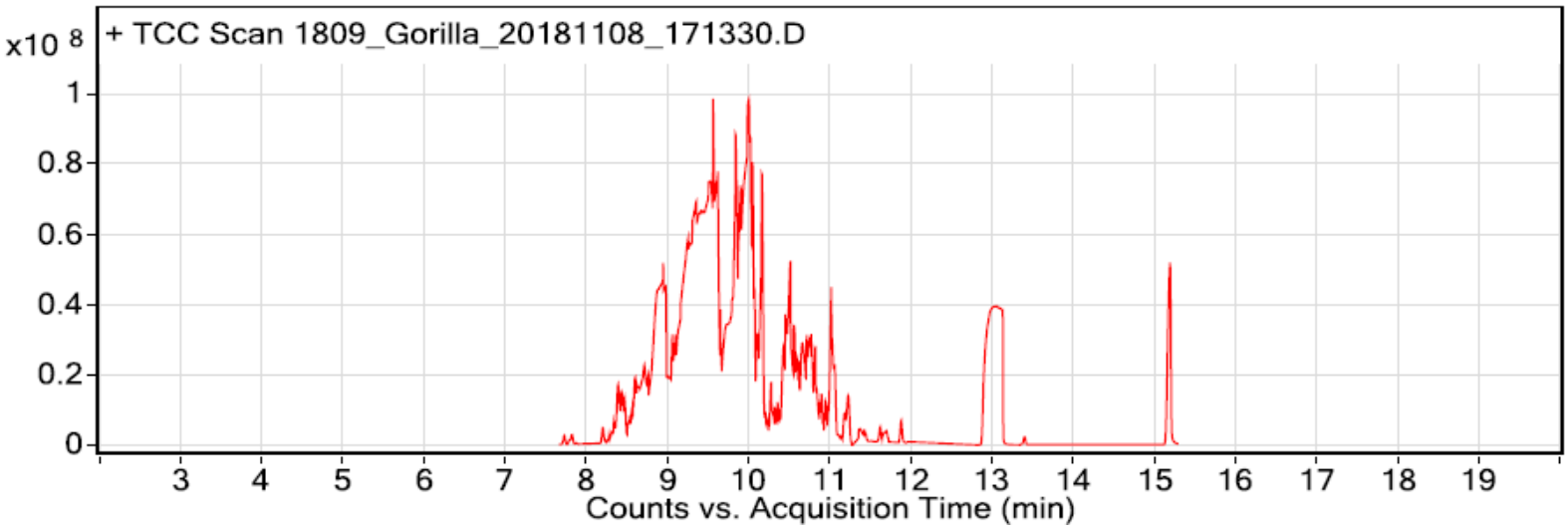
Sample: Gorilla heavy duty construction adhesive

Oddy test result: Permanent

Date collected: 11/08/2018

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) 11.6 min: 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 11.9 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
7.730	88.0	C12H24	168.2	4865324	74630-42-5	1-Undecene, 7-methyl-
7.830	88.8	C10H20	140.2	7485785	62238-07-7	Cyclopropane, 1-methyl-2-(3-methylpentyl)-
8.210	88.3	C9H20O	144.2	10392947	143-08-8	1-Nonanol
8.340	81.6	C9H20O	144.2	13646263	143-08-8	1-Nonanol
8.390	89.1	C9H20O	144.2	24610572	143-08-8	1-Nonanol
8.470	88.3	C9H20O	144.2	16962528	98982-97-9	1-Heptanol, 2,4-dimethyl-,
8.560	80.5	C8H18O	130.1	11604511	26952-21-6	Isooctanol
8.600	80.5	C13H26	182.2	37819839	999136-72-7	5,9-Dimethylundec-1-ene
8.720	95.1	C10H30O5Si5	370.1	14862277	541-02-6	Cyclopentasiloxane, decamethyl-
8.870	84.6	C10H22O	158.2	62236515	999083-84-1	tetrahydro geraniol
9.010	80.6	C9H18N2O4	218.1	21437283	57-53-4	1,3-Propanediol, 2-methyl-2-propyl-, dicarbamate
9.030	95.0	C9H13F6NO	265.1	22236356	999360-65-6	1-(bistrifluoromethylamino-oxy)-1-methylcyclohexane
9.200	89.8	C5H4FN	97.0	68038766	372-48-5	2-fluoropyridine
9.320	80.9	C6H11NO	113.1	19008109	108168-86-1	pentanenitrile, 3-(hydroxymethyl)-
9.370	86.4	C7H12O	112.1	178463533	999018-28-4	1-Cyclobutylcyclopropanol
9.580	80.9	C7H12O	112.1	152175469	57266-86-1	2-Heptenal, (Z)-
9.630	84.2	C6H12N2	112.1	5831565	931-35-1	1H-Imidazole, 2-ethyl-4,5-dihydro-4-methyl-
9.980	80.5	C6H10O2	114.1	96387974	999020-05-8	Cyclopntyl formate
10.080	80.8	C6H11FO	118.1	10194022	69429-56-7	2-Fluoro-3,3-dimethylbutanal
10.160	89.1	C10H20	140.2	101146213	53366-38-4	Cyclopentane, (2-methylbutyl)-
10.290	82.0	C9H18	126.1	30128029	999031-81-1	TRANS DIMETHYL-2,2 HEPTENE-3
10.350	85.3	C11H22	154.2	14444197	72993-32-9	Cyclopentane, 1-butyl-2-ethyl-
10.440	84.3	C11H22	154.2	86290278	61142-79-8	1-Decene, 8-methyl-
10.520	88.4	C9H18	126.1	73050704	53907-60-1	Cyclopentane, 1,1,3,4-tetramethyl-, cis-
10.590	84.0	C9H18	126.1	38684748	53907-60-1	Cyclopentane, 1,1,3,4-tetramethyl-, cis-
10.780	87.5	C12H24	168.2	83098564	74630-40-3	1-Undecene, 8-methyl-
10.840	82.5	C9H18	126.1	42300758	999031-81-1	TRANS DIMETHYL-2,2 HEPTENE-3
10.900	86.9	C11H22	154.2	10229174	61142-79-8	1-Decene, 8-methyl-

10.950	85.1	C14H30O	214.2	22761960	3981-79-1	7-Tetradecanol
11.070	82.3	C7H10O2	126.1	6630411	5164-67-0	EXO-3-HYDROXY-2-NORBORNANONE
11.180	95.8	C12H36O6Si6	444.1	12487434	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.440	82.6	C12H24	168.2	5581601	74630-40-3	1-Undecene, 8-methyl-
11.620	89.8	C12H24O3	216.2	8158567	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
11.880	92.2	C12H24O3	216.2	11846904	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.030	90.9	C9H11N	133.1	60122845	81378-24-7	4-(1,3/2,5-Cyclopentadien-1-yl)butyronitrile
13.040	82.2	C10H15Br	214.0	28984444	92610-69-0	trans-3-Bromo-1,2,4a,5,6,7,8,8a-octahydronaphthaline
13.070	81.8	CS2	75.9	41240168	75-15-0	Carbon disulfide
15.200	96.8	C12H22O4	230.2	135232744	106-79-6	Decanedioic acid, dimethyl ester