

**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

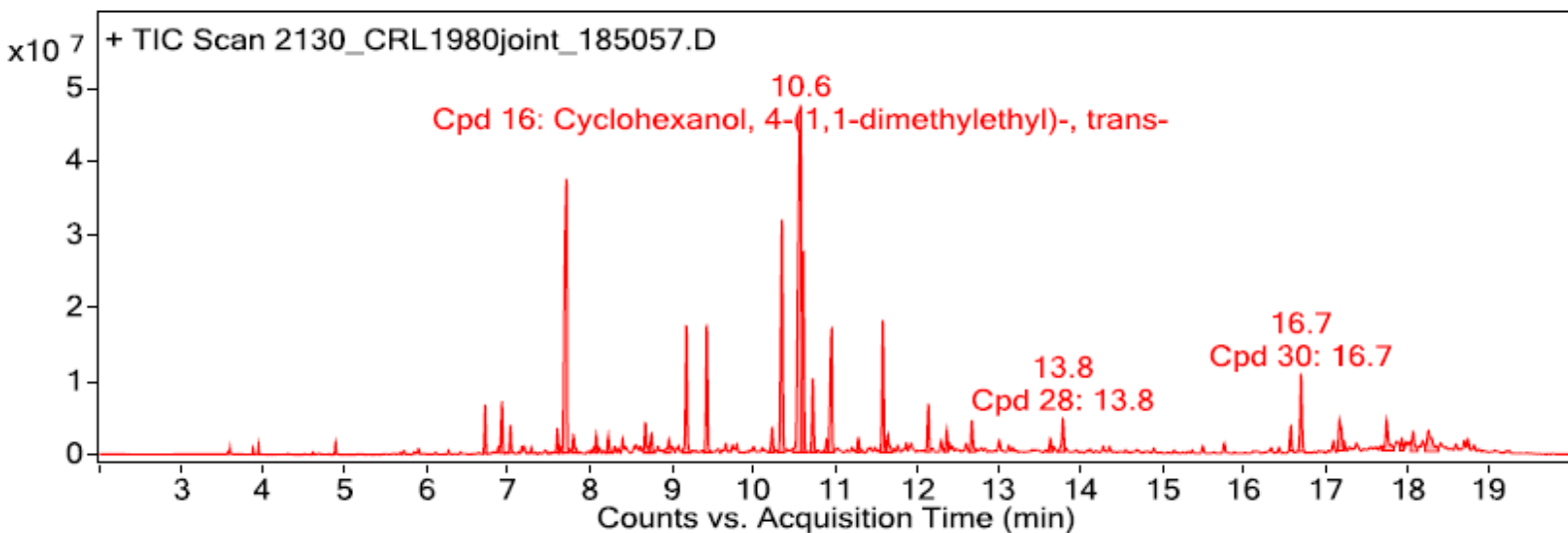
Sample: Astariglas GP cast PMMA sheets

Oddy test result: Permanent

Date collected: 04/28/2018

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-hydroxy-1-methylethyl) propyl ester propanoic acid; (2) 12.7 min: 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester propanoic acid



Library results

RT	Score	Formula	MW	Area	CAS #	Name
6.700	92.5	C11H24	156.2	7318823	62016-28-8	Octane, 2,2,6-trimethyl-
6.900	88.2	C8H24O4Si4	296.1	9062085	556-67-2	Cyclotetrasiloxane, octamethyl-
7.000	87.4	C6H10O2	114.1	4626183	13861-97-7	2(3H)-Furanone, dihydro-4,4-dimethyl-
7.600	81.2	C12H26	170.2	4260768	62199-06-8	Heptane, 5-ethyl-2,2,3-trimethyl-
7.700	95.3	C8H18O	130.1	82414444	104-76-7	1-Hexanol, 2-ethyl-
7.800	84.5	C15H32	212.3	3900140	31295-56-4	Dodecane, 2,6,11-trimethyl-
8.100	92.2	C17H36O3S	320.2	3041610	999508-28-5	Sulfurous acid, 2-ethylhexyl nonyl ester
8.200	89.5	C19H40O3S	348.3	3324259	1000309-19-4	Sulfurous acid, 2-ethylhexyl undecyl ester
8.800	91.3	C16H34	226.3	4736430	544-76-3	Hexadecane
9.000	90.4	C12H26O	186.2	3695036	21078-65-9	1-Decanol, 2-ethyl-
9.200	97.1	C10H30O5Si5	370.1	25014100	541-02-6	Cyclopentasiloxane, decamethyl-
9.400	97.5	C10H20O2	172.1	23961227	103-09-3	Acetic acid, 2-ethylhexyl ester
10.200	94.3	C12H26	170.2	5204621	112-40-3	Dodecane
10.300	96.6	C10H20O	156.2	53822489	937-05-3	Cyclohexanol, 4-(1,1-dimethylethyl)-, cis-
10.600	97.2	C10H20O	156.2	126077243	21862-63-5	Cyclohexanol, 4-(1,1-dimethylethyl)-, trans-
10.600	97.2	C11H20O2	184.1	38797179	103-11-7	2-Propenoic acid, 2-ethylhexyl ester
10.700	82.9	C8H18O	130.1	14625678	104-76-7	1-Hexanol, 2-ethyl-
10.900	88.0	C22H44O3	356.3	2768947	1000383-16-0	Carbonic acid, decyl undecyl ester
11.000	95.1	C10H16N2	164.1	30554802	999094-51-6	2,3-Diethyl-2,3-dimethylsuccinonitrile
11.300	92.0	C16H34	226.3	2818853	544-76-3	Hexadecane
11.600	95.3	C12H36O6Si6	444.1	25311551	540-97-6	Cyclohexasiloxane, dodecamethyl-
11.600	89.3	C21H44O	312.3	4604406	1000406-37-5	Dodecyl nonyl ether
12.100	92.3	C9H14O6	218.1	9148791	102-76-1	1,2,3-Propanetriol, triacetate
12.400	88.9	C12H24O3	216.2	4065094	74367-33-2	Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester
12.700	92.2	C12H24O3	216.2	6794386	77-68-9	Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester
13.600	83.9	C26H54	366.4	2776078	55333-99-8	Eicosane, 7-hexyl-