



United States
Consumer Product Safety Commission

Lifecycle Evaluation of 3D Printers - Appendices

September 2022

Table of Contents

Appendix A: Instrument Parameters 3

 Resins..... 3

 3D Printed Products 4

Appendix B: Chemical Data Tables..... 6

 Resins..... 6

 3D Printed Products 23

Appendix A: Instrument Parameters

Resins

Gas Chromatography-Mass Spectrometry (GC-MS) Parameters	
GC parameters	
GC Column	Rtx-5 MS, 30 m x 0.25 mm ID x 0.25 µm
Carrier gas and Flow rate	H ₂ , 1.0 mL/min constant flow
Oven Temperature program	Initial temp: 80 °C, 2 min hold time Ramp 1: 10.0 °C /min to 315 °C, 15 min hold time
Inlet temperature	250 °C
Injection volume	1.0 µL
Inlet mode	200:1 Split
Total run time	40.5 min
MS parameters	
Mass filter	Quadrupole
Ionization	Electron ionization, 70 eV
Acquisition type	Scan
Solvent delay	2.0 min
MS source	230 °C
MS quad	150 °C
MS Transfer line	320 °C

Direct Analysis in Real Time Mass Spectrometry (DART-MS) Parameters	
Gas	Helium
Gas Temperature	300° C
DART and MS Polarity	Positive
Peaks Voltage	950 V
Mass Range	100 – 900 m/z

Headspace Gas Chromatography-Mass Spectrometry (HS-GC-MS) Parameters	
HS parameters	
Oven Temperature	75 °C
Loop Temperature	80 °C
Transfer Line Temperature	85 °C
Vial Equilibration	7 min
Injection Duration	0.5 min
GC parameters	
GC Column	Rtx-5 MS, 30 m x 0.25 mm ID x 0.25 µm
Carrier gas and Flow rate	H ₂ , 1.0 mL/min constant flow

Oven Temperature program	Initial temp: 50 °C, 5 min hold time Ramp 1: 10.0 °C /min to 280 °C, 0 min hold time Ramp 2: 30.0 °C /min to 315 °C, 1 min hold time
Inlet temperature	200 °C
Injection volume	1.0 µL
Inlet mode	5:1 Split
Total run time	30 min
MS parameters	
Mass filter	Quadrupole
Ionization	Electron ionization, 70 eV
Acquisition type	Scan
Solvent delay	0.5 min
MS source	230 °C
MS quad	150 °C
MS Transfer line	320 °C

3D Printed Products

Gas Chromatography-Mass Spectrometry (GC-MS) Parameters	
GC parameters	
GC Column	Rtx-5 MS, 30 m x 0.25 mm ID x 0.25 µm
Carrier gas and Flow rate	H ₂ , 1.0 mL/min constant flow
Oven Temperature program	Initial temp: 50 °C, 2 min hold time Ramp 1: 20.0 °C /min to 300 °C, 1 min hold time
Inlet temperature	250 °C
Injection volume	1.0 µL
Inlet mode	100:1 Split
Total run time	15.5 min
MS parameters	
Mass filter	Quadrupole
Ionization	Electron ionization, 70 eV
Acquisition type	Scan, mass range 35-500 <i>m/z</i>
Solvent delay	2.0 min
MS source	230 °C
MS quad	150 °C
MS Transfer line	320 °C

Pyrolysis Gas Chromatography/Mass Spectrometry (Pyr-GC-MS) Parameters	
GC parameters	
GC Column	Rtx-5 MS, 30 m x 0.25 mm ID x 0.25 µm
Carrier gas and Flow rate	H ₂ , 1.0 mL/min constant flow
Oven Temperature program	Initial temp: 50 °C, 2 min hold time Ramp 1: 8.0 °C /min to 310 °C, 10 min hold time

Inlet temperature	290 °C
Injection volume	1.0 µL
Inlet mode	100:1 Split
Total run time	45.5 min
MS parameters	
Mass filter	Quadrupole
Ionization	Electron ionization, 70 eV
Acquisition type	Scan, mass range 35-700 <i>m/z</i>
Solvent delay	0.0 min
MS source	230 °C
MS quad	150 °C
MS Transfer line	320 °C
Pyrolysis parameters	
Pyroprobe	600 °C, 20 s
Transfer line	300 °C
Interface	300 °C

Headspace Gas Chromatography-Mass Spectrometry (HS-GC-MS) Parameters	
HS parameters	
Oven Temperature	75 °C
Loop Temperature	80 °C
Transfer Line Temperature	85 °C
Vial Equilibration	7 min
Injection Duration	0.5 min
GC parameters	
GC Column	Rtx-5 MS, 30 m x 0.25 mm ID x 0.25 µm
Carrier gas and Flow rate	H ₂ , 1.0 mL/min constant flow
Oven Temperature program	Initial temp: 50 °C, 5 min hold time Ramp 1: 10.0 °C /min to 280 °C, 0 min hold time Ramp 2: 30.0 °C /min to 315 °C, 1 min hold time
Inlet temperature	200 °C
Injection volume	1.0 µL
Inlet mode	5:1 Split
Total run time	30 min
MS parameters	
Mass filter	Quadrupole
Ionization	Electron ionization, 70 eV
Acquisition type	Scan, mass range 35-500 <i>m/z</i>
Solvent delay	0.5 min
MS source	230 °C
MS quad	150 °C
MS Transfer line	320 °C

Appendix B: Chemical Data Tables¹

Resins

Gas Chromatography-Mass Spectrometry (GC-MS)

Qualitative analysis was performed using GC-MS (Agilent 5977MS/7890GC) to identify major components in each of the resins. Duplicate samples of each liquid resin were diluted (0.5 mL of resin in 4.5 mL dichloromethane) and analyzed on the GC-MS. In addition, chemical standards were purchased by LSC (based on a literature search of 3D resin ingredients) and analyzed on the GC-MS. Analysis of the chemical standards was used to confirm identification of major components in the resins by both retention time and mass spectrum match. The GC-MS instrument parameters for analysis can be found in **Appendix A**.

Table B-1: GC-MS identification of resin components

Photopolymer Resin	GC-MS Analysis					
	Compound	CAS#	Compound	CAS#	Compound	CAS#
C1 (Rigid Grey)	urethane dimethacrylate	72869-86-4	isophorone diisocyanate	4098-71-9	2-hydroxypropyl methacrylate	923-26-2
	2-hydroxyethyl methacrylate	868-77-9	ethylene dimethacrylate	97-90-5	Butylhydroxytoluene	128-37-0
C2 (Rigid White)	2-hydroxyethyl methacrylate	868-77-9	isophorone diisocyanate	4098-71-9	2-hydroxypropyl methacrylate	923-26-2
	3-hydroxypropyl methacrylate	2761-09-3	isobornyl methacrylate	7534-94-3		
C3 (Tough A Grey)	2-hydroxyethyl methacrylate	868-77-9	isophorone diisocyanate	4098-71-9	2-hydroxypropyl methacrylate	923-26-2
C4 (Tough B Grey)	2-hydroxyethyl methacrylate	868-77-9	isophorone diisocyanate	4098-71-9	2-hydroxypropyl methacrylate	923-26-2
	ethylene dimethacrylate	97-90-5				
C5 (Elastic Clear)	4-hydroxybutyl acrylate	2478-10-6	isophorone diisocyanate	4098-71-9		
C8 (Hi temp Clear)	2-hydroxyethyl methacrylate	868-77-9	isophorone diisocyanate	4098-71-9		
C9 (Light Grey)	2-hydroxyethylmethacrylate	868-77-9	isophorone diisocyanate	4098-71-9	ethylene dimethacrylate	97-90-5
	cyclohexyl methacrylate	101-43-9				
C15 (Dark Grey)	2-hydroxypropyl methacrylate	923-26-2	isophorone diisocyanate	4098-71-9	2-hydroxyethyl methacrylate	868-77-9

¹ The instruments and materials are identified in this report to specify the experimental procedure adequately. Such identification is not intended to imply recommendation or endorsement by the Consumer Product Safety Commission, nor is it intended to imply that the materials or equipment identified are necessarily the best available for the purpose.

	ethylene dimethacrylate	97-90-5				
C16 (Black)	3-hydroxypropyl methacrylate	2761-09-3	isophorone diisocyanate	4098-71-9		
C17 (Clear)	2-hydroxypropyl methacrylate	923-26-2	isophorone diisocyanate	4098-71-9	ethylene dimethacrylate	97-90-5
	2-hydroxyethyl methacrylate	868-77-9				
C19 (Rigid Grey)	2-hydroxyethyl methacrylate	868-77-9	diisocyanate isophorone	4098-71-9	2-hydroxypropyl methacrylate	923-26-2
	3-hydroxypropyl methacrylate	2761-09-3	isobornyl methacrylate	7534-94-3		
D1 (Plant based Translucent green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D2 (Plant-based Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D3 (Plant based White)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D4 (Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	trimethylolpropane triacrylate	15625-89-5
D5 (Clear)	4-Acryloylmorpholine	5117-12-4				
E1 (Clear Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E2 (Clear Red)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E3 (Grey)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E4 (Beige)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E5 (Maroon)	4-Acryloylmorpholine	5117-12-4				
E6 (Pure Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E7 (Translucent)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E8 (White)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E9 (Yellow)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E10 (Blue)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E11 (WW Clear Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
E12 (WW Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
E13 (ABS-like Grey)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E14 (ABS-like Clear Blue)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		

E15 (WW Clear Red)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
F1 (Black)	4-Acryloylmorpholine	5117-12-4	2-hydroxyethyl acrylate	818-61-1		
F2 (Gray)	4-Acryloylmorpholine	5117-12-4	2-hydroxyethyl acrylate	818-61-1		
F3 (Hi-Temp Yellow)	4-Acryloylmorpholine	5117-12-4	trimethylolpropane triacrylate	15625-89-5		

Direct Analysis in Real Time Mass Spectrometry (DART-MS)

Qualitative analysis was performed using DART-MS (JEOL JMS-T100LC System) to identify major components in each of the resins and corroborate the results from the GC-MS analysis. Samples were analyzed using helium gas in both the positive and negative ionization mode along with chemical standards. The DART-MS instrument parameters for analysis can be found in **Appendix A**.

Table B-2: DART-MS identification of resin components

Photopolymer Resin	GC-MS Analysis					
	Compound	CAS#	Compound	CAS#	Compound	CAS#
D1 (Plant based Translucent green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D2 (Plant-based Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D3 (Plant based White)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D5 (Clear)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
D4 (Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E1 (Clear Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E2 (Clear Red)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E3 (Grey)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E4 (Beige)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E5 (Maroon)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E6 (Pure Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E7 (Translucent)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E8 (White)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		

E9 (Yellow)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E10 (Blue)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E11 (WW Clear Green)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
E12 (WW Black)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
E13 (ABS-like Grey)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E14 (ABS-like Clear Blue)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5		
E15 (WW Clear Red)	4-Acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5	2-hydroxyethyl acrylate	818-61-1
F1 (Black)	4-Acryloylmorpholine	5117-12-4	2-hydroxyethyl acrylate	818-61-1		
F2 (Gray)	4-Acryloylmorpholine	5117-12-4	2-hydroxyethyl acrylate	818-61-1		
F3 (Hi-Temp Yellow)	4-Acryloylmorpholine	5117-12-4				

Fourier-Transform Infrared Spectroscopy (FTIR)

Additional chemical content identification was performed using a FTIR Spectrometer (Thermo Nicolet 6700 FTIR) with Smart Orbit Diamond Attenuated Total Reflectance (ATR) accessory, DTGS KBr detector, resolution of 4 cm.⁻¹ Resin samples were tested neat. The FTIR spectrum for each resin tested was compared to spectra in the reference search library (HR Aldrich) for best match. In addition, a chemical standard library was built and used as a secondary search library by collecting the FTIR spectrum of the resin chemical standards.

Table B-3: FTIR identification of resins

Photopolymer Resin	FTIR Analysis	
	Compound	CAS#
C1(Rigid Grey)	Diurethane dimethacrylate, mixture of isomers	
C2 (Rigid White)	2-hydroethyl methacrylate, 97%	
C3 (Tough A Grey)	Diurethane dimethacrylate, mixture of isomers	
C4 (Tough B Grey)	Diurethane dimethacrylate, mixture of isomers	
C5 (Elastic Clear)	Isobornyl acrylate	
C8 (Hi temp Clear)	1,6-hexanediol diacrylate, tech, 90%	
C9 (Light Grey)	Bisphenol A ethoxylate (2EO/Phenol) dimethacrylate, average	

C15 (Dark Grey)	Diurethane dimethacrylate, mixture of isomers	
C16 (Black)	Diurethane dimethacrylate, mixture of isomers	72869-86-4
C17 (Clear)	Diurethane dimethacrylate, mixture of isomers	72869-86-4
C19 (Rigid Grey)	Poly(ethylene)glycol methacrylate, average MN CA 360	
D1 (Plant based Translucent green)	tri(propylene glycol) diacrylate	42978-66-5
D2 (Plant-based Black)	tri(propylene glycol) diacrylate	42978-66-5
D3 (Plant based White)	tri(propylene glycol) diacrylate	42978-66-5
D4 (Green)	1,6-hexanediol diacrylate	13048-33-4
D5 (Clear)	tri(propylene glycol) diacrylate	42978-66-5
E1 (Clear Green)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E2 (Clear Red)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E3 (Grey)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E4 (Beige)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E5 (Maroon)	tri(propylene glycol) diacrylate	42978-66-5
E6 (Pure Black)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E7 (Translucent)	tri(propylene glycol) diacrylate	42978-66-5
E8 (White)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	42978-66-5
E9 (Yellow)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E10 (Blue)	Bisphenol A ethoxylate (1 EO/phenol) diacrylate	64401-02-1
E11 (WW Clear Green)	Tetra(ethylene glycol) diacrylate	1783-71-9
E12 (WW Black)	tri(propylene glycol) diacrylate	42978-66-5
E13 (ABS-like Grey)	tri(propylene glycol) diacrylate	42978-66-5
E14 (ABS-like Clear Blue)	tri(propylene glycol) diacrylate	42978-66-5
E15 (WW Clear Red)	tri(propylene glycol) diacrylate	42978-66-5
F1 (Black)	1,6-hexanediol diacrylate	13048-33-4
F2 (Gray)	1,6-hexanediol diacrylate	13048-33-4
F3 (Hi-Temp Yellow)	1,6-hexanediol diacrylate	13048-33-4

Flashpoint

Flashpoint analysis was performed using an Eraflash Automatic Flash Point Tester (Cannon Instruments). Flashpoint testing determines the lowest temperature a chemical can vaporize to form an ignitable mixture in air if an ignition source is provided. Duplicate samples of each liquid resin were tested following ASTM Method D7236-16a Standard

Test Method for Flash Point by Small Scale Closed Cup Tester (Ramp Method). Approximately 2 mL of resin was gradually heated to 212 °F and tested for ignition.

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

Quantitative elemental content in the resins was determined by microwave assisted acid digestion, followed by ICP-OES analysis (Agilent 5100). The method used was adapted from internal CPSC SOP-21-05-00: ICP-OES Elemental Analysis. Approximately 0.2 g of liquid resin was placed into a pre-cleaned Teflon digestion test tube along with 4 mL of trace metal grade nitric acid and 2 mL of trace metal grade hydrochloric acid. The vessels were capped and placed in a microwave (Milestone UltraWAVE). The samples were heated to 240 °C and digested for 10 min under pressure. Samples were cooled, diluted to a final volume of 30 mL, filtered through a 0.45 µm filter, and analyzed by ICP-OES. Duplicate samples of each liquid resin were digested and analyzed.

Note: Elements detected above the detection limit of 1 ppm are highlighted in yellow.

Table B-4: Elemental content of Brand 3 liquid resins by ICP-OES analysis (mg/kg) *

Element	C9 Grey	C16 Black	C17 Clear	C15 Dark Grey	C19 (R-Grey)
Aluminum	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Antimony	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Arsenic	1.0	nd < 1	nd < 1	nd < 1	1.1
Barium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Cadmium	nd < 1	nd < 1	nd < 1	730.2	nd < 1
Calcium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Chromium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Cobalt	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Copper	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Iron	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Lead	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Magnesium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Manganese	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Mercury	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Molybdenum	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Nickel	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Phosphorous ¹	552.6	265.3	444.6	755.9	657.7
Selenium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Tin	22.4	3.3	34.7	33.1	13.1
Titanium	113.6	148.4	3.4	187.9	nd < 1
Vanadium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Zinc	nd < 1	59.1	nd < 1	nd < 1	nd < 1

* n=2 samples for each resin type

†nd= non-detectable

¹ Results were above the calibration curve.

Table B-5: Elemental content Brand 3 liquid resins by ICP-OES analysis (mg/kg) *

Element	C1-R-Grey	C2 R-White	C3 T-Grey	C4 T-Dark Grey	C5 F-Clear	C8 Hi-temp Clear
Aluminum	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Antimony	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Arsenic	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Barium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Cadmium	nd < 1	nd < 1	nd < 1	10.0	nd < 1	159.8
Calcium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Chromium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Cobalt	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Copper	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Iron	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Lead	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	4.4
Magnesium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Manganese	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Mercury	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Molybdenum	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Nickel	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Phosphorous ¹	1146.2	700.5	332.9	236.4	835.3	1123.8
Selenium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Tin	13.0	13.4	19.0	12.3	10.2	5.4
Titanium	87.9	17.1	77.5	46.0	25.2	nd < 1
Vanadium	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1	nd < 1
Zinc	nd < 1	nd < 1	nd < 1	nd < 1	34.1	nd < 1

* n=2 samples for each resin type

†nd= non-detectable

¹ Results were above the calibration curve.

Table B-6: Elemental content of Brand 4 and 6 liquid resins by ICP-OES analysis (mg/kg)

*

Element	F1 Black	F2 Grey	F3 yellow	D1 Translucent Green	D2 Plant Based Black	D3 Plant Based White	D4 Green	D5 Clear
Aluminum	nd<1 †	nd<1	8.65	nd<1	nd<1	9.36	nd<1	nd<1
Antimony	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Arsenic	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Barium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	36.29
Cadmium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Calcium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Chromium	nd<1	nd<1	nd<1	10.00	7.66	7.48	1.96	nd<1
Cobalt	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Copper	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1

Iron	nd<1	nd<1	35.54	nd<1	nd<1	nd<1	nd<1	nd<1
Lead	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Magnesium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Manganese	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Mercury	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Molybdenum	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Nickel	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Phosphorous ¹	330.90	328.40	1099.90	2497.00	3300.80	2433.70	2722.20	4248.00
Selenium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Tin	106.98	105.27	127.45	18.99	17.46	12.01	nd<1	nd<1
Titanium	nd<1	21.43	54.57	nd<1	nd<1	20.26	nd<1	nd<1
Vanadium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Zinc	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1

* n=2 samples for each resin type

†nd= non-detectable

¹ Results were above the calibration curve.

Table B-7: Elemental content of Brand 5 liquid resins by ICP-OES analysis (mg/kg) *

Element	E1 Clear Green	E2 Clear Red	E3 Grey	E4 Skin	E5 Maroon	E6 Pure Black	E7 Translucent
Aluminum	nd<1	nd<1	9.79	10.18	8.75	nd<1	nd<1 †
Antimony	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Arsenic	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Barium	nd<1	nd<1	nd<1	nd<1	36.29	nd<1	nd<1
Cadmium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Calcium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Chromium	1.78	3.55	3.00	nd<1	9.80	nd<1	nd<1
Cobalt	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Copper	nd<1	nd<1	nd<1	nd<1	nd<1	2.14	nd<1
Iron	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Lead	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Magnesium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Manganese	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Mercury	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Molybdenum	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Nickel	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Phosphorous ¹	2651.80	2511.60	4446.60	4317.70	3667.20	3689.90	4257.60
Selenium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Tin	nd<1	nd<1	nd<1	nd<1	4.14	nd<1	nd<1

Titanium	10.45	4.69	4.32	4.09	26.85	nd<1	nd<1
Vanadium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Zinc	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1

* n=2 samples for each resin type

†nd= non-detectable

¹ Results were above the calibration curve.

Table B-8: Elemental content of Brand 5 liquid resins by ICP-OES analysis (mg/kg) *

Element	E8 White	E9 Yellow	E10 Blue	E11 Water Washable Clear Green	E12 Water Washable Black	E13 ABS-Like Grey	E14 ABS-Like Clear Blue	E15 Water Washable Clear Red
Aluminum	15.09	11.74	11.73	nd<1	nd<1	8.01	nd<1	nd<1
Antimony	nd<1	nd<1	nd<1	70.12	35.93	nd<1	nd<1	35.25
Arsenic	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Barium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Cadmium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Calcium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Chromium	nd<1	nd<1	nd<1	2.01	nd<1	11.27	nd<1	4.06
Cobalt	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Copper	nd<1	nd<1	1.44	nd<1	2.72	nd<1	nd<1	nd<1
Iron	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Lead	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Magnesium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Manganese	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Mercury	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Molybdenum	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Nickel	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Phosphorous ¹	4548.20	4542.10	4506.10	2058.30	3154.00	2624.20	4430.30	1978.20
Selenium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Tin	nd<1	nd<1	nd<1	7.59	6.65	22.19	17.07	8.14
Titanium	2.55	3.82	4.31	10.10	nd<1	nd<1	21.27	nd<1
Vanadium	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1
Zinc	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1	nd<1

* n=2 samples for each resin type

†nd= non-detectable

¹ Results were above the calibration curve.

High Definition X-Ray Fluorescence (HDXRF)

Qualitative elemental content in the solidified resins was determined by curing the liquid resins in sunlight, followed by HDXRF (XOS HDPrime) analysis. Approximately 5-10 mL of each liquid resin was poured into borosilicate glass vials, placed in a covered rack, and set outside to harden in sunlight. HDXRF analysis was performed on each of the solidified resins to determine additional elemental content.

Note: Elements detected are highlighted in yellow.

Table B-9: Elemental content of Brand 3 liquid resins by HDXRF analysis (mg/kg)

Element	C1-R-Grey	C2 R-White	C3 T-Grey	C4 T-Dark Grey	C5 F-Clear	C8 Hi-temp Clear
Aluminum	nd<3435	nd<10633	nd<5257	nd<4378	nd<5971	nd<10921
Antimony	13.3 ± 5.9	18.1 ± 5.4	18.4 ± 6.5	11.5 ± 5.3	15.0 ± 5.9	16.9 ± 7.3
Arsenic	nd<0.1	nd<0.3	nd<0.1	nd<0.1	nd<0.1	nd<0.1
Barium	nd<14.4	nd<9.7	nd<15.4	nd<17.5	nd<2.4	nd<2.0
Bismuth	nd<0.1	nd<0.3	nd<0.1	nd<0.1	6.8 ± 0.6	nd<0.2
Bromine	nd<0.1	nd<0.3	nd<0.1	nd<0.1	nd<0.1	nd<0.1
Calcium	nd<9.0	nd<42.6	nd<6.2	nd<11.8	161 ± 27.0	nd<14.0
Cadmium	nd<1.9	nd<1.6	nd<1.7	nd<1.6	nd<1.5	nd<1.7
Cerium	nd<8.8	nd<30.0	nd<7.5	nd<11.0	nd<4.5	nd<7.7
Chlorine	nd<55.2	nd<189	nd<56.9	nd<56.2	nd<44.3	nd<73.9
Chromium	nd<0.9	nd<3.7	nd<1.0	nd<1.1	nd<0.9	nd<1.4
Cobalt	nd<0.4	nd<1.8	nd<0.4	nd<0.6	nd<0.3	nd<0.5
Copper	nd<0.2	nd<0.8	nd<0.2	nd<0.3	nd<0.2	nd<0.4
Gallium	nd<0.2	nd<0.4	nd<0.1	nd<0.1	nd<0.1	nd<0.1
Gold	nd<0.2	nd<0.7	nd<0.1	nd<0.2	nd<0.2	nd<0.2
Hafnium	nd<0.5	nd<1.9	nd<0.6	nd<0.7	nd<0.4	nd<0.7
Indium	nd<2.2	nd<2.4	nd<1.1	nd<1.9	nd<2.0	nd<2.5
Iron	nd<0.7	57.0 ± 8.1	nd<0.8	8.0 ± 1.7	2.1 ± 0.6	nd<0.9
Lanthanum	nd<12.9	nd<34.0	nd<13.9	nd<17.4	nd<5.9	nd<9.7
Lead	nd<0.1	nd<0.3	nd<0.1	nd<0.1	nd<0.1	nd<0.2
Manganese	nd<1.5	nd<5.0	nd<1.5	nd<1.7	1.2 ± 0.7	nd<2.1
Mercury	nd<0.1	nd<0.4	nd<0.1	nd<0.2	nd<0.1	nd<0.2
Nickel	3.1 ± 0.3	nd<4.5	3.4 ± 0.3	nd<1.5	2.2 ± 0.2	nd<1.4
Phosphorus	nd<382	nd<1855	nd<487	nd<470	nd<551	nd<1007
Potassium	nd<9.4	nd<55.5	nd<10.4	nd<14.4	nd<12.0	nd<16.3
Rubidium	0.5 ± 0.2	1.5 ± 0.4	0.4 ± 0.2	0.5 ± 0.2	nd<0.2	nd<0.2
Selenium	nd<0.1	nd<0.3	nd<0.1	nd<0.1	nd<0.1	nd<0.1
Silicon	nd<1515	312767 ± 24180	nd<1014	86205 ± 9419	nd<2828	nd<1407
Silver	nd<1.5	nd<1.3	nd<0.8	nd<1.0	nd<0.9	nd<1.5
Strontium	1.6 ± 0.4	3.8 ± 0.7	1.5 ± 0.4	1.9 ± 0.4	1.1 ± 0.4	1.3 ± 0.5
Sulfur	nd<125	nd<519	nd<119	nd<222	nd<85.5	nd<157
Tantalum	nd<0.5	nd<1.8	nd<0.5	nd<0.7	nd<0.6	nd<0.7
Tin	40.2 ± 8.8	42.2 ± 7.6	52.3 ± 9.6	37.2 ± 8.0	32.8 ± 8.0	22.8 ± 8.7

Titanium	221 ± 21.4	nd<7.7	251 ± 22.8	235 ± 26.0	nd<1.3	nd<1.6
Tungsten	nd<0.5	nd<1.5	nd<0.5	nd<0.5	nd<0.4	nd<0.6
Vanadium	nd<5.0	nd<8.2	nd<5.1	nd<5.9	nd<1.8	nd<4.0
Zinc	nd<0.1	nd<0.8	nd<0.2	nd<0.2	5.2 ± 0.5	nd<0.2

nd= non-detectable

Table B-10: Elemental content of Brand 3 liquid resins by HDXRF analysis (mg/kg)

Element	C9 Grey	C15 Dark Grey	C16 Black	C17 Clear	C19 (R-Grey)
Aluminum	nd<8745	nd<5322	nd<13499	nd<9529	nd<11674
Antimony	14.4 ± 5.7	14.9 ± 5.8	nd<9.0	nd<7.9	22.0 ± 5.8
Arsenic	nd<0.1	nd<0.1	nd<0.2	nd<0.2	nd<0.2
Barium	nd<16.8	nd<20.6	nd<28.8	nd<6.4	nd<9.4
Bismuth	nd<0.1	nd<0.1	14.0 ± 1.8	nd<0.2	nd<0.3
Bromine	nd<0.1	nd<0.1	nd<0.3	nd<0.1	nd<0.2
Calcium	nd<9.8	2432 ± 122	nd<10.6	nd<10.7	nd<35.1
Cadmium	nd<0.9	nd<1.7	nd<4.7	nd<2.6	nd<1.7
Cerium	nd<8.4	nd<9.3	nd<9.9	nd<9.3	nd<26.2
Chlorine	nd<51.0	nd<66.2	nd<100	nd<67.2	nd<174
Chromium	nd<0.9	nd<1.0	nd<2.5	nd<1.5	nd<3.5
Cobalt	nd<0.4	nd<0.4	nd<0.7	nd<0.6	nd<1.8
Copper	nd<0.4	nd<0.2	nd<0.6	nd<0.4	nd<1.1
Gallium	nd<0.1	nd<0.1	nd<0.3	nd<0.3	nd<0.3
Gold	nd<0.2	nd<0.2	nd<0.7	nd<0.4	nd<0.6
Hafnium	nd<0.6	nd<0.5	nd<1.2	nd<0.8	nd<1.9
Indium	nd<2.0	nd<2.0	nd<5.7	nd<3.4	nd<2.1
Iron	nd<0.8	1.1 ± 0.4	nd<1.4	nd<0.8	40.0 ± 6.4
Lanthanum	nd<14.3	nd<15.8	nd<21.1	nd<13.3	nd<35.1
Lead	nd<0.1	nd<0.1	nd<0.3	nd<0.3	nd<0.3
Manganese	nd<1.4	nd<1.6	nd<3.3	2.4 ± 1.1	nd<4.4
Mercury	nd<0.1	nd<0.3	nd<0.4	nd<0.5	nd<0.4
Nickel	2.1 ± 0.2	1.6 ± 0.2	1.4 ± 0.7	4.9 ± 1.1	nd<4.2
Phosphorus	nd<503	nd<521	nd<748	nd<708	nd<1525
Potassium	nd<16.7	nd<12.3	40.0 ± 36.4	nd<17.1	nd<40.3
Rubidium	0.5 ± 0.2	0.5 ± 0.2	nd<0.3	nd<0.2	1.2 ± 0.4
Selenium	nd<0.1	nd<0.1	nd<0.2	nd<0.1	nd<0.2
Silicon	nd<1167	nd<1423	nd<3463	nd<1600	255934 ± 22414
Silver	nd<0.9	nd<1.4	nd<3.9	nd<1.3	nd<1.3
Strontium	1.3 ± 0.4	2.2 ± 0.4	nd<0.4	nd<0.3	3.3 ± 0.6
Sulfur	nd<158	nd<123	6562 ± 1248	4355 ± 854	nd<418
Tantalum	nd<0.5	nd<0.5	nd<1.1	nd<0.6	nd<1.5
Tin	52.1 ± 9.2	82.0 ± 11.1	nd<13.1	91.2 ± 14.7	39.8 ± 7.5
Titanium	264 ± 23.5	442 ± 31.0	306 ± 35.5	nd<2.7	nd<6.7
Tungsten	nd<0.5	nd<0.5	nd<1.1	nd<0.7	nd<1.4

Vanadium	nd<5.2	nd<6.6	nd<8.5	nd<3.9	nd<7.0
Zinc	1.7 ± 0.3	nd<0.2	9.2 ± 1.3	nd<0.3	nd<0.5

nd= non-detectable

Table B-11: Elemental content of Brand 4 and 6 liquid resins by HDXRF analysis (mg/kg)

Element	F1 Black	F2 Grey	F3 yellow	D1 Translucent Green	D2 Plant Based Black	D3 Plant Based White	D4 Green	D5 Clear
Aluminum	nd<13084	nd<15835	nd<12255	nd<17229	nd<9247	nd<12982	nd<12559	nd<13539
Antimony	28.9 ± 11.8	26.7 ± 11.4	33.8 ± 12.7	20.1 ± 11.1	19.7 ± 11.4	nd<8.5	28.1 ± 12.5	nd<8.0
Arsenic	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.3	nd<0.2
Barium	nd<5.2	nd<23.8	nd<39.6	nd<9.2	nd<6.1	nd< 44.1	nd<9.7	nd<5.7
Bismuth	nd<0.4	nd<0.3	nd<0.3	nd<0.2	nd<0.2	nd<0.3	nd<0.4	nd<0.2
Bromine	nd<0.2	nd<0.2	8.7 ± 0.7	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.1
Calcium	44.5 ± 25.1	nd<23.0	nd<22.5	nd< 4.5	nd<9.3	nd<15.1	nd<9.3	nd<8.8
Cadmium	nd<3.6	nd<3.2	nd<3.5	nd<3.3	nd<2.8	nd<2.9	nd<1.8	nd<1.5
Cerium	nd<14.2	nd<16.0	nd<16.3	nd<14.6	nd<9.4	nd<17.6	nd<13.3	nd< 5.2
Chlorine	nd<95.5	nd<97.9	nd<98.3	nd<103	nd<89.3	nd<125	nd< 83	1236 ± 348
Chromium	nd<2.7	nd<2.6	nd<2.8	18.5 ± 5.4	9.9 ± 3.4	13.4 ± 4.9	nd<2.5	nd<2.3
Cobalt	nd<0.8	nd<0.8	nd<1.4	nd<0.8	nd<0.5	nd<0.8	nd<0.8	nd<0.8
Copper	nd<0.4	nd<0.4	nd<0.4	3.4 ± 1.0	2.5 ± 0.7	nd<0.6	3.5 ± 1.0	nd<0.6
Gallium	nd<0.2	nd<0.2	nd<0.3	nd<0.2	nd<0.2	ND 0.2	nd<0.2	nd<0.2
Gold	1.6 ± 0.7	nd<0.5	1.9 ± 0.7	1.2 ± 0.6	1.2 ± 0.5	1.8 ± 0.7	nd<0.5	1.6 ± 0.7
Hafnium	nd<1.2	nd<1.2	nd<1.1	nd<1.3	nd<1.0	nd<1.2	nd<1.2	nd<1.2
Indium	nd<4.1	nd< 3.7	nd<3.9	nd<3.5	nd<2.3	nd<3.7	nd<3.9	nd<3.4
Iron	nd<1.7	nd< 1.2	72.6 ± 6.3	nd<1.7	nd<1.1	nd<0.7	nd<1.1	nd<1.8
Lanthanum	nd<17.6	nd< 20.6	nd<35.2	nd<17.8	nd<11.4	nd<35.6	nd<17.0	nd<19.5
Lead	nd<0.3	nd< 0.3	nd<0.2	nd<0.3	nd<0.3	nd<0.3	0.9 ± 0.7	0.4 ± 0.3
Manganese	4.4 ± 1.9	nd< 3.3	nd<3.3	nd<3.3	nd<2.1	nd<3.3	4.8 ± 2.0	nd<3.3
Mercury	nd<0.3	nd< 0.3	nd<1.4	nd<0.6	nd<0.2	nd<0.3	nd<0.3	nd<0.3
Nickel	10.3 ± 1.7	10.2 ± 1.7	6.4 ± 1.5	9.6 ± 1.6	6.8 ± 1.2	9.2 ± 1.7	8.2 ± 1.6	9.7 ± 1.7
Phosphorus	nd<596	nd< 632	nd<1181	nd<1409	nd<1026	nd<1566	nd< 372	nd<1916
Potassium	50.4 ± 40.4	37.1 ± 37.1	51.9 ± 41.7	nd<19.3	nd<14.2	nd<24.8	nd<20.1	nd<18.1
Rubidium	nd<0.3	nd< 0.3	nd<0.3	nd<0.2	nd<0.2	nd<0.3	nd<0.3	nd<0.3
Selenium	nd<0.2	nd< 0.1	nd<0.2	nd<0.1	nd<0.1	nd<0.2	nd<0.2	nd<0.2
Silicon	nd<1946	nd< 2884	nd<2398	nd<2885	nd<1943	nd<2661	nd<2734	nd<2466
Silver	nd<2.6	nd< 2.4	nd<2.6	nd<2.5	nd<2.6	nd<1.4	nd<2.8	nd<1.3
Strontium	1.2 ± 0.5	1.2 ± 0.5	0.8 ± 0.5	0.8 ± 0.4	0.9 ± 0.4	1.1 ± 0.5	1.2 ± 0.5	1.0 ± 0.5
Sulfur	6512 ± 1238	7250 ± 1302	6778 ± 1265	nd<872	4701 ± 886	6794 ± 1260	6611 ± 1239	6217 ± 1221
Tantalum	nd<1.1	nd< 1.1	nd<0.7	nd< 1.1	nd<0.8	nd<1.1	nd<1.0	nd<0.7
Tin	302 ± 24.9	290 ± 23.9	329 ± 26.8	40.1 ± 10.9	38.6 ± 11.1	42.2 ± 11.5	21.2 ± 9.4	17.8 ± 8.3

Titanium	nd<3.2	116 ± 21.8	824 ± 57.3	nd<4.0	nd<2.8	1068 ± 64.6	nd<4.6	nd<3.1
Tungsten	nd<0.7	nd<0.7	nd<0.6	nd<0.6	nd<0.5	nd<1.0	nd<1.0	nd<0.7
Vanadium	nd<5.9	nd<6.4	nd<12.1	nd<5.9	nd<3.9	nd<13.0	nd<4.9	nd<5.4
Zinc	4.4 ± 0.7	nd<0.4	nd<0.4	nd<0.4	nd<0.3	nd<0.5	nd<0.4	nd<0.4

nd= non-detectable

Table B-12: Elemental content of Brand 5 liquid resins by HDXRF analysis (mg/kg)

Element	E1 Clear Green	E2 Clear Red	E3 Grey	E4 Skin	E5 Maroon	E6 Pure Black	E7 Translucent
Aluminum	nd<13609	nd<11825	nd<13244	nd<14152	nd<17319	nd<14667	nd<13426
Antimony	30.5 ± 12.2	20.8 ± 12.4	26.8 ± 12.4	27.0 ± 11.7	22.4 ± 11.7	23.9 ± 12.5	33.2 ± 13.0
Arsenic	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.2
Barium	nd<9.1	nd<9.1	nd<44.0	nd<46.2	nd<474	nd<9.3	nd<10.3
Bismuth	nd<0.2	nd<0.3	nd<0.2	nd<0.4	nd<0.4	nd<0.4	nd<0.4
Bromine	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.1
Calcium	nd<9.6	nd<9.1	nd<15.9	nd<14.7	377 ± 64.5	nd<17.7	15.9 ± 15.9
Cadmium	nd<2.8	nd<1.9	nd<3.1	nd<3.0	nd< 2.0	nd<1.7	nd<3.4
Cerium	nd<12.6	nd<12.4	nd<18.0	nd<17.7	nd< 9.2	nd<12.9	nd<14.0
Chlorine	nd<182	nd<165	nd<190	nd<169	nd<256	nd<186	1173 ± 339
Chromium	nd<2.8	nd<3.1	nd<3.0	nd<0.3	15.2 ± 5.4	nd<2.1	nd<2.2
Cobalt	nd<0.7	nd<0.7	nd<0.8	nd<0.8	nd<0.8	nd<1.1	nd<0.8
Copper	3.1 ± 0.9	nd<0.5	nd<0.4	nd<0.5	nd<0.4	4.9 ± 1.1	nd<0.6
Gallium	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.3	nd<0.2	nd<0.3
Gold	1.4 ± 0.6	nd<0.5	nd<0.5	nd<0.5	1.1 ± 0.6	1.2 ± 0.6	nd<0.5
Hafnium	nd<1.2	nd<1.0	nd<1.1	nd<1.1	nd<1.2	nd<1.3	nd<1.2
Indium	nd<3.7	nd<2.3	nd<4.2	nd<2.3	nd<4.1	nd<2.1	nd<4.4
Iron	nd<1.0	nd<1.0	nd<1.7	nd<1.1	nd<1.9	nd<1.6	nd<1.1
Lanthanum	nd<17.2	nd<15.6	nd<33.4	nd<38.0	nd<37.1	nd<18.5	nd<17.9
Lead	nd<0.4	nd<0.6	0.8 ± 0.7	0.6 ± 0.4	0.5 ± 0.4	nd<0.4	0.6 ± 0.4
Manganese	3.4 ± 1.5	4.3 ± 1.9	nd<202	3.8 ± 1.7	nd<3.6	nd<3.1	nd<3.3
Mercury	nd<0.3	nd<0.6	nd<0.4	nd<0.3	nd<0.3	nd<0.3	nd<0.4
Nickel	7.1 ± 1.4	3.3 ± 1.1	9.2 ± 1.6	9.2 ± 1.6	10.5 ± 1.8	9.2 ± 1.6	10.2 ± 1.7
Phosphorus	nd<1536	nd<1294	nd<1976	nd<2038	nd<1779	nd<1820	nd<1934
Potassium	nd<19.9	nd<19.5	nd<21.5	nd<20.1	332 ± 85.3	nd<23.7	35.1 ± 35.1
Rubidium	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3
Selenium	nd<0.2	nd<0.1	nd<0.2	nd<0.2	nd<0.2	nd<0.2	nd<0.2
Silicon	nd<2146	nd<1864	nd<4990	nd<3953	nd<6918	nd<3827	nd<2867
Silver	nd<2.5	nd<2.0	nd<2.4	nd<2.4	nd<1.1	nd<1.5	nd<2.6
Strontium	1.0 ± 0.5	nd<0.4	1.0 ± 0.5	1.1 ± 0.5	1.6 ± 0.5	1.0 ± 0.5	1.1 ± 0.5
Sulfur	nd<740	nd<742	nd<773	nd<840	7535 ± 1333	7452 ± 1312	7444 ± 1318

Tantalum	nd<1.0	nd<0.7	nd<1.1	nd<1.0	nd<1.1	nd<1.0	nd<1.1
Tin	15.2 ± 8.1	nd<7.1	15.1 ± 8.3	16.3 ± 8.2	18.3 ± 8.7	nd<8.1	23.0 ± 9.7
Titanium	nd<4.6	nd<4.5	1126 ± 65.3	1084 ± 64.2	1125 ± 68.8	nd<5.0	nd<4.6
Tungsten	nd<0.5	nd<0.5	nd<0.9	nd<1.0	nd<0.6	nd<0.6	nd<1.0
Vanadium	nd<5.5	nd<5.8	nd<13.1	nd<13.1	nd<15.2	nd<5.4	nd<6.1
Zinc	nd<0.4	nd<0.4	nd<0.4	nd<0.4	nd<0.5	nd<0.5	nd<0.4

nd= non-detectable

Table B-13: Elemental content of Brand 5 liquid resins by HDXRF analysis (mg/kg)

Element	E8 White	E9 Yellow	E10 Blue	E11 Water Washable Clear Green	E12 Water Washable Black	E13 ABS-Like Grey	E14 ABS-Like Clear Blue	E15 Water Washable Clear Red
Aluminum	nd<13957	nd<15061	nd<15158	nd<13086	nd<13163	nd<14504	nd<16059	nd<15113
Antimony	23.8 ± 11.5	nd<8.6	nd<8.4	102 ± 16.4	46.3 ± 12.9	24.7 ± 11.2	31 ± 12	45.2 ± 13.6
Arsenic	nd<0.2	nd<0.3	nd< 0.2	nd<0.3	nd<0.2	nd<0.2	nd<0.2	nd<0.2
Barium	nd< 7.2	nd<45.1	nd<46.5	nd<5.4	nd<9.7	nd<42.3	13.0 ± 13.0	nd<4.4
Bismuth	nd<0.4	nd<0.3	nd<0.4	nd<0.3	nd<0.2	nd<0.2	nd<0.3	nd<0.2
Bromine	nd<0.2	nd<0.1	nd<0.2	nd<0.2	nd<0.3	nd<0.1	nd<0.2	nd<0.2
Calcium	nd<19.9	nd<14.6	nd<14.8	22.1 ± 19.7	nd<16.9	87.7 ± 32.4	nd<18.8	nd<14.6
Cadmium	nd<2.8	nd<1.6	nd<3.0	nd<3.1	nd<3.3	nd<2.9	nd<3.1	nd<1.7
Cerium	nd<17.9	nd<16.0	nd<18.8	nd<14.4	nd<14.1	nd<18.7	nd<13.9	nd<13.3
Chlorine	nd<183	nd<183	nd<189	1654 ± 394	749 ± 276	nd<142	nd<128	696 ± 274
Chromium	nd<2.3	nd<1.3	nd<2.4	nd<2.9	nd<0.3	19.6 ± 5.6	nd<2.4	nd<3.2
Cobalt	nd<0.8	nd<0.7	nd<1.2	nd<0.8	nd<0.7	nd<0.8	nd<0.8	nd<0.7
Copper	nd<0.6	nd<0.5	4.7 ± 1.1	2.7 ± 1.0	7.3 ± 1.2	nd<0.6	1.4 ± 0.8	nd<0.4
Gallium	nd<0.2	nd<0.3	nd<0.2	nd<0.2	nd<0.2	nd<0.3	nd<0.2	nd<0.2
Gold	1.8 ± 0.7	nd<0.5	1.6 ± 0.7	nd<0.5	1.2 ± 0.6	1.4 ± 0.6	1.3 ± 0.6	nd<0.5
Hafnium	nd<1.2	nd<1.1	nd<1.3	nd<1.2	nd<1.3	nd<1.2	nd<1.2	nd<1.1
Indium	nd<3.6	nd<2.3	nd<3.9	nd<4.1	nd<2.2	nd<3.4	nd<2.3	nd<3.7
Iron	nd<2.0	nd<1.6	nd<1.8	nd<1.8	nd<1.7	nd< 1.1	nd< 1.2	nd<1.1
Lanthanum	nd<39.6	nd<33.5	nd<37.9	nd<18.2	nd<18.5	nd<32.7	nd<18.0	nd<17.8
Lead	nd<0.6	nd<0.4	0.6 ± 0.4	0.7 ± 0.4	nd<0.3	0.4 ± 0.3	nd<0.3	nd<0.3
Manganese	nd<3.3	nd<3.1	nd<3.3	nd<3.2	nd<2.9	nd<3.3	nd<3.2	nd<3.4
Mercury	nd<0.3	nd<0.5	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3
Nickel	10.4 ± 1.8	4.5 ± 1.2	9.7 ± 1.7	10.4 ± 1.7	8.3 ± 1.6	8.9 ± 1.6	10.1 ± 1.7	3.7 ± 1.2
Phosphorus	nd<1742	nd<2072	nd<1461	nd<1372	nd<1442	nd<1327	nd<1832	nd<1196
Potassium	nd<15.5	nd< 2.7	nd<23.2	62.8 ± 42.8	34.3 ± 34.3	nd<37.8	nd<22.5	53.9 ± 41.1
Rubidium	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3	nd<0.3
Selenium	nd<0.2	nd<0.1	nd<0.2	nd<0.2	nd<0.1	nd<0.1	nd<0.2	nd<0.2
Silicon	nd<3801	nd<4267	nd<3652	nd<2462	nd<4149	nd<4862	nd<2439	nd<2384
Silver	nd<2.3	nd<1.5	nd<2.5	nd<2.7	nd<1.3	nd<2.2	nd<2.5	nd<2.6

Strontium	1.0 ± 0.5	nd<0.4	0.8 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	nd<0.4	0.9 ± 0.5	nd<0.4
Sulfur	7629 ± 1337	nd<873	6505 ± 1240	6571 ± 1250	nd<814	nd<824	6797 ± 1257	6430 ± 1234
Tantalum	nd<1.0	nd<0.7	nd<1.1	nd<1.0	nd<1.0	nd<1.1	nd<1.0	nd<0.7
Tin	nd<7.2	nd<7.4	nd<7.3	40.4 ± 11.6	29.9 ± 10.1	55.5 ± 12.1	60.4 ± 12.9	21.4 ± 9.4
Titanium	1161 ± 67.8	1120 ± 65.4	1056 ± 64.5	nd<3.1	nd<4.5	771 ± 54.1	nd<5.0	nd<3.5
Tungsten	nd<0.6	nd<0.9	nd<0.6	nd<0.6	nd<0.6	nd<0.6	nd<0.7	nd<0.6
Vanadium	nd<13.1	nd<12.9	nd<13.1	nd<5.0	nd<5.0	nd<11.4	nd<5.5	nd<5.5
Zinc	nd<0.4	nd<0.3	nd<0.4	nd<0.4	nd<0.5	nd<0.4	nd<0.3	nd<0.4

nd= non-detectable

Volatile Organic Compounds (VOCs) Analysis via Headspace GC-MS (HS-GC-MS)

Qualitative analysis was performed using HS-GC-MS (Agilent 7697HS/7890GC/5977MS) to target and identify VOC content in each of the resins. Duplicate samples of each liquid resin were diluted (1 mL of resin in 9 mL water) in a 20 mL headspace vial, sealed and analyzed on the HS-GC-MS. An EPA VOC mix standard (EPA 502/524.2 VOC Mix, Sigma Aldrich) containing VOC analytes (200 µg/mL each) was purchased and analyzed in conjunction with the resin samples. Ten milliliters of deionized water was added to a 20 mL headspace vial, sealed, and spiked with the VOC mix standards at a concentration of 1 µg/mL. Analysis of the VOC mix standard was used to confirm identification of VOCs in the resins by both retention time and mass spectrum match using a NIST MS library search. In addition, resin samples from each of the four brands (Brand 3, 4, 5 and 6) were spiked with the VOC mix standard at a concentration of 2 µg/mL and analyzed via HS-GC-MS. Detailed HS-GC-MS instrument parameters for analysis can be found in **Appendix A**. Samples were analyzed at a temperature of 75 °C to maximize the release of any potential VOC's. Typically, vat polymerization 3D printers operate at room temperature.

Note: VOCS detected are highlighted in yellow.

Table B-14: VOC Analysis of select Brand 3,4 and 6 liquid resins by HS-GC-MS

Analyte	CAS #	F1 Black	F2 Grey	F3 yellow	D1 Translucent Green	D2 Plant Based Black	D3 Plant Based White	D4 Green	D5 Clear	C1-R-Grey
Benzene	71-43-2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Bromobenzene	108-86-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Butylbenzene	104-51-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
sec-Butylbenzene	135-98-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
tert-Butylbenzene	98-06-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
2-Chlorotoluene	95-49-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
4-Chlorotoluene	106-43-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dibromo-3-chloropropane	96-12-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dichlorobenzene	95-50-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,3-Dichlorobenzene	541-73-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2

1,4-Dichlorobenzene	106-46-7	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Ethylbenzene	100-41-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Hexachloro-1,3-butadiene	87-68-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Naphthalene	91-20-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Propyl benzene	103-65-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,1,2,2-Tetrachloroethane	100-42-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Tetrachloroethylene	79-34-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Toluene	127-18-4	<2	<2	<2	<2	<2	<2	<2	<2	<2
1,2,3-Trichlorobenzene	108-88-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Trichloroethylene	87-61-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,3-Trichloropropane	79-01-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trimethylbenzene	96-63-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trichlorobenzene	120-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Cumene	98-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
o-Xylene	95-47-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	<2	nd<2	nd<2
1,3,5-Trimethylbenzene solution	526-73-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
m-Xylene	108-38-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	<2	nd<2	nd<2
p-Cymene	99-87-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
p-Xylene	106-42-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	<2	nd<2	nd<2

nd= non-detectable

Table B-15: VOC Analysis of Brand 5 liquid resins by HS-GC-MS

Analyte	CAS #	E1 Clear Green	E2 Clear Red	E3 Grey	E4 Skin	E5 Maroon	E6 Pure Black	E7 Translucent
Benzene	71-43-2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Bromobenzene	108-86-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Butylbenzene	104-51-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
sec-Butylbenzene	135-98-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
tert-Butylbenzene	98-06-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
2-Chlorotoluene	95-49-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
4-Chlorotoluene	106-43-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dibromo-3-chloropropane	96-12-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dichlorobenzene	95-50-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,3-Dichlorobenzene	541-73-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,4-Dichlorobenzene	106-46-7	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Ethylbenzene	100-41-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Hexachloro-1,3-butadiene	87-68-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Naphthalene	91-20-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Propyl benzene	103-65-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,1,2,2-Tetrachloroethane	100-42-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Tetrachloroethylene	79-34-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Toluene	127-18-4	<2	<2	<2	<2	<2	<2	<2

1,2,3-Trichlorobenzene	108-88-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Trichloroethylene	87-61-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,3-Trichloropropane	79-01-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trimethylbenzene	96-63-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trichlorobenzene	120-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Cumene	98-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
o-Xylene	95-47-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,3,5-Trimethylbenzene solution	526-73-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
m-Xylene	108-38-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
p-Cymene	99-87-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
p-Xylene	106-42-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2

nd= non-detectable

Table B-16: VOC Analysis of Brand 5 liquid resins by HS-GC-MS (µg/mL)

Analyte	CAS #	E8 White	E9 Yellow	E10 Blue	E11 Water Washable Clear Green	E12 Water Washable Black	E13 ABS-Like Grey	E14 ABS-Like Clear Blue	E15 Water Washable Clear Red
Benzene	71-43-2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Bromobenzene	108-86-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Butylbenzene	104-51-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
sec-Butylbenzene	135-98-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
tert-Butylbenzene	98-06-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
2-Chlorotoluene	95-49-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
4-Chlorotoluene	106-43-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dibromo-3-chloropropane	96-12-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2-Dichlorobenzene	95-50-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,3-Dichlorobenzene	541-73-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,4-Dichlorobenzene	106-46-7	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Ethylbenzene	100-41-4	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Hexachloro-1,3-butadiene	87-68-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Naphthalene	91-20-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Propyl benzene	103-65-1	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,1,2,2-Tetrachloroethane	100-42-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Tetrachloroethylene	79-34-5	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Toluene	127-18-4	<2	<2	<2	<2	<2	<2	<2	<2
1,2,3-Trichlorobenzene	108-88-3	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Trichloroethylene	87-61-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,3-Trichloropropane	79-01-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trimethylbenzene	96-63-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
1,2,4-Trichlorobenzene	120-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
Cumene	98-82-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
o-Xylene	95-47-6	nd<2	<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2

1,3,5-Trimethylbenzene solution	526-73-8	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
m-Xylene	108-38-3	nd<2	<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
p-Cymene	99-87-6	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2
p-Xylene	106-42-3	nd<2	<2	nd<2	nd<2	nd<2	nd<2	nd<2	nd<2

nd= non-detectable

3D Printed Products

Gas Chromatography-Mass Spectrometry (GC-MS)

Qualitative analysis was performed using GC-MS (Agilent 5977MS/7890GC) to identify extractable components in each of the printed products. Extractable testing was performed on each of the 3D printed products produced from the five different printer manufacturers: Printer A, Printer B, Printer C, Printer D, and Printer E. Extraction was accomplished by adding approximately 0.5 g of printed material to an appropriate extraction vial with 5 mL of isopropyl alcohol (IPA) and placed in a sonicator at room temperature for 30 minutes followed by analysis using the GC-MS. Identification of extractable components was confirmed by mass spectrum match using a NIST MS library search. The GC-MS instrument parameters for analysis can be found in **Appendix A**.

Table B-17: GC-MS IPA extraction analysis for Printer A printed products

Sample	Compound	CAS
A1 white	Not identified*	
A2 white	Not identified*	
A3 yellow	Not identified*	
A4 black	Not identified*	
A5 grey	Not identified*	
A6 red	L-Lactide	4511-42-6
A7 blue	Not identified*	
A8 clear	L-Lactide	4511-42-6
A9 green	Not identified*	
A10 pink	Not identified*	
A11 orange	L-Lactide	4511-42-6
A12 black	L-Lactide	4511-42-6
A13 green	Not identified*	
A14 red	Not identified*	
A15 white	Not identified*	
A16 blue	Not identified*	
A17 green	Not identified*	
A18 black	Not identified*	
A19 grey	Not identified*	
A20 yellow	Not identified*	
A21 white	Not identified*	
A22 red	Not identified*	

A23 orange	Not identified*	
A24 grey	Not identified*	
A25 bronze	Not identified*	
A27 clear	Not identified*	
A28 clear	Not identified*	
A29 black	caprolactam	105-60-2
A30 red	Not identified*	
A31 green	Not identified*	
A32 blue	Not identified*	
A33 yellow	Not identified*	
A34 grey	Not identified*	
A35 white	Not identified*	
A36 grey	Not identified*	
A37 white	Not identified*	
A38 black	Not identified*	
A39 black	2(3H)-furanone	20825-71-2
A40 white	adipic acid, di(trans-hex-3-enyl) ester	NIST 354023
	Lys-Ala	NIST 1087347
A41 red	Lys-Ala	NIST 1087347
A42 blue	Not identified*	
A43 black	Not identified*	
A44 white	Not identified*	
A45 clear	Not identified*	

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-18: GC-MS IPA extraction analysis for Printer B printed products

Sample	Compound	CAS
B1 red	L-Lactide	4511-42-6
B2 orange	Not identified*	
B3 blue	Not identified*	
B4 black	Not identified*	
B5 purple	Not identified*	
B6 yellow	Not identified*	
B7 green	Not identified*	
B8 white	Not identified*	
B9 off-white	Not identified*	
B10 grey	Not identified*	
B11 clear	Not identified*	
B12 white	Not identified*	
B13 black	Not identified*	
B14 orange	Not identified*	
B15 black	Not identified*	

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-19: GC-MS IPA extraction analysis for Printer C printed products

Sample	Compound	CAS	Compound	CAS
C1 grey	isoterpinolene	568-63-0	isophorone diisocyanate	4098-71-9
	trifluoroacetic acid	76-05-1		
C2 white	isoterpinolene	568-63-0	S-lactoylglutathione	25138-66-3
C3 grey	D-cycloserine	68-41-7	isophorone diisocyanate	4098-71-9
C4 grey	Not identified*			

C5 clear	5-ethyl-1,3-dioxane-5-methanol	5187-23-5	3-formyl-7-methoxychromone	42059-56-3
	3-chloropropionic acid, 3-chloroprop-2-enyl ester	NIST 299221		
C6 purple	isophorone diisocyanate	4098-71-9	hexaethylene glycol	2615-15-8
C7 brown	dimethyl sulfite	616-42-2	hexaethylene glycol	2615-15-8
C8 clear	Not identified*			
C9 grey	Not identified*			
C10 white	Not identified*			
C11 grey	5-ethyl-1,3-dioxane-5-methanol	5187-23-5	2-hydroxyethyl acrylate	818-61-1
	isophorone diisocyanate	4098-71-9	1-hydroxycyclohexyl phenyl ketone	947-19-3
	8-methoxycoumarin-3-carboxylic acid	2555-20-6		
C12 blue	5-ethyl-4-methyl-3-heptanone	27607-63-2	2,6-di-tert-butyl-4-methoxyphenol	489-01-0
	isophorone diisocyanate	4098-71-9	1-hydroxycyclohexyl phenyl ketone	947-19-3
C14 white	isophorone diisocyanate	4098-71-9		
C15 grey	2-methyl-1,4-butanediol	2938-98-9	DL-3,4-dihydroxymandelic acid	14883-87-5
	isophorone diisocyanate	4098-71-9	1-hydroxycyclohexyl phenyl ketone	947-19-3
	DL-mevalolactone	674-26-0		
C16 black	isophorone diisocyanate	4098-71-9	oleoyl serotonin	1002100-44-8
	citraconic acid	498-23-7		
C17 clear	isophorone diisocyanate	4098-71-9	DL-mevalolactone	674-26-0

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-20: GC-MS IPA extraction analysis for Printer D printed products

Sample	Compound
D1 green	Not identified*
D2 black	Not identified*
D3 white	Not identified*
	Not identified*
D4 green	Not identified*
D5 clear	Not identified*

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-21 : GC-MS IPA extraction analysis for Printer E printed products

Sample	Compound	CAS	Compound	CAS
E1 green	Not identified*			
E2 red	Not identified*			
E3 grey	Not identified*			
E4 flesh	Not identified*			
E5 red	4-acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5
E6 black	4-acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5
E7 clear	Not identified*			
E8 white	Not identified*			
E9 yellow	Not identified*			

E10 blue	Not identified*		
E11 green	4-acryloylmorpholine	5117-12-4	
E12 black	Not identified*		
E13 grey	4-acryloylmorpholine	5117-12-4	
E14 blue	Not identified*		

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Note: A library match (in percent) is given for each compound, indicating how consistent the unknown samples compare to known standards. For certain compounds, the library match was found to be too low, and therefore, misleading. The identifications from the NIST library are only intended as a guide and should be used as a basis for decision of whether additional verification of the compounds against relevant reference standards should be carried out.

Pyrolysis Gas Chromatography/Mass Spectrometry (Pyr-GC–MS)

Qualitative analysis was performed using Pyr-GC–MS (CDS Pyroprobe 6200 Pyrolyzer, Agilent 5977MS/7890GC) to identify the thermal composition of the printed materials. Pyr-GC–MS was used to characterize the polymer matrices of multiple 3D printed products produced from the five different printer manufacturers: Printer A, Printer B, Printer C, Printer D, and Printer E. A small piece was cut from the 3D printed material and analyzed neat (“as is”) using the pyrolyzer, followed by analysis using the GC-MS. The pyrolyzates (smaller molecules), derived from the decomposition of the printed material, were identified by mass spectrum using a NIST MS library. The Pyr-GC–MS instrument parameters for analysis are found in **Appendix A**.

Table B-22: Pyr-GC-MS polymer identification of 3D printed materials (solid filaments)

Solid Filament	Pyr-GC–MS Analysis					
	Compound	CAS#	Compound	CAS#	Compound	CAS#
Printer A PLA material (Various colors)	Acetaldehyde	75-07-0	Acetic acid	64-19-7	2,3-pentanedione	600-14-6
	Acrylic acid	79-10-7	1,4-dioxane-2,5-dione,3,6-dimethyl (meso and DL)	4511-42-6		
Printer A Tough PLA material (Various colors)	Acetaldehyde	75-07-0	Acetic acid	64-19-7	2,3-pentanedione	600-14-6
	Acrylic acid	79-10-7	1,4-dioxane-2,5-dione,3,6-dimethyl (meso and DL)	4511-42-6	Methyl methacrylate	80-62-6
Printer A ABS material (Various colors)	Styrene	100-42-5	p-ethyl-phenol	123-07-9	Styrene dimer	n/a
	Hybrid trimers	n/a				
Printer A Nylon material (Transparent, black)	Caprolactam	105-60-2				
Printer A TPU95A material (Various colors)	Cyclopentanone	120-92-3	1,4-butanediol	110-63-4		

Printer A PC material (Various colors)	Phenol	108-95-2	p-cresol	106-44-5	p-ethyl-phenol	123-07-9
Printer B PLA material (Various colors)	Acetaldehyde	75-07-0	Acetic acid	64-19-7	2,3-pentanedione	600-14-6
	Acrylic acid	79-10-7	1,4-dioxane-2,5-dione,3,6-dimethyl (meso and DL)	4511-42-6		
Printer B Tough PLA material (Various colors)	Acetaldehyde	75-07-0	Acetic acid	64-19-7	2,3-pentanedione	600-14-6
	Acrylic acid	79-10-7	1,4-dioxane-2,5-dione,3,6-dimethyl (meso and DL)	4511-42-6	Methyl methacrylate	80-62-6

Table B-23: Pyr-GC-MS thermal composition of 3D printed materials (liquid resin)

Liquid Resin	Pyr-GC-MS Analysis								
	Compound	CAS#	Library match %	Compound	CAS#	Library match %	Compound	CAS#	Library match %
Printer C (Rigid)	Bisphenol A	80-05-7	90.6	Isophorone diisocyanate (2 peaks)	4098-71-9	91.5	Ethylene glycol dimethacrylate	97-90-5	86.6
	2-Hydroxyethyl methacrylate	868-77-9	62.3	2-Hydroxypropyl methacrylate	923-26-2	75.4	Iso-Bornyl methacrylate	7534-94-3	42.9
	Camphene	79-92-5	44.2	4-Amino-1-butanol	13325-10-5	59.8	Bisphenol A, TBDMS derivative	n/a	41.9
Printer C (Model, Brown)	Bisphenol A	80-05-7	90.6	Isophorone diisocyanate (2 peaks)	4098-71-9	88.9	Ethylene glycol dimethacrylate	97-90-5	93.5
	2-ethyl-cycloheptanone	3183-41-3	7.42	2-Hydroxypropyl methacrylate	923-26-2	75.7			
Printer D (Plant-based) (Various colors)	Bisphenol A	80-05-7	76.5	Cyclopropyl carbinol	2516-33-8	50.8	N-Acryloylmorpholine	5117-12-4	94.6
	2,4,6-trimethyl benzoic acid	480-63-7	72.3	Allyl isovalerate	2835-39-4	18.2	1,2,3-trimethyl benzene	526-73-8	18.8
Printer D (Basic) (Various colors)	Bisphenol A	80-05-7	76.5	Cyclopropyl carbinol	2516-33-8	50.8	N-Acryloylmorpholine	5117-12-4	94.6
	2,4,6-trimethyl benzoic acid	480-63-7	72.3	Allyl isovalerate	2835-39-4	18.2	1,2,3-trimethyl benzene	526-73-8	18.8
Printer E (Standard) (Various colors)	Bisphenol A	80-05-7	93.5	Phenol	108-95-2	75.3	N-Acryloylmorpholine	5117-12-4	94.1
	Allyl isovalerate	2835-39-4	21.0	2-methyl phenol	95-48-7	32.9	2,4,6-trimethyl benzoic acid	480-63-7	58.0
	p-isopropynylphenol	4286-23-1	28.3	Mesitylene	108-67-8	20.7	p-Cumenol	99-89-8	21.1

	Bisphenol A, TBDMS derivative	n/a	33.3	4-benzyloxy-4-(2,2-dimethyl-4-dioxolanyl)-butylaldehyde	149180-87-0	72.7			
Printer E (ABS-like) (Grey, clear blue)	Bisphenol A	80-05-7	30.3	Pentanal	110-62-3	21.3	N-Acryloylmorpholine	5117-12-4	85.0
	Allyl isovalerate	2835-39-4	20.6	2,4,6-trimethyl benzoic acid	480-63-7	76.4	4-acetyl-morpholine	1696-20-4	82.9

Headspace GC-MS (HS-GC-MS)

Qualitative analysis was performed using HS-GC-MS (Agilent 7697HS/7890GC/5977MS) to identify VOC content emitted from the 3D printed products. A sample of each printed material was tested neat (“as is”) and a sample of reach was tested in water (0.5 g of material in 10 mL water). In both cases, a 20 mL headspace vial was used, sealed, and analyzed on the HS-GC-MS. The HS-GC-MS instrument parameters for analysis are found in **Appendix A**.

Table B-24: HS-GC-MS analysis for neat Printer A printed products

Sample	Compound	CAS	Compound	CAS
A1 white	Not identified*			
A2 white	2-hydroxychalcone	644-78-0		
A3 yellow	Not identified*			
A4 black	Not identified*			
A5 grey	decamethylcyclotetrasiloxane	541-02-6		
A6 red	Not identified*			
A7 blue	decamethylcyclotetrasiloxane	541-02-6		
A8 clear	octamethylcyclotetrasiloxane	556-67-2	decamethylcyclotetrasiloxane	541-02-6
A9 green	2-hydroxychalcone	644-78-0	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclotetrasiloxane	541-02-6		
A10 pink	hexamethylcyclotrioxane	541-05-9	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclotetrasiloxane	541-02-6		
A11 orange	hexamethylcyclotrioxane	541-05-9	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclotetrasiloxane	541-02-6		
A12	Not identified*			
A13	Not identified*			
A14 red	Not identified*			
A15 white	Not identified*			
A16 blue	n-benzylaniline	103-32-2	styrene	100-42-5
A17 green	ethylbenzene	100-41-4	styrene	100-42-5
A18 black	n-benzylaniline	103-32-2	styrene	100-42-5
A19 grey	n-benzylaniline	103-32-2	styrene	100-42-5
A20 yellow	ethylbenzene	100-41-4	styrene	100-42-5
	ethylbenzene	100-41-4	styrene	100-42-5
A21 white	benzylacetic acid	501-52-0		
A22 red	Not identified*			
A23 orange	Not identified*			
A24 grey	Not identified*			
A25 bronze	4-vinylcyclohexene	100-40-3	n-benzylaniline	103-32-2
	styrene	100-42-5		

A27 clear	Not identified*
A28 clear	Not identified*
A29 black	Not identified*
A30 red	Not identified*
A31 green	Not identified*
A32 blue	Not identified*
A33 yellow	Not identified*
A34 grey	Not identified*
A35 white	Not identified*
A36 grey	Not identified*
A37 white	Not identified*
A38 black	Not identified*
A39 black	Not identified*
A40 white	Not identified*
A41 red	Not identified*
A42 blue	Not identified*
A43 black	Not identified*
A44 white	Not identified*
A45 clear	Not identified*

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-25: HS-GC-MS analysis for Printer A printed products in water

Sample	Compound	CAS	Compound	CAS
A1 white	Not identified*			
A2 white	Not identified*			
A3 yellow	Not identified*			
A4 black	Not identified*			
A5 grey	Not identified*			
A6 red	Not identified*			
A7 blue	octamethylcyclotetrasiloxane	556-67-2	decamethylcyclopentasiloxane	541-02-6
A8 clear	octamethylcyclotetrasiloxane	556-67-2	decamethylcyclopentasiloxane	541-02-6
A9 green	hexamethylcyclotrioxane	541-05-9	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclopentasiloxane	541-02-6		
A10 pink	2-hydroxychalcone	644-78-0	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclopentasiloxane	541-02-6		
A11 orange	2-hydroxychalcone	644-78-0	octamethylcyclotetrasiloxane	556-67-2
	decamethylcyclopentasiloxane	541-02-6		
A12	Not identified*			
A13	Not identified*			
A14 red	Not identified*			
A15 white	Not identified*			
A16 blue	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		
A17 green	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		
A18 black	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		
A19 grey	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		
A20 yellow	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		
A21 white	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8		

A22 red	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8	
A23 orange	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8	
A24 grey	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8	
A25 bronze	4-(2-aminoethyl)benzenesulfonyl fluoride hydrochloride	34284-75-8	
A27 clear			Not identified*
A28 clear			Not identified*
A29 black			Not identified*
A30 red			Not identified*
A31 green			Not identified*
A32 blue			Not identified*
A33 yellow			Not identified*
A34 grey			Not identified*
A35 white			Not identified*
A36 grey			Not identified*
A37 white			Not identified*
A38 black			Not identified*
A39 black			Not identified*
A40 white			Not identified*
A41 red			Not identified*
A42 blue			Not identified*
A43 black			Not identified*
A44 white			Not identified*
A45 clear			Not identified*

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-26: HS-GC-MS analysis for neat Printer B printed products

Sample	Compound	CAS
B1 red		Not identified*
B2 orange		Not identified*
B3 blue		Not identified*
B4 black		Not identified*
B5 purple		Not identified*
B6 yellow		Not identified*
B7 green		Not identified*
B8 white		Not identified*
B9 off-white		Not identified*
B10 grey		Not identified*
B11 clear		Not identified*
B12 white		Not identified*
B13 black		Not identified*
B14 orange	2-propadienylmesitylene	29555-07-5
	mephedrone	1189805-46-6
B15 black		Not identified*

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-27: HS-GC-MS analysis for Printer B printed products in water

Sample	Compound	CAS
---------------	-----------------	------------

B1 red	Not identified*
B2 orange	Not identified*
B3 blue	Not identified*
B4 black	Not identified*
B5 purple	Not identified*
B6 yellow	Not identified*
B7 green	Not identified*
B8 white	Not identified*
B9 off-white	Not identified*
B10 grey	Not identified*
B11 clear	Not identified*
B12 white	Not identified*
B13 black	Not identified*
B14 orange	Not identified*
B15 black	Not identified*

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-28: HS-GC-MS analysis for neat Printer C printed products

Sample	Compound	CAS	Compound	CAS
C1 grey	2-hydroxypropyl methacrylate	923-26-2	2,4,5-trimethylbenzaldehyde	5779-72-6
C2 white	2-hydroxypropyl methacrylate	923-26-2	2,4,6-trimethylbenzaldehyde	487-68-3
C3 grey	4-acryloylmorpholine	5117-12-4		
C4 grey	Not identified*			
C5 clear	3-amino-3-(4-methylphenyl)propionic acid	68208-18-4	isoterpinolene	586-63-0
C6 purple	2-propyl-1-heptanol	10042-59-8	4-hydroxycinnamic acid (l-phenylalanine methyl ester) amide	615264-52-3
C7 brown	propylene glycol methyl ether acetate	108-65-6	2-hydroxypropyl methacrylate	923-26-2
	3-amino-3-(4-methylphenyl)propionic acid	68208-18-4		
C8 clear	Not identified*			
C9 grey	Not identified*			
C10 white	Not identified*			
C11 grey	cyclohexane	110-82-7	propylene glycol methyl ether acetate	108-65-6
	2-butoxyethanol	111-76-2	2-ethylhexanol	104-76-7
	phencyclidine	77-10-1	6-methylchromone-2-carboxylic acid	5006-44-0
C12 blue	cyclohexane	110-82-7	2-butoxyethanol	111-76-2
	mebeverine	3625-06-7	2-hydroxypropyl methacrylate	923-26-2
C14 white	2-hydroxypropyl methacrylate	923-26-2		
C15 grey	3-hydroxypropyl methacrylate	2761-09-3	2,4,6-trimethylbenzaldehyde	487-68-3
C16 black	propylene glycol methyl ether acetate	108-65-6	2-hydroxypropyl methacrylate	923-26-2
	3-hydroxypropyl methacrylate	2761-09-3		
C17 clear	3-hydroxypropyl methacrylate	2761-09-3		

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-29: HS-GC-MS analysis for Printer C printed products in water

Sample	Compound	CAS
C1 grey	Not identified*	
C2 white	Not identified*	
C3 grey	2,4,6-trimethylbenzaldehyde	487-68-3
C4 grey	3-amino-3-(4-methylphenyl)propionic acid	68208-18-4
C5 clear	2-ethylhexanol	104-76-7
C6 purple	Not identified*	
C7 brown	Not identified*	
C8 clear	Not identified*	
C9 grey	Not identified*	
C10 white	Not identified*	
C11 grey	cyclohexane	110-82-7
C12 blue	cyclohexane	110-82-7
	1,2,3-trimethylbenzene	526-73-8
C14 white	Not identified*	
C15 grey	Not identified*	
C16 black	Not identified*	
C17 clear	Not identified*	

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-30: HS-GC-MS analysis for neat Printer D printed products

Sample	Compound	CAS	Compound	CAS
D1 green	2,4,5-trimethylbenzaldehyde	5779-72-6		
D2 black	toluene	108-88-3	2,4,5-trimethylbenzaldehyde	5779-72-6
	toluene	108-88-3	2,4,5-trimethylbenzaldehyde	5779-72-6
D3 white	1-(2-hydroxy-5'-butylphenyl)-1-ethanone(E)oxime	103582-33-8		
D4 green	Not identified*			
D5 clear	2,4,5-trimethylbenzaldehyde	5779-72-6	2-ethyl-2-phenylmalondiamide	7206-76-0
	tri(propylene glycol) diacrylate	42978-66-5		

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-31: HS-GC-MS analysis for Printer D printed products in water

Sample	Compound	CAS
D1 green	Not identified*	
D2 black	Not identified*	
D3 white	Not identified*	
D4 green	Not identified*	
D5 clear	Not identified*	

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Table B-32: HS-GC-MS analysis for neat Printer E printed products

Sample	Compound	CAS	Compound	CAS
E1 green	3-formyl-7-methoxychromone	42059-56-3		
E2 red	2,4,5-trimethylbenzaldehyde	5779-72-6		
E3 grey	4-acryloylmorpholine	5117-12-4	2,4,6-trimethylbenzaldehyde	487-68-3

E4 flesh	2,4,6-trimethylbenzaldehyde	487-68-3		
E5 red	4-acryloylmorpholine	5117-12-4	tri(propylene glycol) diacrylate	42978-66-5
E6 black	4-acryloylmorpholine	5117-12-4		
E7 clear	1-chlorohexane	544-10-5	tri(propylene glycol) diacrylate	42978-66-5
E8 white	Not identified*			
E9 yellow	4-acryloylmorpholine	5117-12-4		
E10 blue	4-acryloylmorpholine	5117-12-4		
E11 green	(E)-1-nitro-1-propene	17082-05-2	3-formyl-7-methoxychromone	42059-56-3
E12 black	Not identified*			
E13 grey	3-amino-3-(4-methylphenyl)propionic acid	68208-18-4		
E14 blue	Not identified*			

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%

Table B-33: HS-GC-MS analysis for Printer E printed products in water

Sample	Compound	CAS
E1 green	Not identified*	
E2 red	Not identified*	
E3 grey	Not identified*	
E4 flesh	Not identified*	
E5 red	tri(propylene glycol) diacrylate	42978-66-5
E6 black	Not identified*	
E7 clear	Not identified*	
E8 white	Not identified*	
E9 yellow	3-formyl-7-methoxychromone	42059-56-3
E10 blue	Not identified*	
E11 green	Not identified*	
E12 black	Not identified*	
E13 grey	Not identified*	
E14 blue	Not identified*	

*Not identified- no peaks above baseline were able to be identified with a NIST hit >30%.

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

Quantitative elemental content in the 3D printed products was determined by microwave assisted acid digestion, followed by ICP-OES analysis (Agilent 5100). The method used was adapted from internal CPSC SOP-21-05-00: ICP-OES Elemental Analysis. Approximately 0.2 g of printed material was placed into a pre-cleaned Teflon digestion test tube along with 4 mL of trace metal grade nitric acid and 2 mL of trace metal grade hydrochloric acid. The vessels were capped and placed in a microwave (Milestone UltraWAVE). The samples were heated to 240 °C and digested for 10 minutes under pressure. Samples were cooled, diluted to a final volume of 30 mL, filtered through a 0.45 µm filter, and analyzed by ICP-OES. Duplicate samples of each 3D printed product were digested and analyzed.

Note: Elements detected above the detection limit of 1 ppm are highlighted in yellow.

Table B-34: Elemental content of Printer A 3D printed products by ICP-OES analysis (mg/kg)

Element	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Aluminum	51.6	939.1	nd<7.5	nd<7.5	3930.5	nd<37.5	753.3	nd<7.5	nd<7.5	nd<7.5
Antimony	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<75	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Arsenic	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<3.75	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Calcium	nd<37.5	nd<37.5	299.5	nd<37.5	nd<37.5	nd<7.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Cobalt	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Copper	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	41.1	nd<0.94	11.6	nd<0.94
Chromium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Iron	nd<7.5	76.3	nd<7.5	nd<7.5	44.6	137.60	10.8	nd<7.5	nd<7.5	nd<7.5
Lead	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<3.75	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Magnesium	nd<7.5	43	nd<7.5	nd<7.5	85.5	nd<37.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Manganese	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Mercury	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Molybdenum	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<3.75	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Nickel	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Phosphorus	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	28.2	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Selenium	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<7.5	nd<3.8	nd<3.8	nd<3.8	nd<3.8
Tin	43.4	58.4	41	44.5	68.7	nd<37.5	30.6	21.7	44	33.8
Titanium	185.7	295.1	35.2	1.1	282.3	151.8	121.2	40.3	136.5	153.9
Vanadium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<7.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Zinc	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	34.9	nd<37.5	nd<37.5	nd<37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-35: Elemental content of Printer A 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20
Aluminum	nd<7.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Antimony	nd<37.5	nd<75	nd<75	nd<75	nd<75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75
Arsenic	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd<3.75	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Calcium	nd<37.5	nd<7.5	26.0	11.2	4.1	nd < 37.5	24.0	nd < 37.5	nd < 37.5	nd < 37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Cobalt	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9

Copper	nd<0.9 4	nd<37.5	nd<37.5	nd<37.5	nd<37.5	2.6	2.2	2.0	2.6	2.7
Chromium	nd<0.9 4	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Iron	nd<7.5	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Lead	nd<0.9 4	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Magnesium	nd<7.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	141.0	128.0	113.3	138.9	108.6
Manganese	nd<0.9 4	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Mercury	nd<0.9 4	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9
Molybdenum	nd<0.9 4	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Nickel	nd<0.9 4	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Phosphorus	nd<37.5	7324.5*	5877.4*	23.9	23.8	57.8	78.2	42.8	45.9	63.8
Selenium	nd<3.8	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd < 1.9	1.1	nd < 1.9	nd < 1.9	nd < 1.9
Tin	34.1	nd<37.5	nd<37.5	nd<37.5	nd<37.5	4.3	1.2	nd < 0.9	nd < 0.9	0.4
Titanium	0.7	nd<37.5	nd<37.5	nd<37.5	60.7	115.6	137.5	13.9	152.6	136.5
Vanadium	nd<0.9 4	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Zinc	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5

* above highest calibration point (>750 ppm)

Table B-36: Elemental content of Printer A 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	A21	A22	A23	A24	A25	A27	A28	A29	A30	A31
Aluminum	65.1	nd < 37.5	51.9	3865.8*	nd < 37.5	nd<37.5	46.3	nd<37.5	nd < 37.5	nd < 37.5
Antimony	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd<75	nd<75	nd<75	nd < 75	nd < 75
Arsenic	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 7.5	nd < 7.5
Barium	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5
Calcium	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd<7.5	63.0	38.7	nd < 37.5	nd < 37.5
Cadmium	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.9 4	nd<0.9 4	nd<0.9 4	nd < 0.9	nd < 0.9
Cobalt	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	2.6	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9
Copper	2.6	2.3	3.0	2.8	2.7	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9
Chromium	nd < 0.9	nd < 0.9	nd < 0.9	2.2	38.9	nd<37.5	nd<37.5	nd<37.5	10.6	2.3
Iron	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	35.7	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 7.5	nd < 7.5
Lead	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<3.7 5	nd<3.7 5	nd<3.7 5	nd < 0.9	nd < 0.9
Magnesium	140.5	141.2	112.3	146.2	595.5	nd<37.5	nd<37.5	nd<37.5	0.5	1.4

Manganese	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5	nd<37.5	40.7	40.5
Mercury	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd<37.5	nd<37.5	nd<37.5	nd < 1.9	nd < 1.9
Molybdenum	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	1.0
Nickel	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	1.9	nd<37.5	nd<37.5	nd<37.5	0.9	nd < 0.9
Phosphorus	69.4	76.4	51.7	43.5	92.0	nd<37.5	nd<37.5	nd<37.5	70.4	79.9
Selenium	nd < 1.9	nd < 1.9	nd < 1.9	1.0	nd < 1.9	nd<7.5	nd<7.5	nd<7.5	1.1	nd < 1.9
Tin	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9
Titanium	150.3	45.5	159.0	78.2	131.0	nd<37.5	179.4	nd<37.5	129.2	120.9
Vanadium	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd<7.5	nd<7.5	nd<7.5	nd < 0.9	697.0
Zinc	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	1662.1	nd<37.5	nd<37.5	nd<37.5	36.6	nd < 37.5

* above highest calibration point (>750 ppm)

Table B-37: Elemental content of Printer A 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	A32	A33	A34	A35	A36	A37	A38	A39	A40	A41
Aluminum	233.5	nd < 37.5	nd < 37.5	nd < 37.5	107.9	78.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Antimony	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75	nd < 75
Arsenic	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Barium	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Calcium	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	91.1	nd < 37.5	nd < 37.5	nd < 37.5	905.6*
Cadmium	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Cobalt	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Copper	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Chromium	15.3	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Iron	nd < 7.5	nd < 7.5	32.9	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Lead	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Magnesium	2.6	0.6	nd < 0.9	nd < 0.9	1.6	0.5	nd < 0.9	nd < 0.9	nd < 0.9	9.5
Manganese	40.2	41.5	20.8	42.3	40.6	39.2	40.1	nd < 0.9	nd < 0.9	nd < 0.9
Mercury	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9
Molybdenum	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Nickel	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Phosphorus	70.1	72.0	36.4	70.5	74.6	90.5	69.3	nd < 37.5	nd < 37.5	nd < 37.5

Selenium	nd < 1.9	1.1	nd < 1.9	nd < 1.9	1.1	1.1	nd < 1.9	nd < 1.9	1.1	1.2
Tin	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	0.1	nd < 0.9	0.2
Titanium	135.7	121.1	90.8	30.8	150.1	166.5	41.5	125.8	182.2	83.4
Vanadium	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Zinc	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5

* above highest calibration point (>750 ppm)

Table B-38: Elemental content of Printer A 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	A42	A43	A44	A45
Aluminum	575.4	nd<37.5	nd < 37.5	nd<37.5
Antimony	nd < 75	nd<75	nd < 75	nd<75
Arsenic	nd < 7.5	nd<3.75	nd < 7.5	nd<3.75
Barium	nd < 37.5	nd<37.5	nd < 37.5	nd<37.5
Calcium	nd < 37.5	46.7	nd < 37.5	36.4
Cadmium	nd < 0.9	nd<0.94	nd < 0.9	nd<0.94
Cobalt	nd < 0.9	nd<37.5	nd < 0.9	nd<37.5
Copper	nd < 0.9	nd<37.5	nd < 0.9	nd<37.5
Chromium	13.8	nd<37.5	nd < 0.9	nd<37.5
Iron	nd < 7.5	nd<3.75	nd < 7.5	nd<3.75
Lead	nd < 0.9	nd<3.75	nd < 0.9	nd<3.75
Magnesium	4.3	nd<37.5	nd < 0.9	nd<37.5
Manganese	nd < 0.9	nd<37.5	nd < 0.9	nd<37.5
Mercury	nd < 1.9	nd<37.5	nd < 1.9	nd<37.5
Molybdenum	nd < 0.9	nd<3.75	nd < 0.9	nd<3.75
Nickel	nd < 0.9	nd<37.5	nd < 0.9	nd<37.5
Phosphorus	nd < 37.5	nd<37.5	5968.8*	nd<37.5
Selenium	nd < 1.9	nd<7.5	1.2	nd<7.5
Tin	0.3	nd<37.5	nd < 1.9	nd<37.5
Titanium	65.9	159.8	14.3	nd<37.5
Vanadium	nd < 0.9	nd<7.5	nd < 0.9	nd<7.5
Zinc	nd < 37.5	nd<37.5	nd < 37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-39: Elemental content of Printer B 3D printed products by ICP-OES analysis (mg/kg)

Element	B1	B2	B3	B4	B5	B6	B7	B8
Aluminum	174.7	123.6	117.6	14.6	31.1	161.3	247	56.4
Antimony	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Arsenic	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Calcium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Cobalt	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Copper	nd<0.94	nd<0.94	93.4	nd<0.94	nd<0.94	nd<0.94	63.7	nd<0.94
Chromium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Iron	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Lead	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Magnesium	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Manganese	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Mercury	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Molybdenum	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Nickel	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Phosphorus	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Selenium	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8
Tin	39.8	38.2	38.9	38.3	39.7	39.1	39.5	37.6
Titanium	149.3	144.8	148	50.7	128.3	148.5	152.7	163.4
Vanadium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Zinc	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-40: Elemental content of Printer B 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	B9	B10	B11	B12	B13	B14	B15
Aluminum	nd<37.5	43.7	nd<37.5	54.3	49.7	16.8	nd < 37.5
Antimony	nd<75	nd<37.5	nd<75	nd < 75	nd < 75	nd < 75	nd < 75
Arsenic	nd<3.75	nd<0.94	nd<3.75	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Barium	543.6	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	74.1	nd < 37.5
Calcium	4.6	nd<37.5	nd<7.5	nd < 37.5	56.6	215.5	nd < 37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Cobalt	nd<37.5	nd<0.94	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9

Copper	nd<37.5	nd<0.94	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Chromium	nd<37.5	nd<0.94	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	0.6
Iron	nd<3.75	760.3	nd<3.75	122.8	997.6*	nd < 7.5	nd < 7.5
Lead	nd<3.75	nd<0.94	nd<3.75	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Magnesium	nd<37.5	nd<7.5	nd<37.5	nd < 0.9	1.2	2.2	0.6
Manganese	nd<37.5	3.3	nd<37.5	29.4	nd < 0.9	nd < 0.9	nd < 0.9
Mercury	nd<37.5	nd<0.94	nd<37.5	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9
Molybdenum	nd<3.75	nd<0.94	nd<3.75	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Nickel	nd<37.5	nd<0.94	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Phosphorus	nd<37.5	nd<37.5	522.6	249.5	252.5	251.3	246.4
Selenium	nd<7.5	nd<3.8	nd<7.5	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9
Tin	nd<37.5	31.1	nd<37.5	10.4	12.8	10.0	10.6
Titanium	nd<37.5	171	88.5	197.3	183.5	141.8	3.0
Vanadium	nd<7.5	nd<0.94	nd<7.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Zinc	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	366.1	nd < 37.5	nd < 37.5

* above highest calibration point (>750 ppm)

Table B-41: Elemental content of Printer C 3D printed products by ICP-OES analysis (mg/kg)

Element	C1	C2	C3	C4	C5	C6	C7	C8	C9
Aluminum	nd<7.5	nd<7.5	127.5	107.4	nd<37.5	15.5	nd < 37.5	nd<37.5	nd<37.5
Antimony	nd<37.5	nd<37.5	nd<75	nd<75	nd<75	nd < 75	nd < 75	nd<75	nd<75
Arsenic	nd<0.94	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd < 7.5	nd < 7.5	nd<3.75	nd<3.75
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd<37.5	nd<37.5
Calcium	nd<37.5	nd<37.5	nd<7.5	nd<7.5	nd<7.5	nd < 37.5	nd < 37.5	nd<7.5	nd<7.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94
Cobalt	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5
Copper	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5
Chromium	nd<0.94	nd<0.94	nd<37.5	nd<37.5	29.3	10.6	nd < 0.9	nd<37.5	nd<37.5
Iron	15.1	nd<7.5	nd<3.75	nd<3.75	nd<3.75	nd < 7.5	nd < 7.5	nd<3.75	nd<3.75
Lead	nd<0.94	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd < 0.9	nd < 0.9	nd<3.75	nd<3.75
Magnesium	nd<7.5	nd<7.5	nd<37.5	nd<37.5	nd<37.5	0.6	nd < 0.9	nd<37.5	nd<37.5
Manganese	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5

Mercury	nd<0.9 4	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 1.9	nd < 1.9	nd<37.5	nd<37.5
Molybdenum	nd<0.9 4	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd < 0.9	nd < 0.9	nd<3.75	nd<3.75
Nickel	nd<0.9 4	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd<37.5	nd<37.5
Phosphorus	921.0*	641.7	2654.0*	534.6	283.0	833.4*	871.4*	2897.9*	32.9
Selenium	nd<3.8	nd<3.8	nd<7.5	nd<7.5	nd<7.5	nd < 1.9	nd < 1.9	nd<7.5	nd<7.5
Tin	46.8	30.3	nd<37.5	nd<37.5	nd<37.5	34.2	26.3	nd<37.5	nd<37.5
Titanium	89.5	5.5	104.7	56.7	87.0	10.0	146.7	nd<37.5	nd<37.5
Vanadium	nd<0.9 4	nd<0.94	nd<7.5	nd<7.5	nd<7.5	nd < 0.9	nd < 0.9	nd<7.5	nd<7.5
Zinc	nd<37. 5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd<37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-42: Elemental content of Printer C 3D printed products by ICP-OES analysis (mg/kg)

Element	C10	C11	C12	C14	C15	C16	C17
Aluminum	nd < 37.5	nd < 37.5	nd < 37.5	14	nd<7.5	nd<7.5	nd<7.5
Antimony	nd < 75	nd < 75	nd < 75	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Arsenic	nd < 7.5	nd < 7.5	nd < 7.5	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Barium	nd < 37.5	nd < 37.5	nd < 37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Calcium	nd < 37.5	nd < 37.5	nd < 37.5	1493.1	1576.3	nd<37.5	nd<37.5
Cadmium	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Chromium	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Cobalt	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Copper	nd < 0.9	nd < 0.9	5.7	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Iron	nd < 7.5	nd < 7.5	nd < 7.5	nd<7.5	nd<7.5	nd<7.5	3.7
Lead	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Magnesium	nd < 0.9	nd < 0.9	nd < 0.9	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Manganese	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Mercury	nd < 1.9	nd < 1.9	nd < 1.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Molybdenum	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Nickel	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Phosphorus	1159.8*	598.8*	697.9*	634.7	647	357.9	518.8
Selenium	nd < 1.9	nd < 1.9	nd < 1.9	nd<3.8	nd<3.8	nd<3.8	nd<3.8
Tin	11.1	15.5	16.2	72.7	71.9	22.1	68.9
Titanium	19.3	124.6	42.8	143	105.2	115.2	46.4

Vanadium	nd < 0.9	nd < 0.9	nd < 0.9	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Zinc	nd < 37.5	nd < 37.5	nd < 37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-43: Elemental content of Printer D 3D printed products by ICP-OES analysis (mg/kg)

Element	D1	D2	D3	D4	D5
Aluminum	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Antimony	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Arsenic	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Calcium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Cobalt	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Copper	nd<0.94	1.3	nd<0.94	nd<0.94	nd<0.94
Chromium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Iron	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Lead	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Magnesium	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<7.5
Manganese	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Mercury	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Molybdenum	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Nickel	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Phosphorus	2458.5*	3436.7*	2441.0*	2751.9*	4241.6*
Selenium	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<3.8
Tin	28.6	33.7	19.4	nd<7.5	nd<7.5
Titanium	17.9	40.3	32.4	nd<0.94	11.6
Vanadium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94
Zinc	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5

* above highest calibration point (>750 ppm)

Table B-44: Elemental content of Printer E 3D printed products by ICP-OES analysis (mg/kg)

Element	E1	E2	E3	E4	E5	E6	E7	E8
Aluminum	nd<7.5	nd<7.5	nd<7.5	nd<7.5	692.4	32.6	196.3	nd < 37.5
Antimony	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<75	nd<75	nd<75	nd < 75
Arsenic	nd<0.94	0.52	nd<0.94	0.52	nd<3.75	nd<3.75	nd<3.75	nd < 7.5
Barium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	263.1	nd<37.5	nd<37.5	nd < 37.5

Calcium	nd<37.5	nd<37.5	nd<37.5	nd<37.5	133.3	nd<7.5	4.9	nd < 37.5
Cadmium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd < 0.9
Cobalt	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Copper	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Chromium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Iron	nd<7.5	8.9	nd<7.5	nd<7.5	nd<3.75	nd<3.75	nd<3.75	nd < 7.5
Lead	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd < 0.9
Magnesium	nd<7.5	nd<7.5	nd<7.5	nd<7.5	303.0	nd<37.5	nd<37.5	8.4
Manganese	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Mercury	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 1.9
Molybdenum	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<3.75	nd<3.75	nd<3.75	nd < 0.9
Nickel	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Phosphorus	2755*	2754.2	4058.2*	4196.4*	2107.1*	3719.4*	3821.2*	4458.1*
Selenium	nd<3.8	nd<3.8	nd<3.8	nd<3.8	nd<7.5	nd<7.5	nd<7.5	nd < 1.9
Tin	nd<7.5	nd<7.5	nd<7.5	nd<7.5	nd<37.5	nd<37.5	nd<37.5	nd < 0.9
Titanium	19.9	nd<0.94	8.1*	13.3*	nd<37.5	59.2	nd<37.5	55.6
Vanadium	nd<0.94	nd<0.94	nd<0.94	nd<0.94	nd<7.5	nd<7.5	nd<7.5	nd < 0.9
Zinc	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd<37.5	nd < 37.5

* above highest calibration point (>750 ppm)

Table B-45: Elemental content of Printer E 3D printed products by ICP-OES analysis (mg/kg) cont.

Element	E9	E10	E11	E12	E13	E14
Aluminum	235.7	286.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Antimony	nd<75	nd<75	87.8	nd < 75	nd < 75	nd < 75
Arsenic	nd<3.75	nd<3.75	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Barium	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Calcium	4.4	9.1	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5
Cadmium	nd<0.94	nd<0.94	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Cobalt	nd<37.5	nd<37.5	2.1	nd < 0.9	10.9	nd < 0.9
Copper	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Chromium	nd<37.5	nd<37.5	2.6	1.2	nd < 0.9	1.1
Iron	nd<3.75	23.9	nd < 7.5	nd < 7.5	nd < 7.5	nd < 7.5
Lead	nd<3.75	nd<3.75	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Magnesium	nd<37.5	nd<37.5	nd < 0.9	2.5	6.6	nd < 0.9
Manganese	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9

Mercury	nd<37.5	nd<37.5	nd < 1.9	nd < 1.9	nd < 1.9	nd < 1.9
Molybdenum	nd<3.75	nd<3.75	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Nickel	nd<37.5	nd<37.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Phosphorus	2895.2*	4465.1*	2010.1*	3073.9*	2295.7*	4449.4*
Selenium	nd<7.5	nd<7.5	nd < 1.9	nd < 1.9	nd < 1.9	1.1
Tin	nd<37.5	nd<37.5	5.3	5.6	15.5	14.0
Titanium	nd<37.5	76.4	11.7	5.6	58.8	4.8
Vanadium	nd<7.5	nd<7.5	nd < 0.9	nd < 0.9	nd < 0.9	nd < 0.9
Zinc	nd<37.5	nd<37.5	nd < 37.5	nd < 37.5	nd < 37.5	nd < 37.5

* above highest calibration point (>750 ppm)

High-Definition X-Ray Fluorescence (HDXRF)

Qualitative surface elemental content in the 3D printed products was determined by HDXRF (XOS HDPrime) analysis. HDXRF analysis was performed on each of the printed materials to determine elemental content and corroborate the results from the ICP-OES analysis.

Note: Elements detected are highlighted in yellow

Table B-46: Elemental content of Printer A 3D printed children's products by HDXRF analysis (mg/kg)

Element	A1	A2	A3	A4	A5	A6	A7	A8
Antimony	11.2	nd	nd	nd	nd	nd	nd	nd
Barium	nd	nd	26.6	6.2	nd	987.5	nd	nd
Bismuth	nd	nd	nd	nd	nd	nd	nd	nd
Bromine	nd	nd	nd	nd	nd	nd	nd	nd
Calcium	nd	nd	505	nd	nd	nd	29.6	nd
Chlorine	nd	nd	140.5	nd	nd	251.5	nd	nd
Chromium	nd	nd	nd	nd	nd	nd	nd	nd
Copper	nd	nd	nd	nd	nd	nd	53.7	nd
Gallium	nd	nd	nd	nd	nd	nd	nd	nd
Gold	2.5	2.1	nd	0.7	1.4	nd	nd	0.8
Iron	nd	114	nd	nd	70.2	nd	23.6	nd
Lead	0.6	nd	0.2	nd	0.3	nd	nd	nd
Manganese	nd	2.9	nd	3.9	4.6	nd	2.2	nd
Nickel	7.7	2.9	2.8	2.3	3.6	nd	2.8	2.7
Potassium	29.9	709	68.5	36.5	476	nd	360	16.8
Rubidium	nd	5.7	nd	nd	3.5	0.7	0.9	nd
Strontium	0.5	0.6	1.2	0.4	0.6	2.1	1.2	0.5

Sulfur	7502	3328.5	8254.5	7058	6918.5	nd	7750	6950.5
Tantalum	nd	nd	nd	nd	nd	nd	nd	nd
Tin	59.5	86.0	50.7	60.2	98.3	48.5	37.7	13.1
Titanium	11642	4675.5	nd	nd	1827	nd	198.0	nd
Vanadium	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	14.4	0.4	1.4	nd	nd	nd	nd	nd

Table B-47: Elemental content of Printer A 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	A9	A10	A11	A12	A13	A14	A15	A16
Antimony	228	nd	nd	7.2	6.6	8.0	15.3	6.3
Barium	nd	nd	nd	nd	nd	nd	nd	nd
Bismuth	nd	nd	0.6	nd	nd	nd	nd	nd
Bromine	nd	nd	nd	nd	nd	nd	nd	nd
Calcium	nd	nd	nd	80.2	nd	54.2	90.5	nd
Chlorine	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	127	nd	nd	nd	nd	nd	nd	nd
Copper	18.0	nd	nd	nd	31.6	nd	nd	nd
Gallium	nd	nd	nd	nd	nd	nd	nd	nd
Gold	0.6	0.8	0.8	nd	nd	nd	nd	nd
Iron	nd	nd	nd	nd	nd	nd	nd	nd
Lead	nd	nd	nd	nd	nd	nd	nd	nd
Manganese	2.6	2.75	nd	nd	nd	nd	nd	nd
Nickel	2.6	3.4	2.7	nd	nd	nd	nd	nd
Potassium	50.3	nd	15.5	nd	nd	nd	nd	nd
Rubidium	nd	nd	nd	0.7	0.6	0.7	0.6	nd
Strontium	0.6	0.5	0.5	2.2	2.1	2.2	2.3	1.1
Sulfur	7148.5	7434.5	6978.5	nd	nd	nd	nd	nd
Tantalum	nd	nd	nd	nd	nd	nd	nd	nd
Tin	55.3	42.8	44.6	53.3	32.4	39.1	37.2	nd
Titanium	3498.5	4035.5	nd	nd	1840.5	nd	4546.5	553
Vanadium	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	2.0	4.5	nd	nd	nd	nd	nd	nd

Table B-48 Elemental content of Printer A 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	A17	A18	A19	A20	A21	A22	A23	A24
Antimony	5.7	6.0	6.0	10.6	6.3	4.6	14.9	5.2
Barium	nd	nd	nd	nd	nd	nd	nd	nd
Bismuth	nd	nd	nd	nd	nd	nd	nd	nd
Bromine	nd	nd	nd	nd	nd	nd	nd	nd
Calcium	nd	nd	nd	nd	nd	nd	nd	nd
Chlorine	nd	nd	nd	nd	nd	409.5	nd	nd
Chromium	nd	nd	nd	nd	nd	nd	nd	nd
Copper	nd	0.3	nd	nd	nd	nd	nd	nd
Gallium	nd	nd	nd	nd	nd	nd	nd	nd
Gold	nd	nd	nd	nd	nd	nd	nd	nd
Iron	1.7	nd	nd	nd	nd	nd	nd	1.7
Lead	nd	nd	nd	nd	nd	nd	nd	nd
Manganese	nd	0.5	nd	nd	nd	nd	nd	nd
Nickel	nd	nd	nd	nd	nd	nd	nd	nd
Potassium	nd	nd	nd	nd	nd	nd	nd	nd
Rubidium	nd	nd	nd	nd	nd	0.3	nd	nd
Strontium	1.0	1.0	1.0	1.4	1.1	1.8	1.1	1.0
Sulfur	nd	nd	nd	nd	nd	nd	nd	nd
Tantalum	nd	nd	nd	nd	nd	nd	nd	nd
Tin	nd	nd	nd	nd	nd	34.7	nd	nd
Titanium	1959.5	nd	1854	2828.5	5588	nd	4089	nd
Vanadium	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	nd	5.1	nd	nd	nd	nd	nd	nd

Table B-49: Elemental content of Printer A 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	A25	A27	A28	A29	A30	A31	A32	A33
Antimony	nd	nd	5.9	10.2	6.3	6.2	nd	15.3
Barium	nd	nd	nd	nd	nd	212.5	nd	nd
Bismuth	nd	nd	nd	nd	nd	2437	nd	nd
Bromine	nd	nd	nd	nd	0.5	nd	0.4	0.4
Calcium	nd	nd	nd	nd	nd	nd	nd	nd
Chlorine	nd	nd	138	nd	nd	nd	nd	nd
Chromium	nd	nd	nd	nd	nd	61.3	nd	nd
Copper	5915	nd	nd	1.6	nd	0.8	17.4	nd
Gallium	nd	nd	nd	nd	nd	3.3	nd	nd
Gold	nd	nd	nd	nd	nd	nd	nd	nd

Iron	40.8	nd	nd	nd	nd	nd	1.2	nd
Lead	nd	nd	nd	nd	nd	nd	nd	nd
Manganese	nd	nd	nd	nd	74.5	65.4	69.0	78.8
Nickel	nd	nd	nd	nd	nd	nd	nd	nd
Potassium	nd	nd	35.9	nd	nd	nd	nd	nd
Rubidium	nd	nd	nd	nd	0.6	nd	0.7	0.3
Strontium	1.0	nd	1.0	0.8	2.1	3.2	1.8	1.8
Sulfur	nd	nd	nd	nd	nd	nd	nd	nd
Tantalum	nd	nd	nd	nd	nd	nd	nd	nd
Tin	nd	nd	nd	nd	nd	nd	nd	nd
Titanium	nd	nd	nd	nd	511	141.5	3565	706
Vanadium	nd	nd	nd	nd	nd	601	nd	nd
Zinc	1787	nd	nd	nd	nd	14.8	nd	nd

Table B-50: Elemental content of Printer A 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	A34	A35	A36	A37	A38	A39	A40	A41
Antimony	nd	6	113	nd	11.7	nd	nd	7.3
Barium	nd	nd	nd	nd	nd	nd	nd	nd
Bismuth	nd	nd	nd	nd	nd	nd	nd	nd
Bromine	0.3	0.3	0.5	0.2	0.4	nd	nd	nd
Calcium	nd	nd	nd	108.8	nd	nd	nd	1665
Chlorine	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	107.5	nd	54.3	nd	nd	nd	nd	nd
Copper	nd	nd	nd	nd	nd	nd	nd	nd
Gallium	nd	nd	nd	nd	nd	nd	nd	nd
Gold	nd	nd	nd	nd	nd	nd	nd	nd
Iron	87.2	nd	nd	nd	nd	2.3	nd	16.3
Lead	nd	nd	nd	nd	nd	nd	nd	nd
Manganese	74.2	76.0	69.6	65.7	72.4	nd	nd	nd
Nickel	nd	nd	nd	nd	nd	nd	nd	nd
Potassium	nd	nd	nd	nd	nd	nd	nd	nd
Rubidium	nd	nd	0.6	0.6	0.6	nd	0.3	nd
Strontium	1.7	1.7	1.9	1.8	1.9	1.2	1.3	2.1
Sulfur	nd	nd	nd	nd	nd	nd	nd	nd
Tantalum	0.8	0.9	nd	nd	nd	nd	nd	nd
Tin	nd	nd	nd	nd	nd	nd	nd	nd
Titanium	3883.5	19.3	2708.5	15690	20.2	nd	3961.5	nd

Vanadium	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	nd	nd	nd	nd	nd	nd	nd	nd

Table B-51: Elemental content of Printer A 3D printed children’s products by HDXRF analysis (mg/kg) cont.

Element	A42	A43	A44	A45
Antimony	5.7	13.3	6.8	10.5
Barium	nd	nd	nd	nd
Bismuth	nd	nd	nd	nd
Bromine	nd	nd	nd	nd
Calcium	nd	nd	nd	nd
Chlorine	nd	nd	nd	nd
Chromium	nd	nd	nd	nd
Copper	16.8	nd	nd	nd
Gallium	nd	nd	nd	nd
Gold	nd	nd	nd	nd
Iron	4.8	nd	nd	nd
Lead	nd	nd	nd	nd
Manganese	nd	nd	nd	nd
Nickel	nd	nd	nd	nd
Potassium	nd	nd	nd	nd
Rubidium	0.8	0.3	0.6	0.3
Strontium	1.7	1.8	1.3	1.5
Sulfur	nd	nd	nd	nd
Tantalum	nd	nd	nd	nd
Tin	nd	nd	nd	nd
Titanium	67.9	nd	nd	nd
Vanadium	nd	nd	nd	nd
Zinc	nd	nd	nd	nd

Table B-52: Elemental content of Printer B 3D printed children’s products by HDXRF analysis (mg/kg)

Element	B1	B2	B3	B4	B5	B6	B7	B8
Antimony	nd	nd	nd	nd	nd	nd	nd	nd
Bromine	nd	nd	nd	nd	nd	nd	nd	nd
Calcium	nd	7.9	9.8	nd	nd	nd	9.8	nd
Chromium	nd	nd	nd	nd	nd	26.3	nd	nd

Copper	nd	nd	122.5	nd	nd	nd	83.5	nd
Gold	0.8	0.6	1.4	0.8	0.6	0.9	1.3	0.7
Iron	nd	nd	nd	nd	nd	nd	nd	nd
Manganese	nd	2.1	nd	nd	1.9	nd	nd	nd
Nickel	3.1	3.4	4.9	4.3	2.5	2.8	4.2	4.0
Potassium	nd	nd	nd	23.5	29.0	47.9	68	nd
Rubidium	nd	nd	nd	nd	0.4	nd	nd	nd
Strontium	nd	0.5	1.2	0.6	0.5	0.4	0.6	1.2
Sulfur	7313	6524.5	3771	6860	7424.5	6616.5	6719	7122.5
Tin	49.0	44.3	39.5	45.2	53.8	45.0	49.2	56.1
Titanium	684	559.5	1965	nd	906	2557.5	3190.5	8056.5
Zinc	nd	nd	nd	nd	nd	nd	1.2	nd

Table B-53: Elemental content of Printer B 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	B9	B10	B11	B12	B13	B14	B15
Antimony	nd	nd	13.3	15.6	16.0	13.9	14.8
Bromine	0.2	nd	nd	nd	nd	nd	nd
Calcium	nd	nd	nd	nd	70.1	342.5	nd
Chromium	nd	nd	nd	nd	nd	nd	nd
Copper	nd	2.2	nd	nd	nd	nd	nd
Gold	nd	0.9	nd	nd	nd	nd	nd
Iron	161.5	1094.5	nd	148.5	1128.5	nd	nd
Manganese	nd	7.1	nd	44.3	1.4	nd	nd
Nickel	nd	3.7	nd	nd	nd	nd	nd
Potassium	nd	19.6	nd	nd	nd	nd	nd
Rubidium	0.8	nd	0.8	0.4	0.7	nd	0.6
Strontium	1.9	0.5	2.1	2.1	1.7	2.0	2.0
Sulfur	nd	6935	nd	nd	nd	nd	nd
Tin	42.3	44.4	45.6	39.5	48.6	40.6	40.8
Titanium	4638.5	2699.5	nd	8017	8601.5	1834	nd
Zinc	40.6	42.1	nd	nd	455	nd	nd

Table B-54: Elemental content of Printer C 3D printed children's products by HDXRF analysis (mg/kg)

Element	C1	C2	C3	C4	C5	C6	C7	C8
Antimony	nd	nd	14.9	13.6	5.3	11.9	11.2	12.9

Bismuth	nd	nd	nd	nd	7.3	nd	nd	nd
Calcium	nd	nd	nd	nd	13.6	nd	nd	nd
Chlorine	nd	nd	nd	nd	94.5	nd	nd	nd
Copper	nd	nd	nd	nd	nd	11.3	nd	nd
Gold	0.5	3.3	nd	nd	nd	nd	nd	nd
Iron	nd	67.2	nd	12.2	0.5	nd	nd	nd
Manganese	nd	nd	nd	nd	nd	nd	nd	nd
Nickel	3.9	7.1	nd	nd	nd	nd	nd	nd
Potassium	9.6	32	nd	nd	26.2	nd	nd	nd
Rubidium	nd	0.4	0.4	0.6	nd	0.3	0.5	0.2
Silicon	10227.5	61351	nd	77194.5	nd	nd	nd	nd
Strontium	nd	2.4	1.5	2.4	0.9	1.6	1.5	1.2
Sulfur	4242.5	12735.5	nd	nd	nd	nd	nd	nd
Tin	43.6	36.9	46.1	38.4	26.2	105	85.3	17.3
Titanium	300.5	nd	314.5	314	nd	nd	85.3	nd
Zinc	nd	nd	nd	nd	4.8	nd	nd	nd

Table B-55: Elemental content of Printer C 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	C9	C10	C11	C12	C14	C15	C16	C17
Antimony	11.1	11.4	12.2	10.8	nd	nd	nd	nd
Bismuth	nd	nd	nd	nd	nd	nd	18.2	nd
Calcium	nd	nd	nd	nd	2596	3228.5	nd	nd
Chlorine	nd	nd	nd	nd	nd	nd	nd	nd
Copper	nd	nd	nd	5.4	nd	nd	nd	nd
Gold	nd	nd	nd	nd	1.0	1.1	0.6	1.1
Iron	nd	nd	nd	nd	nd	1.3	nd	nd
Manganese	nd	nd	nd	nd	nd	nd	5.5	nd
Nickel	nd	nd	nd	nd	2.9	3.4	4.0	2.9
Potassium	nd	nd	nd	nd	nd	nd	14.9	10.7
Rubidium	nd	0.2	0.2	nd	nd	nd	nd	nd
Silicon	nd	nd	nd	nd	nd	nd	nd	nd
Strontium	1.3	1.4	1.4	1.4	0.6	1.1	nd	nd
Sulfur	nd	nd	nd	nd	4536.5	4556.5	6481.5	4582
Tin	59.7	39.3	51.9	56.1	89.3	94.1	8.0	78.7
Titanium	236	6.4	630	nd	1232	597	366	17.2
Zinc	nd	nd	nd	nd	nd	nd	14.8	nd

Table B-56: Elemental content of Printer D 3D printed children's products by HDXRF analysis (mg/kg)

Element	D1	D2	D3	D4	D5
Calcium	29.1	nd	nd	9.9	nd
Chlorine	nd	nd	nd	424.5	1213
Chromium	17.4	10.6	13.1	nd	nd
Copper	3.1	3.6	nd	3.1	nd
Gold	0.7	1.4	0.7	0.5	0.8
Manganese	nd	nd	nd	4.2	2.2
Nickel	4.2	3.9	4.9	5.1	4.4
Strontium	nd	nd	nd	0.5	nd
Sulfur	6139.5	5286	6471	6360	3309.5
Tin	40	41.2	27.5	nd	nd
Titanium	nd	nd	1060.5	nd	nd

Table B-57: Elemental content of Printer E 3D printed children's products by HDXRF analysis (mg/kg)

Element	E1	E2	E3	E4	E5	E6	E7
Antimony	nd	nd	nd	nd	11.9	5.6	13.2
Calcium	nd	nd	33.4	nd	nd	nd	nd
Chlorine	308	nd	nd	nd	1150.5	234.5	1411
Chromium	nd	4.4	4.4	nd	10.7	nd	nd
Copper	3.1	nd	nd	nd	nd	7.0	nd
Gold	0.7	0.6	1.3	nd	nd	nd	nd
Iron	nd	nd	nd	nd	nd	nd	nd
Manganese	nd	nd	nd	nd	nd	nd	nd
Nickel	3.6	4.5	4.3	4.4	2.4	nd	nd
Potassium	18.1	nd	nd	nd	nd	nd	nd
Rubidium	nd	nd	nd	nd	0.6	0.5	0.6
Strontium	nd	0.4	nd	nd	1.8	1.6	1.9
Sulfur	6306	6693	6422.5	6469.5	nd	nd	nd
Titanium	nd	nd	1065.5	1096.5	1122	nd	nd
Zinc	nd	nd	nd	nd	nd	nd	nd

Table B-58: Elemental content of Printer E 3D printed children's products by HDXRF analysis (mg/kg) cont.

Element	E8	E9	E10	E11	E12	E13	E14

Antimony	19.7	7.9	18.9	84.6	44.9	14.5	10.5
Calcium	nd	nd	nd	48.1	nd	nd	nd
Chlorine	404	224.5	nd	1548	701	nd	nd
Chromium	nd	nd	nd	nd	nd	12.8	nd
Copper	nd	nd	4.0	2.7	0.9	nd	0.3
Gold	nd	nd	nd	nd	nd	nd	nd
Iron	nd	nd	nd	40.7	nd	nd	nd
Manganese	1.4	nd	nd	nd	nd	nd	nd
Nickel	nd	nd	1.3	nd	nd	nd	1.3
Potassium	nd	nd	nd	nd	nd	nd	nd
Rubidium	0.5	0.3	0.6	0.3	0.3	0.5	0.3
Strontium	1.8	1.6	1.6	1.9	1.8	1.9	1.3
Sulfur	nd	nd	nd	nd	nd	nd	nd
Titanium	1204	1268.5	1253	56.5	13.6	1213	nd
Zinc	nd	nd	nd	68.5	nd	nd	nd

Fourier-Transform Infrared Spectroscopy (FTIR)

Additional chemical content identification was performed using a FTIR Spectrometer (Thermo Nicolet 6700 FTIR) with Smart Orbit Diamond Attenuated Total Reflectance (ATR) accessory, DTGS KBr detector, resolution of 4 cm⁻¹. 3D printed materials were tested neat. The FTIR spectrum for each printed material tested was compared to spectra in the reference search library (HR Aldrich) for best match.

Table B-59: FT-IR identification of Printer A 3D printed children's products

Resin	Component	FTIR analysis
		Compound
A1	Circle piece	Butyl butyryl lactate, 98+%, FCC
	Stick	Tetrahydro-2-furoic acid, 97%
A2	Circle piece	Tetrahydro-2-furoic acid, 97%
	Stick	Poly(propylene:tetrafluoroethane),55mol%C3
A3	Circle piece	glue stick - Ross Stik
	Stick	glue stick - Ross Stik
A4	Circle piece	Polytetrafluoroethylene
	Stick	Polytetrafluoroethylene
A5	Circle piece	Tetrahydro-2-furoic acid, 97%
	Stick	Polytetrafluoroethylene
A6	Circle piece	2-Methoxyethyl Cyanoacetate 98%
	Wing	Butyl butyrlactate 98%

A7	Circle piece	glue stick - Ross Stik
	Stick	Polytetrafluoroethylene
A8	Circle piece	Polytetrafluoroethylene
	Stick	Polytetrafluoroethylene
A9	Circle piece	Polytetrafluoroethylene
	Stick	Polytetrafluoroethylene
A10	Circle piece	Butyl butyryl lactate, 98+%, FCC
	Stick	Tetrahydro-2-furoic acid, 97%
A11	Circle piece	Tetrahydro-2-furoic acid, 97%
	Stick	Allyl cyanoacetate, 99%
A12	Circle piece	N,N-Bis(2-Hydroxyethyl)Formamide
	Rattle	Butyl butyryl lactate 98%
A13	Wing	Butan-3-One-2-Yl Butyrate 98%
	Circle piece	Propargyl Ether 99%
A14	Circle piece	Tetrahydro-2-furoic acid 97%/ Cellulose Propionate
	Stick	Butyl butyryl lactate 98%
A15	Wing	Butyl butyryl lactate 98%
	Circle piece	N-(Tert-butoxycarbonyl)-P-Toluene-Sulfonamide 99%
A16	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A17	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A18	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A19	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A20	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A21	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A22	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A23	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A24	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A25	Circle piece	Tritan TX2001

	Stick	Tritan TX2001
A27	Circle piece	Polypropylene, isotactic, average mw CA 250,000
	Wing	Polypropylene + poly(ethylene:propylene)
A28	Circle piece	Glue stick/N-acetylcysteamine
	Circle piece	Poly(amide 6-6 amide-6)
A29	Circle piece	N-acetylcysteamine 95%
	Wing	<i>glue stick - ross stik</i>
A30	Circle piece	Tritan TX2001
	Stick	Polyester Alpha Wipe
A31	Circle piece	Tritan TX2001
	Stick	Polyester Alpha Wipe
A32	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A33	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A34	Circle piece	Tritan TX2001
	Stick	Tritan TX2001
A35	Circle piece	Tritan TX2001
	Stick	Polyester Alpha Wipe
A36	Circle piece	Tritan TX2001
	Stick	Polyester Alpha Wipe
A37	Circle piece	Polyester Alpha Wipe
	Stick	Polyester Alpha Wipe
A38	Circle piece	Tritan TX2001
	Stick	Polyester Alpha Wipe
A39	Circle piece	Poly(ester urethane), MBI
	Stick	Poly(ester urethane), MBI
A40	Circle piece	Poly(ester urethane), MBI
	Stick	Poly(ester urethane), MBI
A41	Circle piece	Poly(ester urethane), MBI
	Stick	Poly(ester urethane), MBI
A42	Circle piece	Poly(ester urethane), MBI
	Stick	Poly(ester urethane), MBI
A43	Wing A	Polycarbonate Resin
	Wing B	Polycarbonate Resin
A44	Circle piece	Polycarbonate resin
	Stick	Polycarbonate resin

A45	Circle piece	Polycarbonate resin
	Stick	Polycarbonate resin

Table B-60: FT-IR identification of Printer B 3D printed children's products

Resin	Component	FTIR analysis
		Compound
B1	Circle piece	Cellulose propionate
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
B2	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
B3	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
B4	Circle piece	Butyl butyryl lactate, 98+%, FCC
	Stick	Butyl butyryl lactate, 98+%, FCC
B5	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
B6	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
B7	Circle piece	Butyl butyryl lactate, 98+%, FCC
	Stick	Cellulose propionate
B8	Circle piece	Cellulose propionate
	Stick	Triethanolamine
B9	Circle	Allyl Cyanoacetate 99%
	Wing	Allyl Cyanoacetate 99%
B10	Circle piece	Cellulose propionate
	Stick	Butyl butyryl lactate, 98+%, FCC
B11	Circle piece	Allyl Cyanoacetate 99%
	Wing	Butyl butyrolactone 98%
B12	Circle piece	Allyl cyanoacetate, 99%
	Stick	Butyl butyryl lactate, 98+%, FCC
B13	Circle piece	Butyl butyryl lactate, 98+%, FCC
	Stick	Butyl butyryl lactate, 98+%, FCC

B14	Circle piece	2-methoxyethyl cyanoacetate, 98%
	Stick	Butyl butyryl lactate, 98+%, FCC
B15	Circle piece	Allyl cyanoacetate, 99%
	Stick	Allyl cyanoacetate, 99%

Table B-61: FT-IR identification of Printer C 3D printed children's products

Resin	Component	FTIR analysis
		Compound
C1	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers
C2	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers
C3	Wing	Diurethane Dimethacrylate, mixture of isomers
	Stick	N-Butylurethane
C4	Wand	Poly(ether urethane)diisocyanate, MBCI
	Wing	Ethyl N-Hydroxy-Tert-butyl)Carbamate
C5	Circle piece	Tetrathane 2900 Polyether glycol
	Wing	Tetrathane 2900 Polyether glycol
C6	Circle piece	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
	Stick	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
C7	Circle piece	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
	Stick	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
C8	Circle	Tris(2-(acryloyloxy)ethyl) isocyanurate
	Wing	Tris(2-(acryloyloxy)ethyl) isocyanurate
C9	Circle	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
	Stick	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
C10	Circle piece	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
	Stick	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
C11	Circle piece	Crelan VP-KL 5-2668
	Stick	Crelan VP-KL 5-2668
C12	Circle piece	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
	Stick	Diurethane dimethacrylate, mix of isomers CAS# 72689-86-4
C14	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers

C15	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers
C16	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers
C17	Circle piece	Diurethane dimethacrylate, mixture of isomers
	Stick	Diurethane dimethacrylate, mixture of isomers

Table B-62: FT-IR identification of Printer D 3D printed children's products

Resin	Component	FTIR analysis
		Compound
D1	Circle piece	Poly(isopropyl methacrylate), average MW CA. 100,000
	Stick	Pyruvic aldehyde, 40 wt.% solution in water
D2	Circle piece	Tri(propylene glycol) diacrylate
	Stick	Ethylene glycol dicyclopentenyl ether acrylate
D3	Circle piece	Ursus spelaeus
	Stick	(S)-(+)-erythrose hydrate, 97%
D4	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (4 EO/phenol) diacrylate, average MN CA. 688
D5	Circle piece	Bisphenol A ethoxylate (4 EO/phenol) diacrylate, average MN CA. 688
	Stick	Bisphenol A ethoxylate (4 EO/phenol) diacrylate, average MN CA. 688

Table B-63: FT-IR identification of Printer E 3D printed children's products

Resin	Component	FTIR analysis
		Compound
E1	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Poly(isopropyl methacrylate), average MW CA. 100,000
E2	Circle piece	Poly(isopropyl methacrylate), average MW CA. 100,000
	Stick	Bisphenol A ethoxylate (4 EO/phenol) diacrylate, average MN CA. 688
E3	Circle piece	Poly(isopropyl methacrylate), average MW CA. 100,000
	Stick	Bisphenol A ethoxylate (4 EO/phenol) diacrylate, average MN CA. 688
E4	Circle piece	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
	Stick	Bisphenol A ethoxylate (1 EO/phenol) diacrylate, average MN CA. 424
E5	Circle piece	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate

	Wing	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
E6	Wing	Poly(Isopropyl Methacrylate)
	Stick	Poly(Isopropyl Methacrylate)
E7	Circle piece	Poly(Isopropyl Methacrylate)
	Wing	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
E8	Circle piece	Bisphenol A ethoxylate diacrylate CAS# 64401-02-1
	Stick	Bisphenol A ethoxylate diacrylate CAS# 64401-02-1
E9	Wing	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
	Stick	Poly(Isopropyl Methacrylate)
E10	Wing	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
	Stick	Bisphenol A Ethoxylate (1EO/Phenol) Diacrylate
E11	Circle piece	Tri(propylene glycol) diacrylate
	Stick	Tri(propylene glycol) diacrylate, mix of isomers CAS 42978-66-5
E12	Circle piece	Tri(propylene glycol) diacrylate, mix of isomers CAS 42978-66-5
	Stick	Tri(propylene glycol) diacrylate, mix of isomers CAS 42978-66-5
E13	Circle piece	Tri(propylene glycol) diacrylate, mix of isomers CAS 42978-66-5
	Stick	Tri(propylene glycol) diacrylate, mix of isomers CAS 42978-66-5
E14	Circle piece	Poly(isopropyl methacrylate), average MW CA. 100,000
	Stick	Bisphenol A ethoxylate diacrylate CAS# 64401-02-1