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Flexible

Photopolymer Resin for Form 1+ and Form 2

FLFLGR02 MATERIAL PROPERTIES

Prepared: 04/19/2016

Formlabs Flexible resin has elastomeric properties allowing you to print parts on the Form 1+ and Form 2 3D printers that are bendable and compressible. Parts are pliable when thin and resilient when thick. Flexible has compression characteristics that make it great for creating parts like custom grips, stamps, keypads, gaskets and wearable prototypes. It does not shatter upon failure making it ideal for high impact applications.

	METRIC[1]		IMPERIAL[1]		METHOD
	Green	**Postcured[2]**	**Green**	**Postcured[2]**	
Mechanical Properties					
Tensile Strength[3]	3.3 – 3.4 MPa	7.7 – 8.5 MPa	483 – 494 psi	1110 – 1230 psi	ASTM D412-06 (A)
Elongation at Failure[3]	60%	75 – 85%	60%	75 – 85%	ASTM D412-06 (A)
Compression Set[4]	0.40%	0.40%	0.40%	0.40%	ASTM D395-03 (B)
Tear Strength[5]	9.5 – 9.6 kN/m	13.3 – 14.1 kN/m	54 – 55 lbf/in	76 – 80 lbf/in	ASTM D624-00
Shore Hardness	70 – 75 A	80 – 85 A	70 – 75 A	80 – 85 A	ASTM 2240
Thermal Properties					
Vicat Softening Point[6]	231 °C	230 °C	448 °F	446 °F	ASTM D1525-09

NOTES:

[1]Material properties can vary with part geometry, print orientation, print settings and temperature.

[2]Data was obtained from parts printed using Form 2, 100 um, Flexible settings and post-cured with 290 J/cm^2 of fluorescent bulb UV light, centered at 365 nm.

[3]Tensile testing was performed after 3+ hours at 23 °C, using a Die C dumbbell and 20 in/min cross head speed.

[4]Compression testing was performed at 23 °C after aging at 23 °C for 22 hours.

[5]Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen and a 20 in/min cross head speed.

[6]Thermal testing was performed after 40+ hours with a 10 N loading at 50 °C/hour. Cracks formed in samples during testing.

SOLVENT COMPATIBILITY

G = Good resistance.

Parts exposed to this solvent should not experience a decrease in mechanical properties. (≤ 1% weight gain, ≤ 1% width increase over 24 hours for a 1 x 1 x 1 cm cube)

A = Acceptable resistance.

Parts exposed to this solvent may experience a small decrease in mechanical properties. (1 – 2% weight gain, 1 – 2% width increase over 24 hours for a 1 x 1 x 1 cm cube)

X = Unacceptable resistance.

Parts exposed to this solvent will experience a significant decrease in mechanical properties as well as visible degradation. (> 2% weight gain, > 2% width increase over 24 hours for a 1 x 1 x 1 cm cube)

	FLEXIBLE RESIN FLFLGR02	
	GREEN	POST CURED
Acetic Acid, 5%	A	A
Acetone	X	X
Bleach (~5% NaOCl)	G	A
Butyl Acetate	X	X
Diethyl glycol monomethyl ether	X	X
Hydrogen Peroxide (3%)	A	A
Isooctane	G	G
Isopropyl alcohol	X	X
Sodium hydroxide (0.025%, pH = ~10)	A	G
Salt Water (3.5% NaCl)	G	G
Water	G	G
Xylene	X	X

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Flexible

Photoreactive Resin for Form 1, Form 1+, Form 2

SAFETY DATA SHEET

Prepared: 11/14/2014
Revised: 02/10/2016

GHS/CLP Labelling
Hazard pictograms:

Signal word: Warning

GHS FORMAT

1. Chemical Product and Company Identification

Product Identification: Photoreactive Resin
Product Class: Mixture of methacrylic acid esters, photoinitiators, proprietary pigment and additive package
Product Use: For use in Formlabs printer Form 1, Form 1+, Form 2
Company: Formlabs, Inc.
35 Medford Street, Suite #201
Somerville, MA
Date of Preparation: 11/14/2014
For Emergencies: North America call +1 800 255 3924
Worldwide Intl. call +01 813 248 0585
Reference Contract Number MIS4707563

2. Hazards Identification in Accordance with EC 1272/2008

EMERGENCY OVERVIEW

COLOR: LIGHT GREY
PHYSICAL STATE: LIQUID
ODOR: STRONG ACRYLIC

***Classification of the substance or mixture:**
Skin irritation, Category 2
Eye irritation, Category 2A
Target Organ Systemic Toxicity, Category 3

GHS/CLP LABELLING

Hazard pictograms:

SIGNAL WORD: WARNING

HAZARD STATEMENTS

H315 Causes skin irritation
H317 May cause an allergic skin reaction
H319 Causes serious eye irritation
H335 May cause respiratory irritation
H402 Harmful to aquatic life

PRECAUTIONARY STATEMENT(S)

Prevention:
P261 Avoid breathing gas/mist/vapors/spray
P264 Wash skin thoroughly after handling
P272 Contaminated work clothing should not be allowed out of the workplace
P273 Avoid release into the environment
P280 Wear protective gloves/protective clothing/eye protection/face protection

Response:
P302 + P352: IF ON SKIN (or hair) : Wash with plenty of soap and water.
P305 + P351 + P338: IF IN EYES : Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310: IF SWALLOWED : Immediately call a POISON CENTER or doctor/physician.
P333 + P313 : If skin irritation or rash occurs: Get medical advice/attention.
P362 : Take off contaminated clothing and wash before reuse.
P391 : Collect spillage.

SUPPLEMENTAL HEALTH INFORMATION

Potential Health Effects:

Effects due to processing releases:
Irritating to eyes, respiratory system and skin. Prolonged or repeated exposure may cause: headache, drowsiness, nausea, weakness (severity of effects depends on extent of exposure).

Other:
This product may release fume and/or vapor of variable composition depending on processing time and temperature. Possible cross sensitization with other acrylates and methacrylates.

3. Composition/Information on Ingredient

Components	Approximate % by weight	C.A.S. No. & EINECS No.	Hazard Statements im accordance with EC 1272/2008	UK/EU Classification according to Directive 67/548/EEC
A. Acrylated oligomers (including multifunctional)	Proprietary	Proprietary or not assigned	H315, H317, H319, H335	Xi; Irritant, R36/37/38, R43 S3, S7/9, S20, S26, S29, S37/39
B. Acrylated monomers	Proprietary	Proprietary	H315, H317, H319, H335	Xi; Irritant, R36/37/38, R43 S3, S7/9, S20, S26, S29, S37/39
C. Photoinitiator(s)	Proprietary	Proprietary	H303, H402	
D. Pigments	Proprietary	Proprietary	H316	

4. First-Aid Measures

Emergency Overview: This product is a light grey colored liquid with a strong characteristic odor. This product may cause skin and eye irritation. The inhalation of high vapor concentration may cause a headache and nausea.

Inhalation: In case of exposure to a high concentration of vapor or mist, remove person to fresh air. If breathing has stopped, administer artificial respiration and seek medical attention.

Eye Contact: Immediately flush with plenty of clean water (under eye lids) for at least 20 minutes. Hold eyelids apart to ensure flushing. Washing within one minute of contact is essential to achieve maximum effectiveness. Seek medical attention immediately. Do not apply oil or oily ointments unless ordered by a physician.

Skin Contact: Remove contaminated clothing and rinse contact area thoroughly with soap and water. Particular attention should be paid to hair, nose, and ears, and other areas not easily cleaned. Wash clothing before reuse. If irritation develops, consult a physician.

Ingestion: If ingested, dilute with water by giving glasses of water or milk to the victim. Do not give anything by mouth if the victim is rapidly losing consciousness, is unconscious, or convulsing. *Do not induce vomiting.* If vomiting occurs naturally, keep

airways clear. Get medical attention. Provide an estimate of the time at which the material was ingested and the amount of the substance that was swallowed.

5. Fire-Fighting Measures

Flash Point: > 93 °C / 200 °F

Method: Setaflash

Ignition Temperature: No data

Lower Explosion Limit: No data

Upper Explosion Limit: No data

Extinguishing Media: Use carbon dioxide or dry chemical for small fires; aqueous foam or water spray for large fires.

Special Firefighting Procedures: Firefighters should wear full protection clothing and self-contained breathing apparatus (SCBA). Thoroughly decontaminate firefighting equipment including all firefighting apparel after the incident.

Unusual Fire & Explosion: Emits irritating vapors. High temperatures, accidental impurities, or exposure to radiation or oxidizers may cause spontaneous polymerization generating heat/pressure and rupture/explosion of closed containers.

Exposure Hazard(s): Material — Irritant

When burned, the following hazardous products of combustion can occur:

Carbon oxides
Hazardous organic compounds

6. Accidental Release Measures

Procedures of Personal Precautions: Wear adequate personal protective clothing and equipment, as outlined in Section 8.

Environmental Precautions: Contain spill to prevent spread into drains, sewers, water supplies, or soil. Avoid release into the environment. Dispose of in accordance with all applicable federal, state and local regulations.

Methods of Cleaning Up: In the event of a spill, immediately remove all sources of ignition. Cover the liquid with inert absorbent. Using appropriate personal protective equipment and non-sparking tools, contain spilled material.

Waste Disposal Method: Do not dispose of in sewers, lakes, rivers or streams. Scoop all contaminated material into compatible bottles or drums for proper disposal. Dispose of in accordance with all applicable federal, state and local regulations. National or regional provisions may also be in force.

7. Handling and Storage

Handling Precautions: User Exposure — This product should be used in well-ventilated areas. Product may cause irritation. Avoid contact with eyes. Avoid prolonged or repeated contact with skin. Wash hands with soap and water before eating, drinking, smoking, applying cosmetics, or using toilet facilities. Launder contaminated clothing before reuse. Contaminated leather articles, including shoes, cannot be decontaminated and should be destroyed to prevent reuse. Solvents should never be used to clean hands or skin because they increase the penetration of the material into skin.

Storage Precautions: Suitable — Store in a cool, dry place out of direct sun light, in opaque or amber containers. Store the containers at 10 – 35 °C (50 – 95 °F). Do not exceed 60 °C (140 °F) when in storage. Keep containers closed. Avoid ignition sources.

Special Requirements: Do not heat containers with steam or electrical equipment. Heating this product above 150 °C (300 °F) in the presence of air may cause slow oxidative decomposition; above 260 °C (500 °F) polymerization may occur. Fumes and vapors from this thermal decomposition may be dangerous (carbon monoxide, carbon dioxide, nitrous oxides). Do not breathe fumes.

8. Exposure Controls & Personal Protection

EXPOSURE LIMITS

Component	HSIS Australia	IOELVs (UK)	ACGIH TLV	OSHA PEL	WEEL
1. Acrylated oligomers	None	None	None	None	None
2. Acrylated monomers	None	None	None	None	None
3. Photoinitiator(s)	None	None	None	None	None

No occupational exposure limit values exist for the materials contained in this product.

NOTATIONS

IOELVs — Indicative Occupational Exposure Limit Values
TWA — Time Weighted Average
OEL — Occupational Exposure Limits
PEL — Permissible Exposure Limit
TLV — Threshold Limit Value
STEL — Short Term Exposure Limit
WEEL — Workplace Environmental Exposure Level by the American Industrial Hygiene Association

EXPOSURE CONTROLS

Ventilation Controls: Ensure adequate ventilation.

Respiratory Protection: Respirators are generally not needed under normal conditions of use. If this material is handled at elevated temperature, under mist forming conditions or in case of accidental release of large quantities of product use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Protective Gloves: Wear impervious gloves (nitrile or neoprene) for routine handling.

Eye and Face Protection: Chemical splash goggles or a face shield is recommended during operations where splashing could occur.

Skin Protection: Avoid all skin contact. Depending on the conditions of use, cover as much of the exposed skin area as possible by wearing gloves, aprons, long pants, and long sleeved shirts.

Other Controls: For operations where contact can occur a safety shower and eye wash facility should be available. Always use good personal hygiene and housekeeping practices. Wash hands thoroughly after handling.

Environmental Exposure Controls: Keep product from waterways and watersheds. This substance is not readily biodegradable and is dangerous for the environment. Avoid release into the environment.

9. Physical & Chemical Properties

Appearance: Liquid, light grey color
Odor: Strong/Characteristic/Acrylate

	Value	Unit	Method
Specific Gravity	1.09 – 1.12	g/cm^3	
Boiling Point	> 100	°C	
Flash Point	> 100	°C	
Ignition Temperature	no data		
Lower Explosion Limit	no data		
Upper Explosion Limit	no data		
Viscosity	4500	cps	@ 25 °C (77 °F)

Vapour Pressure: Not established
Solubility in Water: Only very slightly soluble
Solubility in Organic Solvents: Soluble in organic solvents
Volatile Characteristics: Negligible
Electrostatic Discharge: Safe
Electric Conductivity: Dielectric

10. Stability and Reactivity

Stability: Stable when stored in original container designed for use with light sensitive materials under 35°C (95 °F) in dark, cool place.

Conditions to Avoid: Storage > 38 °C (100 °F), exposure to light, loss of dissolved air, and contamination with incompatible materials.

Incompatible Materials to Avoid: Polymerization initiators, including peroxides, strong oxidizing agents, alcohols, copper, copper alloys, carbon steel, iron, rust, and strong bases.

Hazardous Decomposition Products: Hazardous decomposition products may include oxides of carbon, nitrogen and various hydrocarbon fragments.

Hazardous Polymerization: Hazardous polymerization may occur. Uncontrolled polymerization may cause rapid evolution of heat and increase in pressure that could result in violent rupture of sealed storage vessels or containers.

11. Toxicological Information

A. Acrylated oligomers	Not tested
B. Acrylated monomers	Acute Oral Toxicity LD50 > 2000 mg/kg body weight (vendor literature)
C. Photoinitiator(s)	Acute Oral Toxicity LD50 > 2500 mg/kg body weight (tested in rats) (vendor literature) Acute Dermal Toxicity LD50 > 5000 mg/kg body weight (vendor literature)

Individual components of this product are not reported to produce mutagenic effects in humans. None of the components of this material are listed by IARC, NTP, OSHA or ACGIH as carcinogens.

12. Ecological Information

Keep product from waterways and watersheds. This substance is not readily biodegradable. Dispose of in accordance with all applicable federal, state and local regulations.

A. Acrylated oligomers	No data available
B. Acrylated monomers	No data available
C. Photoinitiator(s)	No data available

Additional ecological information: Some monomers contained in this product are Water Hazard Class 1 (vendor literature): slightly hazardous for water. Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.

13. Disposal Considerations

Dispose of in accordance with governmental regulations (community, national or regional). Contact a licensed professional waste disposal service to dispose of this mixture. As with all foreign substances, do not allow to enter storm or sewer drainage systems. Avoid release into the environment.

Contaminated Packaging: Dispose of as unused product. Expose the open emptied container to light until material has solidified, then dispose.

14. Transport Information

Department of transportation classification: Not hazardous by D.O.T. regulations
D.O.T. proper shipping name: Not regulated
International Maritime Dangerous Goods Code (IMDG): Not regulated
International Air Transportation Association (IATA): Not regulated
Other requirements: N/A
ADR: Not regulated
Australian HazChem Code: N/A

15. Regulatory Information

The following provides a summary of the legal requirements.

			EUROPEAN ECONOMIC COMMUNITY (EEC)				CANADA REGS	
Ingredient	**EPA* TSCA**	**CA Prop 65**	**EINECS**	**European Community Standards**	**Listed as dangerous chemicals per ESIS**	**EC 1272/2008**	**DSL**	**NDSL**
A. Acrylated oligomers	Yes	No	Yes	None	No	GHS07, Wng H315, H319	Yes	No
B. Acrylated monomers	Yes	No	Yes	None	No	GHS07, Wng H315, H319	Yes	Yes
C. Photoinitiator(s)	Yes	No	Yes	None	No	H303, H402	Yes	No

All the components present in this product at concentrations equal to or greater than 0.1% are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory.

Substance Preparation Classification:

Irritant

FULL TEXT OF ANY R-PHRASES AND S-PHRASES:

Risk Phrases:
R36/37/38 — Irritating to eyes, respiratory system and skin
R43 — May cause sensitization by skin contact

Safety Phrases:
S3 — Keep in a cool place
S7/9 — Keep container
S20 — When using do not eat or drink
S26 — In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
S29 — Do not empty into drains
S37/39 — Wear suitable gloves and eye/face protection

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

Pursuant to Title III of the Superfund Amendments and Reauthorization Act of 1986, (SARA) and 40 CFR 372 Part 372, this product does not contain chemicals subject to the reporting requirements under Section 313.

California Proposition 65: This product does not contain chemicals which are known to the state of California to cause cancer.

Section 355 (extremely hazardous substances): None of the ingredients is listed.

Section 313 (specific toxic chemical listings): None of the ingredients is listed.

16. Other Information

HMIS (Hazardous Materials Information System) for secondary labelling:

HEALTH	2
FIRE HAZARD	1
REACTIVITY	1
PERSONAL PROTECTIVE EQUIPMENT	D

REFERENCES:

1. 2011 Threshold Limit Values and Biological Exposure Indices. American Conference of Governmental Industrial Hygienists.
2. MSDS + Cheminfo CD-ROM, Canadian Centre for Occupational Health and Safety
3. SAX'S Dangerous Properties of Industrial Materials, Tenth Edition
4. TSCA & SARA Title III, U.S. Environmental Protection Agency and the National Technical Information Services
5. Raw Material Manufacturers Material Safety Data Sheets
6. US National Institute of Medicines Toxnet current edition
7. ESIS: European Chemical Substance Information System, http://ecb.jrc.it/esis
8. NOHSC Hazardous Information Substances Information System, Department of Employment and Workplace Relations, Australian Government, 2005

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