

Glycerol-Derived Acrylate Photoresins: Polyglycerol-Acrylate versus Poly(glycerol sebacate) Acrylate, CAL, DLP, Extrusion, Post-Cure, Degradation and Qualification

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Statement of Significance

Glycerol-derived acrylates can be confused because they share a feedstock word while differing in backbone, polarity, degradation and processing. Polyglycerol-6 acrylate (PG6-A) is an ether-rich acrylated polyol demonstrated in computed axial lithography. Poly(glycerol sebacate) acrylate (PGSA or Acr-PGS) is an acrylated polyester elastomer demonstrated in extrusion-photocuring and DLP blends. ER-119 prevents the glycerol label from substituting for molecular identity or final-article qualification.

Keywords: glycerol-derived acrylate; polyglycerol-6 acrylate; PG6-A; poly(glycerol sebacate) acrylate; PGSA; Acr-PGS; computed axial lithography; DLP; extrusion photopolymerisation; post-cure; degradation; qualification.

Abstract

Direct primary studies establish four separate evidence states. A one-step PG6-A resin printed volumetrically at 405 nm with 6.5 Pa·s viscosity and 0.075 wt% LAP, but uncured residue reuse required a changed exposure and unprocessed prints produced cytotoxic extracts; 99% reported degree of cure and non-cytotoxic extracts followed an additional 60-minute post-cure plus sequential water and bicarbonate washes. Acr-PGS extrusion used blended macromers to create a viscosity window: low-viscosity inks flowed, high-viscosity ink fractured, and a 10/90 blend preserved multilayer geometry. PGSA/PEGDA DLP scaffolds linked composition and architecture to hepatocyte culture for up to 16 days without proving liver regeneration. Separately, a 160 °C, 10 h PGSA heat treatment approximately doubled tensile modulus and strength while changing lipase degradation. These results are not transferable between the ether oligomer and polyester elastomer. Qualification must close synthesis, achieved acrylation, residual acid/reagents, process, dose, wash, thermal or sterilisation history, degradation and geometry.

1. Scope and boundaries

ER-119 owns the distinction between acrylated polyglycerol and acrylated poly(glycerol sebacate), their demonstrated CAL/DLP/extrusion process windows, post-cure and wash state, heat-treatment state, degradation evidence and glycerol-derived release gates. It does not own all bio-derived photoresins, generic VAM physics, all elastomers, universal cytocompatibility, liver regeneration, clinical implants or proprietary recipes.

ER-06 retains biological response; ER-15 degradation and mechanical evolution; ER-30 oxygen inhibition and free-surface/interfacial cure; ER-33 washing/drying; ER-50 true foam photopolymers; ER-71 in-situ monitoring and closed-loop control; ER-86 extractables; ER-100 corpus architecture; and ER-118 polylactide derivatives. ER-119 retains its own CAL process evidence and glycerol-derived identity boundary.

PG6-A contains a polyglycerol ether framework and residual acrylic-acid risk from its Fischer esterification route. PGSA/Acr-PGS contains sebacate ester linkages and is degradation-sensitive. Similar acronyms, glycerol origin or photocurability do not establish equivalence.

2. Controlled identity chain

	PG6-A control	PGSA/Acr-PGS control
Feed/backbone	PG oligomer distribution, ether-rich backbone, OH content	Glycerol:sebacic-acid ratio, polyester Mn/dispersity, OH content
Acrylation	Acid ratio, catalyst/inhibitor, acid value, achieved functionality	Acryloyl-chloride route, catalyst/inhibitor, achieved acrylation, salts/solvents
Process	Transparency, CAL dose field, vial/rotation, 405 nm, viscosity/reuse	Extrusion or DLP, blend/crosslinker, viscosity, layer/voxel and dose
Article	Conversion, residual acid, wash/post-cure, geometry and ageing	Thermal/autoclave state, mechanics, degradation, extractables and geometry

Table 1. Two non-equivalent glycerol-derived acrylate identity chains.

3. Direct primary evidence

3.1 PG6-A in computed axial lithography

Krumins et al. esterified polyglycerol-6 with acrylic acid in a one-step bulk route and used the unpurified product as a CAL resin [1]. The selected PG6-A had 6.5 Pa·s viscosity; 0.075 wt% LAP balanced non-response at 0.05 wt% against overcuring at higher loading. A 405 nm projector delivered 59.6 mW·cm⁻² with a 35 µm focus-plane pixel, while the smallest reported chess-piece feature was 400–500 µm — 0.4 mm for virgin and 0.5 mm for recycled resin. Pixel size is therefore not realised resolution [S1].

Collected uncured resin needed 14.4 s total exposure rather than 12 s for virgin resin to produce comparable resolution; recycled-resin cylinders were approximately 90% of the virgin size. Reusability is a changed vat state requiring exposure, geometry and composition requalification, not evidence of identical performance [S1,S2].

3.2 Processing state controls PG6-A cytotoxicity

Non-processed PG6-A prints produced cytotoxic extracts and acidic leachate. The study associated this with residual acrylic acid and uncured PG6-A; Raman analysis reported 58% degree of cure before processing and 99% after processing [1]. The biological-test specimens received an additional 60-minute post-cure, followed by 60 minutes in deionised water and 60 minutes in 1 M aqueous NaHCO₃ before extract preparation. Only this defined final state supports the reported non-cytotoxic extract result [S3,S4,S5].

3.3 Acr-PGS extrusion-photocuring

Yeh et al. prepared two PGS prepolymers at 120 °C under nitrogen followed by 36 or 48 h vacuum, acrylated them and blended the macromers for extrusion with continuous UV stabilisation [2]. Measured viscosities were 3.18 and 8.78 Pa·s for the low- and high-molar-mass Acr-PGS endpoints. Low-viscosity formulations pooled; the highest-viscosity endpoint fractured; a 10/90 low/high blend retained regular filaments and spacing. Scaffolds up to ten layers were demonstrated. Printing density changed mechanical properties, so a material-only modulus is invalid [S1,S6].

3.4 PGSA/PEGDA DLP architecture

Teng et al. DLP-printed hexagonal PGSA/PEGDA scaffolds with different surface areas and three-dimensional structures [3]. The high-diffusion staircase design supported differences in cell proliferation, and hepatocyte cultures were maintained for up to 16 days. This supports a composition-plus-architecture feasibility result; it does not show whole-liver regeneration, in-vivo integration, clinical function or PGSA-alone performance [S3-S5].

3.5 Heat treatment creates a new PGSA state

Ao-Ieong et al. treated photocured PGSA at 160 °C for 10 h [4]. Reported Young's modulus increased from 4.52 ± 0.37 to 9.36 ± 0.27 MPa and ultimate tensile strength from 0.82 ± 0.07 to 1.66 ± 0.09 MPa, while elongation changed from 21.85 ± 1.84% to 23.15 ± 1.51%. After subsequent autoclaving, values were 8.95 ± 0.40 MPa, 1.47 ± 0.09 MPa and 20.18 ± 1.38%, respectively. In lipase medium at 20 days, mass loss was approximately 1% for the 160 °C condition versus 6% for the 120 °C condition. Heat and autoclave steps are material-state transformations, not administrative post-processing [S4,S7,S8,S9].

4. Release matrix

Gate	Minimum evidence	Claim withheld
Chemical identity	Backbone, Mn/dispersity, achieved acrylation, acid value and residual reagents	PG6-A equals PGSA or generic bio-derived resin
Optical/rheological	Viscosity at temperature/shear, spectra, dose field, oxygen, conversion and geometry	Pixel, layer or exposure transfers between systems

Gate	Minimum evidence	Claim withheld
Post-processing	Wash chemistry/time, post-cure dose, heat and sterilisation sequence	Green, washed, heated and autoclaved states are equivalent
Biological/degradation	Final-article extract, products, mass/mechanics over time and relevant exposure	Cytotoxicity screen equals implant or regeneration claim

Table 2. Minimum release gates for glycerol-derived acrylate articles.

5. Failure-mode interpretation

- The name contains glycerol: identify ether-rich PG6-A versus sebacate polyester PGSA/Acr-PGS.
- The synthesis uses a feed ratio: quantify achieved acrylation and residual acid, acryloyl chloride, catalyst, inhibitor, salts and solvent.
- The resin is used without purification: treat residual chemistry as open until final-article extraction and toxicological assessment close it.
- A 35 μm projector pixel is reported: do not relabel it as 35 μm part resolution.
- Unused resin can be printed again: freeze prior light history and requalify exposure and dimensions.
- The printed extract is non-cytotoxic: retain the 60-minute post-cure and two 60-minute washes that created that state.
- Heat treatment improves mechanics: track the new crosslink/degradation state and the subsequent sterilisation sequence.
- Cells proliferate in a hexagonal scaffold: withhold organ regeneration and clinical claims.

6. Minimum workflow

- Freeze glycerol-derived backbone, monomer/oligomer distribution, synthesis ratio, Mn/dispersity and batch.
- Measure achieved acrylation, residual acid/reagents, acid value, water and inhibitor rather than relying on charge ratios.
- Record initiator, absorber/dopant, viscosity method, optical spectrum, temperature and prior light/open-vat history.
- Map CAL/DLP/extrusion settings, oxygen boundary, conversion and realised geometry against the selected process.
- Freeze wash, neutralisation, post-cure, heat and sterilisation order, each with time, temperature and dose.
- Test final-article mechanics, extractables, degradation products and property retention in the relevant environment.
- Keep cytotoxicity, cell-culture, degradation and regeneration claims within their exact specimen and exposure states.

7. Conclusions

Glycerol-derived acrylates do not form one interchangeable photoresin class. PG6-A provides a transparent, viscous CAL platform with residual-acid and processing-state constraints. PGSA/Acr-PGS provides a sebacate-containing elastomer platform whose extrusion, DLP, thermal and degradation behaviour belongs to distinct formulations and article histories.

The primary evidence also shows why qualification must follow the full state chain: prior light exposure changed PG6-A reuse settings; extensive post-processing changed its extract response; viscosity controlled Acr-PGS filament stability; architecture and composition co-determined the DLP culture result; and heat treatment altered PGSA mechanics and degradation.

ER-119 releases no universal glycerol-derived formulation, sustainability equivalence, resolution, cytocompatibility, degradation rate, sterilisation tolerance or regenerative claim. Release requires molecular identity, process, post-processing and final-article evidence.

Limitations

This qualitative engineering review is not a systematic meta-analysis. Direct studies use different backbones, acrylation routes, initiators, processes, post-cures, washes, thermal histories, geometries and biological models; numerical values are not pooled. No proprietary recipe, universal green claim, complete toxicology, in-vivo validation, sterilisation validation, regulatory approval or clinical-performance claim is supplied.

Author contributions

Juan Seguro: conceptualisation, evidence synthesis, boundary definition, engineering interpretation, manuscript preparation and final author verification.

Competing interests

The author is Founder and Scientific Director of 3Dresyns by Resyner Technologies S.L. No comparative product recommendation is made.

Data availability

No new experimental dataset was generated. Scientific statements derive from the cited primary articles and official standards.

Company information

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