

Interlayer Cohesion and Mechanical Anisotropy in Vat-Photopolymerised Thermosets: Cure Overlap, Network Continuity and Qualification

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Statement of Significance

A layer line is not automatically a weak interface, and orientation-dependent strength is not automatically a measurement of interlayer cohesion. Vat photopolymerisation creates successive layers while the preceding material remains partly reactive, solvent-rich and mechanically evolving. Load transfer can therefore arise from overlapping cure, reaction across the boundary, network interpenetration, chain entanglement and post-cure, while defects, peel loading, supports and residual stress can create the opposite outcome. This review establishes a qualification architecture that separates native interlayer cohesion from anisotropy, printing delamination, post-print repair and fracture toughness.

Keywords: vat photopolymerisation; SLA; DLP; LCD-MSLA; interlayer cohesion; layer interface; mechanical anisotropy; cure depth; network continuity; interphase; post-cure; build orientation; delamination; qualification

Abstract

Vat photopolymerisation produces thermoset objects through sequential exposure, yet the mechanical meaning of the resulting layer boundaries remains unsettled. Interlayer adhesion, Z strength, anisotropy, delamination and fracture are often treated as synonyms even though they describe different observables and can be governed by different mechanisms. This review defines native same-material interlayer cohesion as load transfer across a boundary created during the original VPP build, before any deliberate repair operation. The evidence shows that anisotropy is formulation- and protocol-specific rather than intrinsic to the process. Some DLP and SLA studies report significant orientation dependence, while others find statistically indistinguishable properties when cure penetration, network formation and post-processing are sufficient. Strategies that reduce anisotropy include thermally activated reactions between adjacent layers, core-shell toughening, orthogonal thiol-ene/thiol-epoxy curing, interpenetrating networks, disulfide exchange and boronate-ester network rearrangement. These approaches improve different combinations of cure overlap, interface chemistry, stress relaxation and bulk toughness; none creates a universal interlayer-strength value. Direct interphase work published in 2026 further shows that diffusion width can be quantified by compositional and nanomechanical mapping and can influence tensile response. A minimum evidence set is proposed for resin state, optical overlap, interface-targeted mechanics, build and crack coordinates, failure location, conditioning, statistics and uncertainty. Standard tensile, flexural and compression methods remain useful, but no published ISO or ASTM standard directly defines interlayer cohesion for neat VPP photopolymer thermosets. The central conclusion is that interlayer performance is a realised material-process state that must be demonstrated, not inferred from layer visibility, cure depth, orientation or a product label.

1. Scope and shared qualification framework

ER-73 addresses load transfer across boundaries formed between successive layers of the same vat-photopolymerised thermoset. It covers the origin of the interphase, orientation-dependent mechanical response, interface-targeted measurement, failure-location evidence and process controls required before a printed material is described as having strong, isotropic or improved interlayer performance.

Shared evidence grading, measurement disclosure and decision rules for the Engineering Review series are defined in RP-02, Evidence-to-Decision Qualification Framework for Vat Photopolymerisation [F1]. ER-73 applies that framework to the topic-specific question of native interlayer cohesion.

The central distinction is simple: an orientation effect can reveal a directional system response, but it does not identify the controlling interface unless the specimen, failure path and material state demonstrate that interface directly.

2. Terminology and non-equivalences

Table 1. Terms that must not be treated as interchangeable

Term	Operational meaning in ER-73	What it does not establish
Layer boundary	Geometric boundary between successive exposure steps in the build history.	A mechanically weak plane or a discrete chemical interface.
Native interlayer cohesion	Load transfer across a same-material boundary formed during the original VPP build.	Post-damage healing, joining of separately printed parts or multi-material adhesion.
Interlayer adhesion	Source terminology retained where used; often refers to same-material layer bonding.	A separate adhesive phase or an interface-standard result.
Interphase	Finite region across a nominal boundary with a composition, conversion or modulus gradient.	An infinitely thin mathematical surface.
Mechanical anisotropy	Property dependence on a fully declared specimen and build coordinate system.	Proof that layer cohesion alone controls failure.
Delamination	Crack or separation that propagates along or near a layer boundary.	Any brittle break or any visible layer line.
Cure overlap	Exposure of a new layer extends into material associated with a previous layer.	Quantified interlayer strength or network continuity.
Post-cure strengthening	Mechanical change after additional UV, thermal or chemical treatment.	Native as-printed cohesion, autonomous repair or restored fracture resistance.
Fracture toughness	Sharp-crack resistance under a validated fracture method.	Tensile strength, flexural strength, impact resistance or orientation ratio.

3. How a native VPP interlayer forms

A new VPP layer is not deposited as a fully cured sheet onto an inert solid. Fresh resin contacts a preceding region whose conversion, free volume, residual functionality, solvent content and modulus depend on the exposure history. The next exposure may penetrate across the nominal boundary, activate residual reactive groups and create a finite interphase. At the same time, resin or monomer can diffuse into the preceding network before and during cure. Native cohesion is therefore a coupled result of optical, chemical, transport and mechanical processes.

3.1 Optical overlap

Cure depth greater than the programmed layer thickness is commonly used to support overlap between successive exposures. This is necessary in many workflows but is not a strength measurement. The cured-depth value depends on wavelength, irradiance, dose, absorber state, resin temperature, oxygen, geometry and

the method used to define the cured boundary. A thick exposed region can still contain conversion gradients, residual stress or defects.

3.2 Reaction across the boundary

Kim, Han and Seo added thermally curable epoxy or hydroxyl functionality to an SLA formulation. Thermal post-curing induced reactions between adjacent layers and produced enhanced interlayer bonding and substantially improved mechanical properties without a significant dimensional-stability penalty [3]. Yu and co-workers used an orthogonal thiol-ene and thiol-epoxy strategy: the DLP stage formed the initial network, and a thermally activated thiol-epoxy reaction improved layer-interface adhesion, raised tensile strength across all tested orientations by approximately fivefold and reduced the reported anisotropy to below 5% [5]. These are secondary-reaction strategies, not evidence that every ordinary UV post-cure strengthens interfaces in the same way.

3.3 Diffusion, interpenetration and entanglement

Ecker and co-workers treated the boundary as a finite diffusion zone rather than an ideal surface. In a methacrylate/allyl-thiol multi-material VPP system, diffusion width depended on immersion time and temperature and was quantified by sulfur-sensitive EDX with complementary nanoindentation; the measured interphase influenced tensile properties [12]. A corrigendum to the paper is recorded separately [12C]. The study is directly important for interface metrology, but its quantitative transport window is chemistry- and workflow-specific and should not be transferred to a neat single-resin system without measurement.

3.4 Defects and loading history

Void formation, contamination, undercure, local overcure, incomplete resin renewal and peel-induced damage can all reduce load transfer. A boundary may therefore fail because it was chemically weak, because a defect lay near it, or because printing forces damaged the green structure before final cure. The cause cannot be assigned from the fracture plane alone.

4. Orientation testing is indirect evidence

Build-orientation tests are widely used because they are practical. They expose different relationships between the layer normal, loading axis, specimen surface, supports and failure plane. That makes them valuable system tests, but also makes them non-specific. Orientation changes can alter the number of layers, exposure accumulation, support scars, surface roughness, peel history, platform position, dimensional accuracy and stress state at the same time.

Table 2. Representative evidence and the claim boundary it supports

Study	Controlled comparison	Supported finding	Boundary
Naik and Kiran [1]	Orientation, layer thickness, strain rate and size in VPP tensile specimens.	Anisotropy appeared between specimens built in different planes; thicker layers and lower strain rate reduced strength and stiffness.	Direction, rate and layer thickness are coupled; no direct interlayer-strength value.
Monzón et al. [2]	Three photopolymers, build direction and post-cure in DLP.	Build direction affected mechanics; post-cure sometimes reduced anisotropy depending on resin.	Anisotropy and its correction are formulation-specific.
Li et al. [4]	Core-shell-particle loading in an SLA epoxy resin.	Toughness and tensile response improved; tensile-strength anisotropy fell from 42.1% to 0.3% at the reported formulation.	Reduced orientation spread is not direct proof of interface chemistry.
Stögerer et al. [7]	Three orthogonal build directions in a filled methacrylate composite.	No statistically significant anisotropy under the tested procedures; penetration depth exceeded layer thickness by several times.	Absence of measured anisotropy does not prove an infinitely strong interface.

Study	Controlled comparison	Supported finding	Boundary
Cingesar et al. [8]	Print angle, layer thickness, post-processing, specimen size and shape in two SLA resins.	Printing and post-processing conditions affected mechanical, thermal and physicochemical response.	The final state cannot be represented by orientation alone.
Sardana et al. [13]	Seven orientations with constant print parameters in one MSLA resin.	Compression was orientation-sensitive; tensile and flexural differences were not statistically significant at the tested sample size.	Loading mode and statistical power govern the anisotropy conclusion.

The evidence does not support a universal statement that VPP parts are anisotropic or isotropic. The correct statement is conditional: a defined material, geometry, orientation set, printer, exposure and post-processing workflow produced a measured directional response under a stated load mode.

5. Strategies that can reduce orientation dependence

5.1 Toughening and stress redistribution

Li and co-workers designed epoxide-functional core-shell particles for an SLA resin. The particles improved toughness and interlayer bonding, and reduced the reported tensile-strength anisotropy from 42.1% to 0.3% [4]. The result demonstrates that bulk toughening and interface response can improve together. It does not show that every dispersed rubber phase improves layer cohesion, because particle dispersion, reaction, scattering, cure kinetics and modulus balance are formulation-specific.

5.2 Orthogonal secondary curing

The thermally activated strategies of Kim et al. [3] and Yu et al. [5] add a second chemical pathway after the initial photoprinting step. Their central advantage is not simply a higher final conversion; it is the possibility of reaction across boundaries that were formed during printing. A valid comparison therefore needs matched single-cure controls, identical post-cure thermal histories and evidence that the failure location or orientation response changed for the intended reason.

5.3 Interpenetrating networks

Zhang and co-workers combined greater optical penetration with a subsequently thermocured epoxy network that crossed the DLP printing interface. The resulting interpenetrating network showed little mechanical anisotropy, doubled bending strength relative to the photosensitive resin, increased room-temperature storage modulus by 70% and increased T_g by 57% [10]. These values support that specific IPN route. They should not be translated into a general rule that deeper cure or any dual-network label guarantees interface compatibility.

5.4 Dynamic network rearrangement

Wang and co-workers used UV-induced disulfide metathesis to rearrange a crosslinked acrylate network. The source reports reduced x-z tensile anisotropy, enhanced adhesion among printed layers and correction of severe warpage from about 6% to 1-2% under the investigated UV treatment [9]. Bonacini and co-workers used boronate-ester metathesis to relax part of the printing stress and promote additional bonding between adjacent layers. Their dynamic formulation showed substantially lower anisotropy than a static control, but remained measurably anisotropic under some conditions [11]. Dynamic chemistry can therefore reduce, not automatically eliminate, directional response.

6. Direct and indirect measurement architecture

No single test resolves all interface questions. A defensible programme combines indirect orientation testing with at least one interface-sensitive method and a failure-location record.

6.1 Orientation series

Tensile, flexural and compression tests can reveal directional response when geometry, conditioning and load mode are controlled. ISO 17295:2023 should be used to report part positioning, coordinates and orientation [S1]. For tensile comparisons, ISO 527-1:2019 with ISO 527-2:2025 or ASTM D638-22 can provide a conventional method basis [S2-S4]. ASTM D790-25 and ASTM D695-26 provide flexural and compression routes [S5-S6]. None of these standards defines native VPP interlayer cohesion, and none identifies the controlling failure plane automatically.

6.2 Interface-targeted specimens

A direct comparison should place a known layer boundary, exposure interruption or deliberately controlled interphase in the critical section of a specimen and compare it with a bulk-like control of the same geometry. The method must show where failure occurred. Without failure-location evidence, a lower load can reflect a grip, surface, void or geometry effect rather than the intended boundary.

6.3 Interphase mapping

Compositional mapping, conversion mapping, nanoindentation, microscopy and spectroscopic depth profiling can establish whether a finite interphase exists and whether its composition or modulus differs from the surrounding material. Ecker et al. demonstrate a coupled EDX-nanoindentation route for diffusion width [12]. The same principle can be adapted only when a measurable contrast and adequate spatial resolution exist.

6.4 Fracture-path evidence

Fractography should distinguish interface-localised failure, cohesive failure through one layer, crack deflection near a boundary and defect-triggered bulk fracture. Sardana et al. observed pores and interlayer voids as crack-initiation sites but no clear macroscopic delamination under their imaging conditions [13]. This is a useful warning: a visible layer pattern and an internal defect population can coexist without the final crack following the layer plane.

7. Post-cure, conversion and network state

Post-cure can increase conversion, modulus and T_g, reduce residual extractables and continue reaction across boundaries. It can also increase shrinkage stress, embrittle a network or change the failure location. Štaffová and co-workers identified network density as a key variable in the thermomechanical properties of masked-stereolithography structures and showed that post-curing time, orientation and thickness influence the final response [6]. Cingesar et al. likewise found that printing angle, layer thickness, post-processing, specimen size and shape all affect the realised state [8].

Consequently, the phrase post-cured is insufficient. Report wavelength, irradiance where known, chamber temperature, time, specimen rotation, delay after washing, atmosphere and specimen temperature. Interface conclusions should be repeated after the intended service conditioning when humidity, solvent, heat, UV ageing or sterilisation can alter the network.

8. Coordinate and failure-location reporting

A complete orientation description identifies the machine coordinate system, layer normal, specimen axis, load direction and intended failure plane. Terms such as flat, vertical, X, Z, 0 degrees and 90 degrees are

ambiguous without a diagram or ISO 17295 reference. The report should also state whether supports touched the gauge region, which surface faced the vat film or free surface, and where each specimen was placed on the build platform.

For every failed specimen, classify the dominant location as interface-localised, near-interface, bulk cohesive, surface-originated, support-originated, grip-originated or indeterminate. The classification should be supported by images at a resolution capable of resolving the stated feature.

9. Proposed reporting aids

The following quantities are proposed as engineering reporting aids. They are not standardised properties and must not replace full curves, replicate values or failure images.

9.1 Optical overlap ratio

$O_c = C_d / h_L$

C_d is the cured depth measured under the declared exposure condition and h_L is the programmed layer thickness. O_c documents optical overlap only. It is not an interlayer-strength ratio and should not be compared across different cured-depth methods without qualification.

9.2 Orientation-retention ratio

$R_{orient}(P) = P_{min} / P_{max}$

P is a declared property measured across a complete orientation set. Report every orientation value and uncertainty; the ratio alone can hide a weak maximum, a non-monotonic orientation response or different failure modes.

9.3 Interface-to-bulk retention ratio

$R_{int}(P) = P_{interface} / P_{bulk}$

The numerator and denominator must use matched geometry, material state, rate and environment. R_int is valid only when the interface-targeted specimen actually fails at the intended boundary or when the method measures interface separation directly.

9.4 Interface-localised failure fraction

$f_{int} = N_{int} / N_{total}$

N_int is the number of specimens with verified interface-localised failure and N_total is the total number assessed under that condition. State the imaging method, classification rule and treatment of indeterminate cases.

9.5 Measured interphase width

$\Delta_{int} = \text{width of the declared compositional, conversion or modulus transition}$

The measurement signal, threshold convention, spatial resolution and sectioning direction must accompany delta_int. Different mapping signals need not produce the same width.

10. Minimum qualification matrix

Table 3. Minimum evidence architecture for an interlayer-cohesion claim

Domain	Minimum record or measurement	Required conclusion
Material identity	Exact resin version, batch, formulation changes and storage history.	Defines the chemical system tested.

Domain	Minimum record or measurement	Required conclusion
Printer and optics	Technology, wavelength, irradiance or dose basis, pixel/spot geometry and platform position.	Defines the exposure system.
Layer formation	Layer thickness, exposure sequence, wait/recoat time, resin temperature and O _c .	Documents the layer and overlap history.
Post-processing	Wash medium/time, drying delay, post-cure wavelength, dose/time, temperature and orientation.	Defines the final network state.
Coordinates	ISO 17295-based build, specimen, load and failure-plane description.	Makes orientation comparisons reproducible.
Mechanical response	At least two relevant orientations and one load mode, with full curves and uncertainty.	Establishes directional system response.
Interface-sensitive evidence	Matched interface-targeted and bulk control, or direct separation/interphase method.	Links the result to the intended boundary.
Failure location	Image-based classification for every specimen or a justified sampling plan.	Separates interface failure from bulk and defect failure.
Environment and ageing	Conditioning, temperature, humidity/medium, dwell, ageing and test timing.	Defines the service-relevant state.
Statistics	Replicate count, exclusions, distribution, uncertainty and power where null results are claimed.	Prevents isotropy claims from underpowered tests.

11. Failure modes and interpretation errors

Table 4. Common failures in interlayer-cohesion qualification

Observation	Possible interpretation error	Required control
Cure depth exceeds layer thickness	Optical overlap treated as strength.	Interface-targeted mechanics and failure location.
0 degree and 90 degree tensile values differ	Difference assigned entirely to layer cohesion.	Control platform position, surface, supports, dimensions and defect state.
No significant orientation difference	Material declared universally isotropic.	Power analysis, additional load modes and interface-sensitive test.
Fracture surface shows layer lines	Visible texture treated as delamination.	Trace crack origin and propagation at adequate resolution.
Post-cure raises strength	Native cohesion assumed improved.	Matched pre/post-cure failure-location evidence and conversion record.
Dynamic network reduces anisotropy	Complete isotropy or universal healing claimed.	Static-network control, time-temperature history and residual anisotropy.
Part splits during printing	Final material interface declared weak.	Separate green strength and peel history from final conditioned mechanics.
Good wedge or coupon screen	ISO-level interface qualification inferred.	Use the screen only for selection; perform defined mechanical validation.
Bulk specimen fails away from interface	High interlayer strength quantified without a lower bound.	Report cohesive failure and the test limit; do not invent an interface value.
One product prints successfully	Printer-independent layer cohesion claimed.	Repeat calibration and validation on each intended optical/process system.

12. Standards and current evidence gap

ISO 17295:2023 standardises the representation of AM part positioning, coordinates and orientation [S1]. ISO 527-1:2019 and ISO 527-2:2025, ASTM D638-22, ASTM D790-25 and ASTM D695-26 provide conventional tensile, flexural and compression methods for plastics [S2-S6]. They are useful method

foundations but are not VPP-interface standards and do not prescribe cure overlap, interphase width, layer-boundary placement or failure-location classification.

ASTM WK97748, initiated on 14 January 2026, is a work item to revise ASTM D638 by adding an additive-manufacturing specimen type and conducting an interlaboratory study [S7]. It is not a published standard and does not yet close the interlayer-cohesion gap. No published ISO or ASTM method was identified that directly defines native interlayer cohesion for neat vat-photopolymerised thermosets. Protocols adopted today must therefore be reported as fully specified in-house or adapted methods.

13. Scope boundaries within the Engineering Review series

ER-73 is restricted to native same-material layer boundaries formed during the original VPP build and to the evidence needed to attribute directional mechanical response to those boundaries.

- ER-13 addresses self-healing and interlayer repair after damage or deliberate joining. ER-73 does not treat a repaired interface as native cohesion.
- ER-27 addresses conversion metrology and spatial cure heterogeneity. ER-73 uses conversion and cure depth as state variables but requires separate mechanical evidence.
- ER-31 addresses cure shrinkage, residual stress and warpage. ER-73 includes residual stress only where it changes layer-boundary response or anisotropy.
- ER-34 addresses vat-film separation and peel mechanics. ER-73 distinguishes printing delamination caused during peel from final conditioned interlayer cohesion.
- ER-43 addresses interfaces between intentionally different materials and functionally graded regions. ER-73 addresses nominally same-material successive layers.
- ER-59 addresses sequential dual-cure network architecture. ER-73 uses dual curing only where it changes layer-boundary continuity.
- ER-61 addresses gelation, vitrification and mobility arrest. ER-73 begins from those network-state variables and asks how they realise load transfer across layers.
- ER-70 addresses sharp-crack fracture toughness and damage tolerance. ER-73 records crack and failure locations but does not convert orientation strength into KIC, GIC or a damage-tolerance claim.

14. 3Dresyns implementation boundary

3Dresyns documentation provides implementation and diagnostic context, not independent proof of a universal interlayer-cohesion value. The Curing Rate Control System links exposure to measured cured thickness and explicitly states that final performance depends on the complete material-printer-process-post-processing chain [M1]. The layer-delamination guidance identifies insufficient exposure, cure depth relative to layer thickness, peel forces and support limitations as interacting causes of visible separation [M2].

The Structured Mechanical Screening Protocol provides a printer-native comparative screen of bending, fracture and process stability, while explicitly stating that it does not replace ISO mechanical testing, finite-element analysis or application qualification [M3]. The Failure Atlas classifies delamination and splitting within a broader exposure-mechanics-transport framework [M4]. These tools can support diagnosis and screening, but they do not create a standard interlayer-strength claim.

No 3Dresyns product name, family label, fixed exposure setting, cured-depth factor or successful print should be interpreted as proof of printer-independent layer cohesion, isotropy, fracture toughness or service durability. A product-specific claim requires the exact material version, printer, exposure, layer thickness, orientation, post-processing, conditioning, test method, failure location and uncertainty.

15. Research and standardisation priorities

- an interlaboratory interface-targeted specimen and failure-location protocol for VPP thermosets;

- a common distinction between optical overlap, chemical continuity and mechanical cohesion;
- conversion- and modulus-resolved mapping through a printed same-material layer boundary;
- validated miniature interface tests for small build volumes;
- statistical guidance for declaring practical isotropy rather than merely failing to reject equality;
- coupled records of peel history, green strength and final conditioned cohesion;
- multi-axial and fatigue loading of known layer-boundary orientations;
- ageing studies that track whether humidity, solvent, UV, heat or sterilisation changes the controlling failure plane;
- benchmark artefacts that separate platform position, support contact and layer orientation;
- standard metadata fields linking material batch, printer optics, cure history and interphase measurements.

16. Conclusions

Native interlayer cohesion in vat photopolymerisation is not an isolated resin property. It is realised through the interaction of optical overlap, network formation, diffusion, residual reactivity, post-cure, defects and printing mechanics.

Mechanical anisotropy is an important system observable, but it is not a direct interface measurement. The literature contains both significant and statistically insignificant orientation effects, and both outcomes are credible within their stated materials and workflows. Loading mode, cure state, geometry, statistical power and failure origin determine the interpretation.

Secondary chemical reactions, interpenetrating networks, dispersed tougheners and dynamic exchange can reduce orientation dependence by different mechanisms. Their success must be demonstrated against matched controls and cannot be converted into a universal layer-strength factor.

The minimum defensible claim architecture is therefore:

declared material and process state + ISO-based coordinates + orientation mechanics + interface-sensitive evidence + verified failure location + conditioning + uncertainty

Until a dedicated standard exists, this complete record is the practical basis for describing interlayer cohesion in VPP thermosets.

Limitations

This review is a literature-based engineering synthesis and does not report new interlayer experiments. Several cited studies use the source term interlayer adhesion even when the boundary is between successive layers of the same chemistry; ER-73 retains that terminology only when describing the source and otherwise uses native interlayer cohesion. Quantitative results are formulation-, printer-, geometry- and protocol-specific and are not pooled into a universal anisotropy or cohesion value. The Ecker et al. diffusion study concerns a multi-material methacrylate/allyl-thiol interface and includes a published corrigendum; it supports the finite-interphase measurement concept, not direct transfer of its numerical diffusion window to every VPP resin. No claim is made that the listed conventional plastics standards validate a VPP-specific layer interface.

Author contributions

Juan Seguro: conceptualisation, literature synthesis, engineering framework, writing and critical review.

Competing interests

The author is founder, CEO and CTO of 3Dresyns by Resyner Technologies S.L. Manufacturer documentation is included only as implementation context and is separated from independent scientific evidence.

Data availability

No new experimental dataset was generated for this review. The evidence map and document-control records are maintained with the prepublication review package.

Company information

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References

- [1] Naik, D. L.; Kiran, R. On Anisotropy, Strain Rate and Size Effects in Vat Photopolymerization Based Specimens. *Additive Manufacturing* 2018, 23, 181-196. DOI: [10.1016/j.addma.2018.08.021](https://doi.org/10.1016/j.addma.2018.08.021).
- [2] Monzón, M.; Ortega, Z.; Hernández, A.; Paz, R.; Ortega, F. Anisotropy of Photopolymer Parts Made by Digital Light Processing. *Materials* 2017, 10(1), 64. DOI: [10.3390/ma10010064](https://doi.org/10.3390/ma10010064).
- [3] Kim, H.; Han, S.; Seo, Y. Novel Dual-Curing Process for a Stereolithographically Printed Part Triggers a Remarkably Improved Interlayer Adhesion and Excellent Mechanical Properties. *Langmuir* 2020, 36(31), 9250-9258. DOI: [10.1021/acs.langmuir.0c01553](https://doi.org/10.1021/acs.langmuir.0c01553).
- [4] Li, Y.; Peng, S.; Miao, J.-T.; Zheng, L.; Zhong, J.; Wu, L.; Weng, Z. Isotropic Stereolithography Resin Toughened by Core-Shell Particles. *Chemical Engineering Journal* 2020, 394, 124873. DOI: [10.1016/j.cej.2020.124873](https://doi.org/10.1016/j.cej.2020.124873).
- [5] Yu, B.; Zheng, J.; Wu, J.; Ma, H.; Zhou, X.; Hui, Y.; Liu, F.; He, J. Preparation of Isotropic Tensile Photosensitive Resins for Digital Light Processing 3D Printing Using Orthogonal Thiol-Ene and Thiol-Epoxy Dual-Cured Strategies. *Polymer Testing* 2022, 116, 107767. DOI: [10.1016/j.polymertesting.2022.107767](https://doi.org/10.1016/j.polymertesting.2022.107767).
- [6] Štaffová, M.; Ondreáš, F.; Svatík, J.; Zbončák, M.; Jančář, J.; Lepcio, P. 3D Printing and Post-Curing Optimization of Photopolymerized Structures: Basic Concepts and Effective Tools for Improved Thermomechanical Properties. *Polymer Testing* 2022, 108, 107499. DOI: [10.1016/j.polymertesting.2022.107499](https://doi.org/10.1016/j.polymertesting.2022.107499).
- [7] Stögerer, J.; Baumgartner, S.; Rath, T.; Stampfl, J. Analysis of the Mechanical Anisotropy of Stereolithographic 3D Printed Polymer Composites. *European Journal of Materials* 2022, 2(1), 12-32. DOI: [10.1080/26889277.2022.2035196](https://doi.org/10.1080/26889277.2022.2035196).
- [8] Cingesar, I. K.; Marković, M.-P.; Vrsaljko, D. Effect of Post-Processing Conditions on Polyacrylate Materials Used in Stereolithography. *Additive Manufacturing* 2022, 55, 102813. DOI: [10.1016/j.addma.2022.102813](https://doi.org/10.1016/j.addma.2022.102813).
- [9] Wang, S.; Yin, J.; Huang, W.; Ye, J.; Deng, H.; Huang, J.; Wang, S.; Liu, X.; Xiang, H. UV-Induced Disulfide Metathesis: Strengthening Interlayer Adhesion and Rectifying Warped 3D Printed Materials. *Additive Manufacturing* 2022, 59, 103085. DOI: [10.1016/j.addma.2022.103085](https://doi.org/10.1016/j.addma.2022.103085).
- [10] Zhang, Y.; Huang, Z.; Wang, H.; Li, J. Regulation of the Interface Compatibility of the 3D-Printing Interpenetration Networks Toward Reduced Structure Anisotropy and Enhanced Performances. *ACS Applied Materials & Interfaces* 2023, 15(27), 32984-32992. DOI: [10.1021/acsami.3c06514](https://doi.org/10.1021/acsami.3c06514).
- [11] Bonacini, A.; Saccani, E.; Sciancalepore, C.; Milanese, D.; Drago, G.; Pedrini, A.; Pinalli, R.; Nicolaï, R.; Dalcanale, E. Boronate Esters Dynamic Networks for the Reduction of Mechanical Anisotropy in Vat 3D Printed Manufacts. *ACS Applied Polymer Materials* 2025, 7(4), 2624-2632. DOI: [10.1021/acsapm.4c04101](https://doi.org/10.1021/acsapm.4c04101).
- [12] Ecker, J.; Koch, T.; Liska, R.; Stampfl, J. Quantifying Interfacial Diffusion in Photopolymer-Based Vat Additive Manufacturing. *Materials Today Advances* 2026, 30, 100826. DOI: [10.1016/j.mtadv.2026.100826](https://doi.org/10.1016/j.mtadv.2026.100826).
- [12C] Ecker, J.; Koch, T.; Liska, R.; Stampfl, J. Corrigendum to “Quantifying Interfacial Diffusion in Photopolymer-Based Vat Additive Manufacturing” [*Materials Today Advances* 30 (2026) 100826]. *Materials Today Advances* 2026, 30, 100849. DOI: [10.1016/j.mtadv.2026.100849](https://doi.org/10.1016/j.mtadv.2026.100849).
- [13] Sardana, G.; Nemade, K. H.; Ghosh, S. B.; Bandyopadhyay-Ghosh, S. Orientation-Dependent Mechanical Response of Photopolymer Resin Specimens Fabricated by Masked Stereolithography-Based 3D Printing. *Journal of Materials Science: Materials in Engineering* 2026, 21, 113. DOI: [10.1186/s40712-026-00480-3](https://doi.org/10.1186/s40712-026-00480-3).

Framework, standards and manufacturer documentation

- [F1] Seguro, J. Evidence-to-Decision Qualification Framework for Vat Photopolymerisation. 3Dresyns Engineering Publication RP-02, version-independent concept record. Concept DOI: [10.5281/zenodo.22048032](https://doi.org/10.5281/zenodo.22048032).
- [S1] ISO 17295:2023. Additive manufacturing - General principles - Part positioning, coordinates and orientation. <https://www.iso.org/standard/76471.html>.
- [S2] ISO 527-1:2019. Plastics - Determination of tensile properties - Part 1: General principles. <https://www.iso.org/standard/75824.html>.
- [S3] ISO 527-2:2025. Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics. <https://www.iso.org/standard/527-2>.
- [S4] ASTM D638-22. Standard Test Method for Tensile Properties of Plastics. <https://store.astm.org/d0638-22.html>.
- [S5] ASTM D790-25. Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. <https://store.astm.org/d0790-25.html>.
- [S6] ASTM D695-26. Standard Test Method for Compressive Properties of Rigid Plastics. <https://store.astm.org/d0695-26.html>.
- [S7] ASTM WK97748. Revision of D638-22 Standard Test Method for Tensile Properties of Plastics. Work item initiated 14 January 2026. <https://store.astm.org/workitem-wk97748>.
- [M1] 3Dresyns. The 3Dresyns Curing Rate Control System. Accessed 22 August 2026. <https://www.3dresyns.com/pages/the-3dresyns-curing-rate-control-system>.
- [M2] 3Dresyns. Layer Delamination in SLA Printing. Accessed 22 August 2026. <https://www.3dresyns.com/pages/layer-delamination-in-sla-printing>.
- [M3] 3Dresyns. Structured Mechanical Screening Protocol. Accessed 22 August 2026. <https://www.3dresyns.com/pages/3dresyns-structured-mechanical-screening-protocol-smssp>.
- [M4] 3Dresyns. Photopolymer Printing Failure Atlas. Accessed 22 August 2026. <https://www.3dresyns.com/pages/3dresyns-photopolymer-printing-failure-atlas>.