

Tribology and Wear Qualification of Vat-Printed Parts: Tribosystem Definition, Measurement and Transfer Limits

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3Dresyns by Resyner Technologies S.L.

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Statement of Significance

Wear is a system response involving the material pair, contact geometry, load, motion, environment, surface state, lubrication and debris. A resin cannot be declared wear resistant without defining the tribosystem that produced the result.

Keywords: tribology; wear; friction; tribosystem; surface; debris; vat photopolymerisation; qualification.

Abstract

Three topical studies address solid-lubricant modification of photocurable VPP resins, printing parameters associated with surface quality and wear resistance, and the effects of washing and curing time on tribological and hardness characteristics. Their results support conditional engineering relationships, not a universal ranking of materials. This note defines the minimum tribosystem and reporting record, identifies ASTM G99-23, ASTM G133-22 and ISO 7148-2:2026 as method anchors within their respective scopes, and separates manufacturer-controlled 3Dresyns implementation candidates from independent evidence. RP-02 supplies the shared qualification method.

1. Evidence boundary

Slapnik et al. study solid lubricants in photocurable VPP resins [1]. Portoaca et al. relate defined printing parameters to surface quality and wear resistance [2]. Yosef et al. examine washing solution and curing time in masked stereolithography [3]. The earlier generic photopolymer reviews have been removed because they do not support tribology-specific propositions. Numerical results are not pooled across different contact pairs, motions, loads, surfaces or environments.

2. Topic-specific findings

- Solid-lubricant additions can change friction and wear, but also formulation rheology, dispersion, cure and mechanical behaviour; the complete modified system requires requalification [1].
- Printing and surface-producing variables can alter roughness and the contact state presented to a wear test [2].
- Washing and curing history can change hardness and tribological response in a defined MSLA material-process system [3].
- Heat, transfer films and debris can change the active mechanism during sliding; the running-in and steady-state regions must therefore remain visible [1,3].

3. Minimum measurement and reporting set

Control	Method and minimum record	Required interpretation
Tribosystem	Counterface material/finish, contact geometry, normal load, speed, stroke or track, distance, temperature, humidity/medium and lubrication	All variables belong to the result; a wear figure without them is not transferable
Wear	ASTM G99-23 for pin/ball-on-disk, ASTM G133-22 for linearly reciprocating ball-on-flat, or ISO 7148-2:2026 for polymer-based bearing materials where applicable	Report wear volume and specific wear rate; correct mass-based results for density and inspect transferred material
Friction	Coefficient versus sliding distance or time, synchronised with load, motion and interruptions	Separate running-in, transitions and steady state; do not report only an average
Surface/debris	Roughness and microscopy before/after; retain counterface and debris for analysis	Map grooves, transfer film, polishing, fracture and debris to the friction/wear trace
Material state	Grade/lot, printer, exposure, orientation, wash, dry, post-cure, conditioning and timing	Do not transfer a result to an unmatched printed or post-processed state

4. Method and interpretation limits

- ASTM G99-23 applies to pin-on-disk or ball-on-disk sliding. If its procedure is followed with non-standard parameters, report those parameters and do not compare the result with the standard interlaboratory dataset as though it were equivalent.
- ASTM G133-22 applies to linearly reciprocating ball-on-flat wear and excludes corrosive or chemically aggressive environments and extremes of temperature or humidity from its stated scope.
- ISO 7148-2:2026 addresses polymer-based plain-bearing materials; it is not a universal method for every vat-printed geometry or contact mode.
- A lower friction coefficient does not necessarily mean lower wear, and a short running-in trace cannot establish durability.

5. 3Dresyns implementation examples

3Dresyns engineering resins and compatible solid-lubricant routes are manufacturer-controlled candidates, not independent wear evidence. No exact grade is named without its controlled TDS. Release requires grade/revision, loading and mixing records plus print, cure, mechanical and tribological validation against the real counterface and duty cycle; corrected WP-10/WP-26 cannot replace it.

6. Limitations and priorities

The formulation- and apparatus-specific evidence does not establish a universal VPP wear coefficient or service-life model. Priorities are shared-artifact round robins, build/orientation matrices, transfer/debris analysis and ageing-then-tribology using service-relevant counterfaces and environments.

7. Conclusions

- Wear resistance is a tribosystem claim, not an intrinsic label that can be assigned to a resin in isolation.
- ASTM G99-23, ASTM G133-22 and ISO 7148-2:2026 are applicable only within their stated geometries and scopes.
- Friction history, wear volume, surface change, transfer and debris must be interpreted together; no 3Dresyns grade receives a public wear claim until its documents and application-specific tribosystem are verified.

Declarations

Funding: none. Competing interest: the author is Founder and Scientific Director of 3Dresyns by Resyner Technologies S.L. No new dataset was generated. Juan Segurola verified the article and accepts responsibility.

References

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- [3] Doaa A. Yosef, Tawakol A. Enab, Ibrahim Eldesouky. Tribological and hardness characteristics of resin materials in masked stereolithography: impact of washing solution and curing time. *Progress in Additive Manufacturing*. 2026;11(1):83-94. <https://doi.org/10.1007/s40964-025-01336-6>

Standards

ASTM G99-23. Standard Test Method for Wear and Friction Testing with a Pin-on-Disk or Ball-on-Disk Apparatus. <https://store.astm.org/g0099-23.html>

ASTM G133-22. Standard Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear. <https://store.astm.org/g0133-22.html>

ISO 7148-2:2026. Plain bearings - Testing of the tribological behaviour of bearing materials - Part 2: Testing of polymer-based bearing materials. <https://www.iso.org/standard/88052.html>

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