

Separation and Peel Mechanics in Bottom-Up VPP: A Qualification and Minimum-Reporting Note

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Statement of Significance

A separation-force value is useful only when the interface, projected area, lift history, resin state and green-part state are known. This note identifies the measurements needed to distinguish hydrodynamic, film and cure contributions in a specific bottom-up VPP workflow.

Keywords: separation force; peel; release film; green strength; bottom-up VPP; interface.

Abstract

Bottom-up vat photopolymerisation requires the newly exposed region to detach from the vat interface without damaging the green part. Recent LCD-VPP studies show that interface flexibility, vat design, surface roughness, temporal irradiance and printing temperature can change separation behaviour. This Engineering Qualification Note maps those topic-specific findings to a minimum reporting set. It is not a quantitative meta-analysis: values from different machines and geometries are not pooled because the source conditions are not interchangeable. The common evidence-to-decision method is defined separately in RP-02.

1. Evidence boundary

This note addresses bottom-up separation and peel mechanics. It does not claim a universal force threshold or transfer results between vat films, machine architectures, projected areas or lift profiles. Four current primary studies form the topic-specific evidence base [1–4]. RP-02 supplies the shared qualification framework and is not repeated here.

2. Topic-specific mechanisms

- Pressure and viscous refill contribute as the cured area separates and resin returns to the gap; the measured trace therefore depends on production kinematics and resin state [1].
- Release-interface flexibility, roughness and surface condition alter contact and detachment behaviour [1–3].
- Exposure history and temperature change green-body properties and can shift the measured separation response [4].
- Projected area, orientation and drainage path create layer-specific force histories rather than a single transferable material constant [1].

3. Minimum reporting set

Measurand/control	Minimum method record	Required report
Force–time trace	Calibrated load cell at the production lift profile	Peak, impulse, layer position, sampling rate and calibration
Interface state	Film material, thickness, tension/flexibility, roughness, age and contamination	Treat film replacement or cleaning as a process change
Resin state	Temperature and viscosity after equilibration	Record measurement temperature and timing
Green-part state	Exposure history and an early-age mechanical proxy	Match delay and exposure to the production cycle
Geometry	Projected area, orientation, supports and drainage path	Do not compare unmatched coupons or layers

No consensus standard specific to bottom-up VPP separation-force measurement was identified in the reviewed set. The internal method must therefore define calibration, acquisition, geometry, interface state and uncertainty explicitly.

4. Failure interpretation

- Build-platform delamination indicates that the weakest interface may not be the vat film.
- Green-part fracture during lift couples force history to exposure-dependent green strength.
- Release-film sticking or damage changes the boundary condition and invalidates direct comparison with an earlier film state.
- Cumulative geometric distortion can occur without a single catastrophic peak and requires layer-resolved interpretation.

5. 3Dresyns implementation examples

The following are manufacturer-controlled implementation candidates, not independent evidence:

- 3D-ADD NSA1 may be screened as an interfacial process variable. Any reduction in sticking must be requalified against cure, contamination and finished-part properties using the exact product/TDS revision selected for the study.
- Exposure and lift-profile tuning should be qualified together because either change can move the limiting failure mode.

Any product-specific implementation must identify and verify the current exact grade, TDS/IFU revisions and public links at the time of use. A product identity does not establish universal separation-force reduction.

6. Limitations and priorities

The cited studies use different LCD-VPP systems, interfaces and test configurations. Their numerical results must not be pooled or presented as product constants. Priorities are traceable force artefacts, interface ageing and contamination studies, and acceptance criteria that link the force trace to observed part defects.

7. Conclusions

- Bottom-up separation must be qualified as a layer-resolved material–interface–geometry response, not as a resin constant.
- Force values are transferable only with the interface, resin, green-part, geometry and lift conditions that produced them.
- The four topical sources support the mechanisms above; generic photopolymer reviews have been removed from the evidence list.

Declarations

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