

Sacrificial Mandrels and Cores for Electroforming and Composite Manufacture: Removal, Surface Transfer and Dimensional Control

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Abstract

Sacrificial Mandrels and Cores for Electroforming and Composite Manufacture is evaluated as the bounded decision of whether a sacrificial printed core can carry manufacturing loads, preserve geometry and then be removed without unacceptable residue or damage. The controlled state comprises core chemistry, print/cure state, dimensions, coating/release layer, composite cure temperature/pressure, solvent/water history and removal geometry. For ER-285, both cited sources are confined to their stated point-of-use evidence roles. ER-285 defines measurements, transfer logic, failure modes and release gates specific to this subject; no universal process window, product recipe or compliance conclusion is inferred.

Keywords: sacrificial tooling; mandrel; core; photocuring; composites; removal; dimensional control; surface transfer

1. Significance, scope and ownership

ER-285 owns whether a sacrificial printed core can carry manufacturing loads, preserve geometry and then be removed without unacceptable residue or damage. The review is organised around the decision-specific evidence chain and leaves neighbouring ownership intact.

1.1. Corpus boundary

ER-285 concerns a core or mandrel that must carry manufacturing loads and then be removed without compromising the final article. ER-09 retains simple water-removable sacrificial materials, ER-74 programmed network disassembly, and ER-284 reusable tooling. Solubility alone is therefore outside the claimed qualification endpoint.

2. Subject-specific state model and causal chain

For ER-285, causal interpretation begins by freezing core chemistry, print/cure state, dimensions, coating/release layer, composite cure temperature/pressure, solvent/water history and removal geometry. The relevant state spans hot-load survival through removal and residue control; a core that dissolves but distorts the composite has not passed the manufacturing decision.

3. Direct evidence and point-of-use source map

Zhao and co-workers demonstrated photocured thermosetting sacrificial tooling for hollow fibre composites using a hydrolysable resin architecture. Roy and Dickens quantified dimensional tolerances of additively manufactured soluble tooling. Together they show that pre-removal strength and post-removal solvability must be qualified as separate states. Reference [1] is used for photocured sacrificial tooling for hollow composites. Reference [2] is used for dimensional tolerance evidence for soluble tooling.

4. Measurement architecture

The measurement architecture for ER-285 is built around core geometry, thermal expansion, hot strength/stiffness, surface transfer, residue, removal time and accessibility, composite dimensions and post-removal cleanliness. Hot mechanical support, dimensional transfer, removal kinetics and residue checks are linked to the final composite because none of those measurements alone defines core success.

5. Qualification and transfer

Core qualification is repeated when cure load, access path, wall thickness, removal chemistry or composite interface changes. The bridge has to show both manufacturing survival and complete, non-damaging removal in the new geometry.

6. Failure modes and interpretation traps

The central interpretation trap in ER-285 is that easy dissolution is accepted without proving cure-load survival; core dimensions before cure are taken as final cavity dimensions; disappearance of the bulk core is treated as zero residue. The core must pass hot-load, dimensional, surface-transfer, removal and residue gates independently; disappearance of the core is not sufficient evidence of manufacturing success.

7. Non-compensatory release gates

Gate	Minimum evidence	Blocking failure
Core identity	Chemistry/cure/coating state fixed	Generic soluble-core label
Load survival	Hot strength/stiffness under cure load	Solubility substitutes for strength
Dimensional fidelity	Pre/post cure geometry measured	As-printed geometry only
Surface transfer	Composite interface quality measured	Tool surface assumed transferred
Thermal history	Expansion/shrinkage represented	Temperature excursion ignored
Removal access	Diffusion/removal path representative	Small open coupon generalized
Residue	Residual chemistry/solids checked	No visible core called clean
Final article	Composite dimensions/integrity verified	Core removal alone called success

8. Minimum verification experiment

Measure the printed core, apply the actual or simulated cure temperature and pressure with representative support, remeasure deformation, fabricate a representative shell/laminate, remove the core under a declared protocol and quantify residue, surface transfer and final internal dimensions.

9. Knowledge boundary

Sacrificial tooling demonstrations do not supply a universal removal time, residue limit or cure-load envelope. Accessibility, wall thickness, fluid transport and matrix/tool interaction remain geometry- and chemistry-specific.

10. Conclusions

ER-285 requires a sacrificial core to survive manufacture, transfer the required surface and dimensions, and then be removed without unacceptable residue or damage to the final composite.

References

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2. Madhuparna Roy, Tarik J. Dickens. Additive technology of soluble mold tooling for embedded devices in composite structures: A study on manufactured tolerances. *Additive Manufacturing*. 2017;15:78-86. <https://doi.org/10.1016/j.addma.2017.03.012>

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