

## 3D PRINTED PATTERN MATERIALS FOR SAND CASTING

*PETG, PCTG, ABS, and ASA for Reusable Sand-Casting Patterns*

---

For large reusable 3D printed patterns in sand casting, material choice should be based on print stability, warp resistance, dimensional tolerance, heat resistance, cold-weather handling, coating compatibility, binder exposure, and overall pattern construction. PETG and PCTG are copolyesters and are generally safer low-warp choices for very large printed patterns, especially where dimensional stability and repeatability matter. PCTG is the preferred starting point when toughness, impact resistance, and long-term handling durability are important. PETG is a practical lower-cost alternative.

ABS and ASA are styrenic thermoplastics. They generally sand and machine better than PETG/PCTG and offer better heat resistance, but extremely large patterns printed from styrene-based plastics often have more trouble with warp, curling, splitting, and layer delamination unless print conditions are tightly controlled. ABS and ASA should also be treated cautiously around furan, phenolic/furan, and other chemically bonded no-bake binder systems. Published ABS chemical-resistance references list furfural and furfuryl alcohol as severe or incompatible exposures, and furan no-bake binder systems may contain furfuryl alcohol chemistry. Compatibility depends on the exact resin, catalyst, coating, exposure time, and temperature, so coupon testing is recommended before committing to a full printed pattern.

PCTG, or polycyclohexylenedimethylene terephthalate glycol-modified copolyester, is part of the broader glycol-modified copolyester family. It is related to PETG, but with chemistry that gives it improved toughness, impact resistance, and functional durability. PCTG-type copolyesters have been used for years in demanding commercial and industrial applications where toughness, clarity, chemical resistance, repeated handling, and environmental exposure matter, including consumer products, medical products, packaging, electronics, automotive applications, outdoor-use applications, and nautical/marine-adjacent uses. Those same traits make PCTG a strong candidate for reusable 3D printed foundry patterns, especially when the pattern is large, handled repeatedly, transported in cold weather, or coated with epoxy or primer systems.

### Practical Recommendations

---

For large reusable 3D printed foundry patterns, **PCTG is the best default material** when low warp, dimensional tolerance, cold-weather toughness, and impact resistance are priorities. **PETG** is the lower-cost alternative and remains a strong utility material. **ASA** is useful when sandability, UV resistance, and heat resistance are more important, but it should be tested around furan/phenolic binder systems and epoxy coatings. **ABS** is useful for controlled indoor work but is the least attractive of these four for extremely large cold-weather patterns due to warp, fumes, UV weakness, delamination risk, and styrenic binder-compatibility concerns.

Carbon-filled versions may improve stiffness, reduce flex, and modestly improve dimensional stability, but they do not solve extreme winter use by themselves. In sub-freezing conditions, large printed patterns can still contract, collect condensation, chip, delaminate, or vary dimensionally. For winter operation, a heated pattern shed, insulated storage, supplemental heaters, heated blankets, or climate control are worth considering.

The best solution is usually **printed copolyester pattern faces, stable backing, sealed coating, mechanical registration, and controlled storage/acclimation before molding.**

**MATERIAL COMPARISON TABLE**

Material	Polymer Family	Primary Advantages	Main Concerns	Sandability	Warp / Delam. Risk (Large Prints)	Cold-Weather Suitability	Heat Resistance	Coating / Binder Notes	Foundry Pattern Recommendation
PETG	Copolyester	Low warp, good dimensional tolerance, good layer adhesion, good toughness, widely available, relatively easy to print	Gummy sanding, moderate heat resistance, can creep under load, surface can be slick for coatings if not abraded	Fair to poor	Low compared with ABS/ASA	Good	Moderate	Generally more predictable under epoxy than styrenics in shop use; still requires abrasion, cleaning, and coating tests	Good low-cost utility choice for large printed patterns, core boxes, and shop tooling where sanding quality is not the top priority
PCTG	Copolyester	Low warp, good dimensional tolerance, better toughness and impact resistance than typical PETG, good cold-weather handling, good functional durability	Higher cost than PETG, only fair to sand, moderate heat resistance, less common than PETG	Fair	Low compared with ABS/ASA	Very good	Moderate	Strong candidate for epoxy-coated pattern faces; binder exposure should still be coupon-tested	Best overall starting point for large reusable printed patterns in variable or cold foundry environments
ABS	Styrenic thermoplastic	Good sandability, machinable, traditional industrial FDM material, better heat resistance than PETG/PCTG	Warping more, enclosure needed, fumes/odor, poor UV resistance, large prints can split or delaminate if cooled unevenly	Good	Medium to high	Fair	Good	Published ABS compatibility references list furfural/furfuryl alcohol as severe or incompatible exposures; use caution around furan/phenolic systems and aggressive solvents	Useful for controlled indoor pattern work, but less attractive for extremely large cold-weather or furan-adjacent tooling
ASA	Styrenic thermoplastic	Good sandability, better UV/weather resistance than ABS, good heat resistance, good finished tooling behavior	Needs enclosure, can warp on large prints, fumes/odor, possible splitting/delamination on large parts if thermal control is poor	Good	Medium	Good	Good	Same styrenic caution applies; test around furan/phenolic no-bake systems, epoxy coatings, catalysts, and solvent prep	Good finished pattern material when UV resistance, sandability, and heat resistance matter, but not the safest default where binder compatibility is uncertain
PETG-CF / PCTG-CF	Carbon-filled copolyester	Higher stiffness, reduced flex, potentially improved dimensional stability, lower deflection on large surfaces	More abrasive, requires hardened nozzle, more expensive, may be more brittle, harder to sand, print-direction behavior can matter	Fair to poor	Low, but fiber orientation can make behavior directional	Good to very good	Moderate to improved, depending on grade	Should be tested before use; carbon fill does not eliminate cold-weather contraction, condensation risk, or process variation	Optional upgrade where added stiffness is needed; not a substitute for backing, sealing, registration, or acclimation
ABS-CF / ASA-CF	Carbon-filled styrenic thermoplastic	Higher stiffness and heat resistance than unfilled ABS/ASA, potentially less movement than unfilled styrenics	Still styrenic, still needs enclosure, abrasive, potentially brittle, coating-sensitive, large prints still require thermal control	Fair to good	Medium	Fair to good	Good to improved, depending on grade	Same furan/phenolic and solvent cautions apply; carbon fill does not make styrenic chemistry disappear	Use only after coupon testing; not recommended as the default answer to cold-weather pattern problems

---

## Patternmaking Notes

---

For very large printed patterns, the biggest practical problems are often not nominal tensile strength. They are print warp, thermal stress, layer splitting, seam movement, coating compatibility, cold-weather contraction, and handling damage. Styrene-based plastics such as ABS and ASA can produce good sanded tooling surfaces, but on very large prints they are more likely than PETG/PCTG to warp, curl, split, or delaminate if enclosure temperature, cooling rate, and print orientation are not controlled.

PETG and PCTG, being copolyesters, are generally better choices when low warp and dimensional tolerance are the dominant requirements. PCTG is especially attractive when the pattern will be repeatedly handled, transported, rammed against, or used in colder shop conditions.

For large patterns, the printed plastic should often be treated as the geometry surface, not the entire structure. Repeatable tooling usually requires a stable backing, mechanical registration, sealed surfaces, and controlled handling.

---

## Furan / Phenolic No-Bake Binder Caution

---

The concern with ABS and ASA is not ordinary green sand. Clean clay-bonded green sand is normally not chemically aggressive to PETG, PCTG, ABS, or ASA. The concern is chemically bonded no-bake sand systems, including furan, phenolic/furan, and phenolic-urethane systems, where the pattern surface may be exposed to resin, catalyst, acid, solvent, or binder residue.

Published ABS chemical-resistance references list furfural and furfuryl alcohol as incompatible or severely affecting ABS. Furan no-bake binder systems may contain furfuryl alcohol chemistry. Because ABS and ASA are styrenic plastics, they should be tested before use with furan, phenolic/furan, phenolic-urethane, or other chemically bonded binder systems.

A coating or epoxy seal can reduce direct exposure, but it does not eliminate the need for coupon testing. Coating performance depends on the exact plastic, surface preparation, coating system, binder chemistry, cure conditions, temperature, and exposure time.

---

## Heat Resistance and Cold-Weather Use

---

Heat resistance is still an important consideration for reusable sand-casting patterns, but it should not be confused with cold-weather dimensional control.

ASA and ABS generally offer better heat resistance than PETG and PCTG. Carbon-filled variants may improve stiffness and reduce deflection under some conditions. However, better heat resistance does not eliminate the challenges of sub-freezing pattern use.

In extreme winter conditions, such as outdoor or unheated storage below 32°F, large printed patterns can still contract, collect condensation when moved into a warmer molding area, become more impact-sensitive, and show dimensional variation from one molding session to another. Carbon fiber fill can improve stiffness, but it does not substitute for a separate heated pattern shed, controlled storage, supplemental winter heaters, heated blankets, or climate control.

For repeatable foundry use in sub-freezing weather, supplemental heaters, a small heated pattern shed, insulated pattern storage, heated blankets, or basic climate control should be considered. These measures help keep the pattern closer to the intended molding temperature, reduce condensation risk, and improve repeatability. Material selection can reduce risk, but environmental control is the more direct solution.

**Important:** If the application involves hot-box tooling, shell-core boxes, or direct exposure to approximately 350–500°F service temperatures, PETG, PCTG, ABS, and ASA are not appropriate tooling materials. That is a different tooling category. While there are some materials where this is relevant, such as PPS or PAEK, at this point you're likely moved into metals for tooling.

---

## Carbon Fiber Fill Caution

---

Carbon-filled materials can be useful, but they should not be oversold. Carbon fiber fill can improve stiffness, reduce flex, and may reduce some movement or deflection, depending on the base polymer and print orientation. However, carbon-filled material is usually more abrasive, more expensive, potentially more brittle, harder to sand, and more directionally dependent than unfilled material. Aside from these issues, maintenance of the pattern (sanding) releases airborne particles that are not fully understood yet. These airborne particles may present an inhalation hazard when maintaining patterns.

Carbon fiber fill does not eliminate:

- Cold-weather contraction
- Condensation
- Brittle handling
- Seam movement
- Layer splitting
- Adhesive or coating movement
- Furan/phenolic binder compatibility concerns
- The need for stable backing
- The need for acclimation before molding

**Carbon fill improves the material. Climate control improves the process.**

---

## Construction Recommendations for Large Patterns

---

Material choice alone is not enough for repeatable large-pattern work. For large reusable printed patterns, use:

- Stable backing such as sealed plywood, phenolic board, aluminum plate, or a rigid frame
- Mechanical registration using dowels, keys, bolts, or locating features
- Adequate wall thickness and ribbing
- Print orientation planned around ramming and handling loads
- Sealed surfaces, including back side, edges, seams, and fastener penetrations
- Coupon testing with the actual sand, binder, release, primer, coating, and temperature
- Documented inspection temperature and recommended molding temperature range
- Acclimation before molding if the pattern has been stored or transported cold
- Supplemental heaters, heated blankets, insulated storage, or a heated pattern shed during winter use

**Can we help with your application? Please contact us, we're happy to help.**

Walt & Janelle Jaeger  
Jaeger Technology Group